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(54) **COIN SORTERS**

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Description

This invention relates to coin sorters, and concerns in particular sorters that can both sort coins and also distinguish between real and counterfeit coins.

There are many occasions when it is required to sort a mixed lot of coins into their several denominations - for example, a random mixture of British coins into sets of the seven values for 1p, 2p, 5p, 10p, 20p, 50p and £1 coins. And when such a sort is carried out it is important that provision be made for distinguishing not only real coins of the required type one from another but also for differentiating both between these real coins and forgeries - counterfeit versions thereof - and between real coins of the required type (British coins, say) and real coins of some other type (foreign coins, such as French or German coins).

The actual sorting - the physical separation of each denomination from the others - can be accomplished in a variety of ways, and two of the most common involve one or other of what are known as disc sorters and ramp sorters. A disc sorter feeds the coins to the bottom of an inclined rotating disc carrying around its peripheral area a number of holes, or pockets, into which one coin at a time can be fed to be carried along, up and round, by the disc until it reaches some form of measuring station at which it is recognised by some chosen physical parameter (such as its diameter), the coin then being carried further past a set of spaced "ejection stations" each with its corresponding delivery chute leading to a collection box, one for each denomination, being ejected into the correct chute on the basis of its parameter-recognised value. Because of the large number of possible ejection stations and chutes (for British coins there would need to be seven of them), and because the stations need to be well spaced to prevent a coin being ejected erroneously into the wrong chute, the disc itself has to be correspondingly large - and thus the sorter as a whole is bulky and inconvenient.

A ramp sorter is much simpler, but is still bulky. This type of sorter uses an inclined ramp to the top end of which the coins being sorted are fed one at a time, and down which they are persuaded to roll, there being spaced along the ramp, at suitable intervals, deflector elements that knock the coins into appropriately placed delivery chutes and are, one by one, at steadily decreasing heights above the ramp so that each coin rolls along until it is deflected off, the smaller coins rolling further (under the deflectors for the larger coins) until they meet the one deflector matching their diameter.

As so far described, both disc and ramp sorters merely sort, and do not distinguish between proper and improper coins - here and hereinafter the term "proper" is used to mean those real coins in the set the equipment is intended to sort, while the term "improper" is used to mean all other coins whether real (such as foreign coins) or fake (such as counterfeit coins). It is in principle easy to add suitable distinguishing capability, and there is present-day apparatus of each type that has this ability, though at the cost of making the equipment even more bulky. Thus, in a disc sorter there must be added stations adjacent the disc's peripheral area where the nature - the physical parameters - of the coin can be examined more closely, which tends to result in the disc having to be even larger so as to provide room for the stations at a suitable position around the disc (usually at or near its top). Similarly, for a ramp sorter there must be provided a length at its top end where the same sort of physical examination can be carried out before the coins have rolled down far enough to reach the first deflector element, and this naturally results in the ramp having to be considerably longer.

A coin sorter having both a disc and a ramp is already from European Application EP-A-0 209 675. The pocketed feed disc is used to gather the coins and to deliver them to the ramp.

One or more detector stations are positioned along the ramp for measuring one or more of the coin's physical parameters to determine whether the coin is proper or improper, and thus to validate the coin

The ramp is also used to separate the coins into their various size-defined denominations and feed them to an associated set of delivery chutes, and thus to sort the coins.

GB-A-2 198 274 also relates to a coin sorter having both a disc and a ramp, the disc with a series of circumferentially shaped coin receiving apertures being to gather the coins from an associated feed hopper and to deliver them to the ramp via one or more detector station, the detector station(s) being positioned adjacent the disc and around the peripheral area thereof, each coin picked up by the disc being carried thereby past or through each station and the ramp being used for sorting the coins.

So, although the known sorters do work, they tend to be rather bulky (and in fact most weigh several tens of kilograms, and are in use commonly fixed in place, and quite incapable of easily being carried around and moved from place to place). The present invention seeks to overcome this size and weight problem, and indeed to provide a technically rather more effective apparatus, by proposing a sorter which combines the facilities of both a disc and a ramp sorter. More specifically, the invention suggests a coin sorter having both a disc and a ramp, the disc being to gather the coins from an associated feed hopper and to deliver them to the ramp via one or more detector station at which one or more of the coin's physical parameters, at least one such parameter being the coin's size, measured using a linear charge-coupled device (CCD) detector system, is measured to determine whether the coin is proper or improper (and, if proper, very preferably what denomination it is), and the ramp being in effect simply to separate the coins into their various size-defined denominations and feed them to the appropriate delivery chutes.

The invention provides a coin sorter having both a

pocketed feed disc and a sorting ramp,

the disc being to gather the coins from an associated feed hopper and to deliver them to the ramp via one or more detector station at which one or more of the coin's physical parameters is measured, at least one such parameter being the coin's size, measured using a linear CCD detector system onto which is cast the shadow of the coin being validated, the CCD's output being used to determine whether the coin is proper or improper, and thus to validate the coin,

the detector station(s) being positioned adjacent the disc and around the peripheral area thereof, each coin picked up by the disc being carried thereby past or through each station,

and the ramp being to separate the coins into their various size-defined denominations and feed them to an associated set of delivery chutes, and thus to sort the coins.

In alternative language, the coin sorter comprises the combination of:

a coin feed hopper, into which the mixture of coins to be sorted is placed;

a rotary validating ramp-supply disc as defined hereinafter, which is fed with coins by the coin feed hopper and then rotates to remove coins therefrom, these removed coins then being carried around on the disc as it rotates, there being one or more detector station positioned adjacent the disc and around the peripheral area thereof, past or through which station each coin picked up by the disc is carried, at which station one or more of the physical parameters of each such coin is measured, as the coin passes thereby, to determine whether the coin is proper or improper, and thus to validate the coin, at least one such parameter being the coin's size, measured using a linear CCD detector system onto which is cast the shadow of the coin being validated, the CCD's output being used to validate the coin; and

a coin-separator sorting ramp as defined hereinafter, which is supplied with coins by the rotary ramp-feed disc and then causes them to be separated, and thus sorted, into the several predetermined denominations as they roll therealong and are deflected thereoff, there being a corresponding number of delivery chutes positioned adjacent the ramp to receive the deflected coins.

The disc, or rotary validating ramp-supply disc, used in the invention is in essence an inclined disc mounted for rotation around its axis and having in and round its peripheral area a series of spaced apertures, or pockets, for carrying coins. It is associated with a coin feed hopper from which in operation it picks up coins in the pockets and delivers them to the ramp.

The ramp, or coin-separator sorting ramp, is in essence an inclined walled ramp, or rail, having spaced therealong, above the ramp/rail surface, a series of deflector means that cause the coins to drop off the ramp (into appropriately-placed delivery chutes), these deflector means being such that each coin rolls along until it is deflected off only when it arrives at the deflector means that matches its size. Although the deflector means can be apertures in the wall, through which the coins can fall (the apertures are in order of increasing coin size; the small coins fall through before the large coins), in fact it is very much preferred to employ deflector elements positioned above the ramp and projecting out from the wall to knock the coins away from the wall and off the ramp, the heights getting progressively less so that the smaller coins roll further (under the deflectors for the larger coins) until they meet the one deflector matching their diameter.

The coin sorter of the invention has a feed/validation disc that gathers the coins from a feed hopper and delivers them to a sorting ramp via one or more "proper/improper" validating detector station, the ramp then separating the coins into their various size-defined denominations. This division of effort between the disc and the ramp - the disc validating and the ramp sorting - enables the disc to be very considerably smaller and simpler than those present-day discs which sort as well as validate, and also enables the ramp to be considerably smaller and simpler than those present-day ramps that validate as well as sort. As a result, a sorter constructed from a combination of such a disc and ramp is itself considerably smaller and simpler than the present-day versions of either disc or ramp validating sorter.

The sorter of the invention utilises a coin feed hopper, into which the mixture of coins to be sorted is placed. The hopper may be of any convenient form - typically like a small scoop into which the coin mixture may be poured - and apart from observing that it should feed the coins to the bottom of the validating disc (at around the 6 o'clock position), so that they can be picked up by the pockets along the bottom edge and then taken up and away as the disc rotates, there is little to say about it.

In the sorter of the invention there is used a disc - a rotary validating ramp-supply disc - to which the coins to be sorted are fed from the coin feed hopper. This disc is as defined hereinbefore - that is, it is an inclined disc mounted for rotation around its axis and having in and round its peripheral area a series of spaced apertures, or pockets, for carrying coins.

Apart from the absence of sorting apparatus, and its size, the disc is very similar to those presently used in disc sorters.

As in present-day disc systems, the validating disc, driven around by any appropriate arrangement (usually a small electric motor suitably geared thereto), is mounted on some appropriate backplate, and is inclined at a

steepish angle to the horizontal so that coins from the hopper will fall into the pockets under gravity, and will stay in the pockets as the disc rotates until they reach an exit port (advantageously simply an aperture in the backing plate) through which they can fall onto the top of the sorting ramp. An angle of from 50° to 70°, especially about 60°, to the horizontal is most desirable.

The disc may of course be of any suitable size (diameter) provided naturally that it remains "small". A convenient diameter is around 12in (30cm), but discs of from 8 to 16in (20 to 41cm) would be acceptable.

The disc rotates to bring each pocket successively into line with the hopper, with the validation station, and finally with the sorting ramp top (and the exit port thereto). The speed of rotation depends on a number of factors, such as the efficiency of coin pick-up (which is ideally 100%, but which in practice is more like 80% to 95%) and the ability of the disc to pick up only single coins *per* pocket (rather than a whole mass of coins wedged into place). Desirably it is from 25 to 35, especially 29 or 30, revolutions *per* minute.

The apertures, or pockets, are in and round the validating disc's peripheral area. In other words, they are apertures actually, and very preferably wholly (ie, closed), in the disc body, but adjacent - close to - the edge of the disc. Conveniently they are in fact within a few tenths of an inch (or a few millimetres) of that disc's edge - say, from 0.2 to 0.5in (5 to 13mm).

The pockets are sufficiently spaced around the disc that at the speed of rotation the coins reach the validating station at a rate the validation system can handle, and equally that thereafter they reach the sorting ramp's top at such a rate that as they then progress down the ramp under gravity they maintain a spacing sufficient for the sorting to take place without one coin interfering with the next (and generally, it is most convenient if the pockets are equispaced one from the next). The actual spacing will of course depend on the size of the disc, the size (and shape) of the pockets, and the number of pockets, as well as on the rotary speed. Nevertheless, a typical spacing is such that there is from 1.4 to 2.4in (3.5 to 6cm) between the centres of adjacent pockets.

The pockets can have any suitable size and shape, provided that in the end they can pick up all the coins in the set to be sorted - that all those sizes and shapes of coins will fit into each pocket - and also (and this is an important proviso) that no pocket is more than twice as big as the smallest coin in the set (if it were, then two coins could fit side-by-side in the pocket, and might be picked up with the inevitable result of confusing the system). Basically, then, it is merely necessary that each pocket be at least as large as the largest coin that could possibly be sorted, but not as large as twice the size of the smallest; if, at some later date, a new, bigger coin is minted to go with some particular set to be sorted, then it will be necessary to change the disc for one with suitably bigger pockets. A typical pocket size is from 1 to 1.25in (about 2.5 to 3.2cm): by way of comparison, the largest present British coin, the 50p piece, is 1.18in (3.0cm) in diameter, while the smallest, the 5p piece, is 0.67in (1.7cm), which is more than half the size of the largest.

Although in principle each pocket - and they will most preferably all be the same - is most advantageously perfectly circular, it is possible, and may sometimes be desirable, to provide each pocket with a V-shape on its inside edge (that is, on the part nearest to the inside of the disc). The reason for this is that such a V-shape has the effect of "amplifying" diameter differences of differently-sized coins fitting thereinto, and this may provide much-needed enhancement of the size-detecting capability of the equipment at the validation station.

The coins sorted by the sorter of the invention are delivered to the sorting ramp via one or more disc-adjacent detector station at which one or more of the coin's physical parameters is measured to determine whether the coin is proper or improper, and thus to validate the coin. Preferably, there is one station at which each coin's size - diameter - is measured, this giving (for a proper coin) an indication of the coin's denomination. The or each station is conveniently arranged at or along the top edge of the disc - say, somewhere between the 10 o'clock and 12 o'clock positions.

At each detector station one of the coin's physical parameters is measured (it would be possible to measure two or more at a single station, but generally it is preferred to measure several parameters using several stations each looking at one parameter). The result is to be used to decide whether the coin is proper - a real coin in the set of coins being sorted - or improper - either a fake coin or some coin not in the set under consideration. The two main parameters presently thought most useful for this decision are those of magnetic properties and of size (diameter).

As regards magnetic properties, it will be appreciated that all coins are metal, and have some magnetic effect - ranging from being ferromagnetic (like iron and steel) through weakly magnetic (like cobalt and nickel) and non-magnetic or diamagnetic (that is, "oppositely" magnetic), like aluminium or magnesium. For any substance, such as the material of a coin, an indication of its magnetic properties can be obtained by applying to an object made from it a magnetic field, and then measuring the effect - the degree of magnetisation of the object. By then comparing the result with a set of results for known substances there may be deduced, with some certainty, the nature of the substance from which the object is formed. Thus, in the present invention there may be prepared in advance a set of results related to the substances from which the proper coins are made, and the actual results for any tested coin may be compared with these to see if it is, at least in terms of the material from which it is made, a proper one. And of course any coins that do not match are then rejected.

The general idea of measuring the magnetic nature of an object, and then of using the result to accept or

reject the object for some purpose, is well-known, and needs no further comment here. Nevertheless, in connection with the application of this method to the coin sorter of the invention it might be useful to say that the process involves generating a regularly varying (sine wave) magnetic field adjacent the test object, looking at the resultant field induced into the test object, and by measuring the phase difference between the two, which difference is dependent on (amongst other things) the actual material of which the object is made, and comparing the result with a set of stored values relating to known materials, determining which (if any) of the known materials the test object is made of. A more detailed discussion of this method as actually used in the invention is given hereinafter with reference to the accompanying Drawings.

The magnetic effect measurement method just described can also be employed to provide an indication of the test object's - the coin's - thickness, for the phase difference observed is characteristic not only of the object's material but also of its dimensions and its distance from the field inductor. Thus if, say, two inductor/detector combinations are placed one on each side of the coin the phase comparison information received from each can be manipulated to give a direct assessment of the coin's thickness. This, of course, can be used - compared against a set of thicknesses for permissible, proper, coins - as another check on the validity of the coin.

Of course, while matching magnetic (and thickness) characteristics will successfully enable many improper coins to be rejected, this is not the end of it, for it could well be that a "coin" being tested is made of one of the right substances but nevertheless is not a proper coin because it is the wrong size (like a "50p coin" made from the bronze alloy used for 1p coins). Accordingly, as has been observed at least one validating station measures the size of the coin, and this result, too, be compared with a set of permitted sizes (and possible size variation ranges) for the coin set being sorted, so that any non-matching coin is rejected at this stage.

It is perhaps worth noting that in the majority of cases a mixture of coins can be successfully validated and sorted on size alone, and it is not necessary to check some other parameter (such as the magnetic properties). This is especially true for coins collected in a country that is not surrounded by other countries, so that there is only a low probability of "foreign" coins turning up. However, there are some very common same-size coin pairs that are regrettably used to cheat machinery, such as the British 10p piece and the German 1 Mark (which are almost identical in size, but significantly different in value, and can easily fool simple devices like parking meters), where the only satisfactory way to distinguish one from the other is by a magnetism parameter check.

The general idea of measuring the size of an object, and then of using the result to accept or reject the object for some purpose, is well-known, and needs no further comment here. Indeed, most of the present-day coin sorters make this type of test, a typical arrangement using a fibre optic measuring system in which a shadow of the coin is caused to fall on a closely-spaced linear array of optical fibre ends, and once the pocket/coin is correctly registered with the array (and the disc will conveniently carry registration means, such as cut-outs on its very edge, that permit a registration light to fall on a sensor and so trigger measurement) the light travelling along the fibres is utilised to trigger a "go/no go" recognition system depending on how many of the fibres are still carrying light (which depends on how big the coin and its shadow are). Nevertheless, in connection with the application of this method to the coin sorter of the invention it might be useful to say that while it would be possible to employ the same sort of fibre optic measuring system presently used in the Art this is not effected, for not only is the available resolution of such fibre devices low (so they cannot accurately determine the coin's size) but they are extremely fragile, and simply moving the equipment can cause the fibres to break and the sorter to malfunction. Instead, in the present invention there is employed a linear charge coupled device (CCD) detector, which can be both high resolution (and thus accurate) and resilient, and yet also cheap. Such a device - typified by that sold by Sony under the designation ILX503 - can have a pixel spacing as small as about 10microns (the Sony device's spacing is either 7 or 14microns), and a commensurately high resolution. It can be used accurately to determine a coin's diameter (allowing it to be matched within predefined upper and lower limits) even when - as is preferred - to avoid possible jamming effects the pocket holding the coin is perfectly round (and without the measurement-enhancing V-shape as discussed above).

Although for the most part each coin will sit firmly in the bottom of the disc pocket in which it was picked up out of the feed hopper, it is possible that, because of some physical defect the coin may jam in the pocket above the bottom, with its upper edge higher than it should be, and thus looking like a much larger coin. Accordingly, it is much preferred if, at the validating station measuring each coin's size, the measuring equipment look for whether the coin is properly seated in the pocket. With the required CCD detector system this can be achieved by inspecting the output of the detector both on the top side (giving the apparent size of the coin) and on the bottom side (any output here indicates that the coin is not fully shadowing the detector because it is not properly seated), and either some due allowance can be made in the comparison process or the coin can simply be rejected, and tried again later.

The CCD detector specified for use in the invention is employed primarily to provide a measure of each coin's diameter, and for this purpose it is best positioned and aligned with the actual diameter of the pocket at the moment when the pocket is exactly vertically above the disc's rotational centre (at which moment the coin in the

pocket will in theory be perfectly symmetrically disposed in the pocket with its own diameter congruent with the pocket's). The disc has registration cutouts (as mentioned above) to signal to the CCD measuring system that the coin is in that correct position. Of course, other size measurements can also be taken (either by other CCD-type detector arrays or - and preferably - by the same, diameter-measuring, one). For example, if the same CCD detector array is triggered to look at the pocket-borne coin slightly before or after the "vertical", diameter-measuring, position, then it will see (and "measure") a non-diametrical chord of the coin, and this measurement too can be utilised, by a comparison with known, permissible chord values, as a further check in deciding whether the coin is proper or improper.

Each parameter measured by the relevant validating station is compared with acceptable values for each such parameter as previously determined for the proper coins in the set being sorted, and the thus-sorted coin is rejected or not on the basis of whether its parameter matches or not. Though of course there are other ways of effecting the comparison, it very much preferred to carry it out using a mixture of computer hardware and software, a suitable microprocessor chip having been programmed, and provided with the correct data, to enable it to check each observed parameter against a store of the permissible values for that parameter, and then initiating ejection, or nor, as appropriate. This sort of thing is nowadays relatively easy to arrange, and it has a particularly useful bonus in that the computer system can be programmed so that the sorter carries out other tasks in addition. For example, the system may count the various coins of each type that it allows to pass to the sorter ramp, to work out the total value of each type of coin so passed, and even to prevent any more coins of a chosen denomination passing, even though they are proper coins, once some predetermined number/value of those coins has been accepted (so that the sorter can be set to deliver fixed numbers/values of coins of any denomination, perhaps for insertion into tills or bank coinage envelopes, no matter that there are many more of those coins awaiting sorting in the feed hopper).

One especial advantage of using a computer hardware/software solution for the parameter checking is that the system can be programmed to have a learning mode in which known coins can be inserted into the sorter and the system caused to store the obtained parameter values for future use when checking "unknown" coins.

When a coin has been determined to be an improper coin (or the appropriate collection box is "full") it may be prevented from reaching the sorting ramp (*via* the exit port in the disc backing plate) by the simple expedient of mechanically ejecting it from its pocket. This is typically done by an appropriately synchronised solenoid-operated piston that projects through the backing plate into the pocket, thrusting the coin out, on receipt of a suitable activating signal from the validating system. Of course, the ejection means needs be located before the exit port to the ramp; putting it at around 12.30 o'clock is generally satisfactory if the port is at 1.30.

Coins that are rejected by the validating disc used in the invention can, of course, be removed wholly from the sorter. However, that may not be desirable, for no matter how good the system is there will, for one reason or another, always be a significant chance of rejecting perfectly good, proper, coins (perhaps because the coin failed to seat properly in the pocket, or because it was dirty, or even because it was slightly deformed). Accordingly, rather than remove the "improper" coins altogether from the system, it is preferred simply to send them back into the hopper for a re-run through the validating disc when they are next picked up. Of course, eventually the only coins left will indeed be improper coins - the system could be set to determine this automatically, by noting that some predetermined, statistically-significant number of rejects had occurred in sequence - whereupon the sort is complete and the remaining "coins" can be disposed of. And whereas this disposal could be by hand, the operator reaching into the the hopper and removing them, it would be preferable for the sorter then to enter a "purge" cycle mode in which the coins are sent into a special "improper coin" collection box - and one way to achieve this is to have that box chute-connected to a second exit port from the disc below and after the first (the one supplying the sorting ramp), which no coins can ever reach when the validating disc is rotating normally but which all coins will reach if the disc's direction of rotation is reversed. Then, when the only coins left are improper ones, the purge cycle is begun by reversing the disc's rotation, and all those coins are lifted up to the second exit port and from there sent out to the collection box.

In the sorter of the invention there is used a ramp - a coin-separator sorting ramp - to the top of which the coins to be sorted are supplied by the validating disc. The sorting ramp is as defined hereinbefore - that is, it is an inclined ramp, or rail, having spaced therealong, above the ramp/rail surface, a series of deflector means that cause the coins to drop off the ramp, these deflector means being such that each coin rolls along until it is deflected off only when it arrives at the deflector means that matches its size. As noted above, the deflector means are very preferably deflector elements positioned above the ramp and projecting out from the wall to knock the coins away from the wall and off the ramp, the heights getting progressively less so that the smaller coins roll further (under the deflectors for the larger coins) until they meet the one deflector matching their diameter.

Apart from the absence of validating equipment at the top of the ramp, and thus its size, the ramp used in the invention is very similar to those in present-day ramp sorters.

The ramp is in essence an inclined surface, like a

track or rail, down which the coins roll under gravity. The angle of inclination can be any convenient such that the coins roll rather than stick, but roll slowly enough for the deflector elements to be able to direct them off the ramp into the correct delivery chutes. An angle of from 18° to 30°, especially about 20°, seems most suitable for this purpose.

Spaced along the ramp, above the ramp/rail surface, is a series of deflector elements that are successively at decreasing heights above the ramp so that each coin rolls along (the smaller coins rolling further, under the deflectors for the iarger coins), until it meets the one deflector matching its diameter. These deflectors, which are adjustable in height above the ramp so that they can be positioned, and re-positioned, for different sets of coins with different coin sizes, are little more than physical barriers, suitably spaced along the ramp, that both stop the appropriate coins progressing further and urge the coins off the ramp into the relevant delivery chute, and apart from observing that their number and spacing should be sufficient for the coins to be correctly and cleanly knocked off the ramp without interference, there is little to say about them.

In the sorter of the invention the coins roll along the sorting ramp and are deflected thereoff into the appropriate one of a corresponding number of delivery chutes positioned adjacent the ramp to receive the deflected coins (and deliver them into storage boxes). This part of the sorter is much like that of the present-day sorters, and there is little to say about it other than to observe that while there should of course be a chute for each coin to be sorted there can be more chutes not all of which need be used.

Although, as noted above, the ramp used in the sorter of the invention has no coin validating equipment at its top, it may nevertheless have or be associated with a sensor device that notes when a coin has been delivered thereto by the disc ramp feeder. Linked to and synchronised with the disc validating equipment, this sensor can check on the accuracy of the disc system by monitoring the (number of) coins actually received by the ramp and comparing this with the (number of) coins supposedly fed thereto by the disc, so that any coins that, by some mechanical error, fall off the disc (or erroneously get rejected, or not rejected, by the ejection mechanism) are either discounted or allowed for (by setting an error flag, perhaps), as appropriate.

An embodiment of the invention is now described, though by way of illustration only, with reference to the accompanying diagrammatic Drawings in which:

Figure 1 shows a perspective view from above and one side of a coin sorter of the invention;

Figures 2A-C show respectively the front view, a side view, and a sectional view (from the other side) of the sorter of Figure 1;

Figure 3 shows a block schematic for the control of the coin sorter of Figure 1;

Figure 4 shows waveforms and a block schematic for the alloy sensing system used in the coin sorter of Figure 1; and

Figure 5 shows a flow diagram for the eject mechanism logic of the coin sorter of Figure 1.

The sorter of Figures 1 and 2 comprises essentially a coin sorter (generally 10) having both a disc (11) and a ramp (12). The disc 11 bears pockets (as 13) into which it gathers coins (as 14) from an associated feed hopper (15) and, driven round by an electric motor (103 in Figure 2B), delivers them to the ramp 12 *via* one or more detector station (16,17) at which one or more of the coin's physical parameters is measured, at a moment in time determined with reference to the exact position of the disc as indicated by the signals output by a light source (111) and sensor (112) interacting *via* timing notches (as 113) in the rim of the disc, to determine whether the coin is proper or improper, and thus to validate the coin. The ramp 12 then separates the coins into their various size-defined denominations and feeds them to an associated set of delivery chutes (as 18).

All the mechanical components are mounted upon an angled recessed backplane (generally 100: this is here shown as a surface of a box-like container 101 into which are mounted various logic systems and so on). The degree of the surface's rearward angle is exaggerated for effect (in reality it is little more than 5°), and the surface has a front cover (102) over part of it, so that the components mounted thereon are partially enclosed.

The coin feed hopper 15, into which the mixture of coins to be sorted is placed, is a half funnel-like object mounted over the lower half of the disc 11 and with a narrow wider-diameter feed portion (19: see Figure 2B) around its base adjacent the disc so that coins 14 resting in the bottom of the hopper 15 tip over the edge into this narrow portion where they are of necessity aligned so as more easily to enter the pockets 13 (Figure 2A shows a variety of coins 14 positioned in the pockets 13).

The pockets 13 in the disc 11 are very slightly elongated (V-shaped, or "oval"), with the narrower end pointing radially inwards. This increases the sensitivity of the coin-size measuring apparatus (discussed below). In operation, the disc 11 rotates (clockwise as viewed), and as it is fed with coins 14 by the hopper 15, and these coins enter into the pockets 13, so it removes the coins from the hopper, carrying them around on the disc as it rotates through each of a number of detector stations 16,17 positioned adjacent the disc and around its periphery. In this embodiment the equipment at the first

station 16 looks at each coin's diameter, while that at the second 17 checks its magnetic properties with a ferrite core inductor (17a). The output from the stations' equipment is then used to determine whether the coin is proper or improper, and thus to validate the coin (this is discussed further hereinafter). The diameter-measuring equipment includes a light source (16s) mounted in front (as viewed) of the disc 11 and one or both of two linear charge coupled light detector devices (161d, 162d) mounted behind the disc, one disposed vertically and the other horizontally (as viewed). The vertical CCD 161d provides a measure of the true diameter of the coin; the horizontal one 162d provides a measure of a chord (the amount of light passing *under* the coin because of the slightly oval shape of the pocket 13 can be used to confirm the former). This size information can be compared with a series of acceptable sizes to determine whether the coin is valid - in the sense of being of an "allowable" size - or not.

The station 17 at which each coin's magnetic properties are investigated is next door (clockwise) to the diameter-measuring station 16. At this station 17 is a ferrite core inductor 17a that both causes and detects magnetic field pulses. As described in more detail hereinafter, a sine wave electric signal is applied to the inductor to induce a similarly-shaped magnetic pulse in the coin, and then there is picked up the electric field pulse formed by the currents generated within the coin. This will be out of phase with the originally-supplied sine wave electric signal by an amount representative of the material from which the coin is made, and by comparing the actual phase change against a series of acceptable phase changes it can be determined whether the coin is valid - in the sense of being made of an "allowable" material - or not.

Once both the coin's size and the coin's material has been tested/determined, a suitable logic system can make a programmed decision as to whether or not the coin is a valid one. If the size is an allowable size, and the material is an allowable material, then most likely the coin is valid. If, on the other hand, either - or both - of the coin's size and material is not allowable, then the coin is likely to be an invalid one (either a fake or some real coin that does not fall within the ambit of the series being sorted, such as a foreign coin). Accordingly, as the disc rotates (clockwise) further, the coin is brought into a "reject" station, at which it is aligned with a solenoid-operated eject piston (20) mounted behind the disc. If the logic system has determined that the coin is false - invalid - then the eject piston is operated, and the coin is pushed out of the pocket and falls back into the hopper (so that it can be re-tested later; it is not unknown for a valid coin to get rejected by mistake, particularly if it is physically deformed [as it might be by heavy use] so it is desirable to give all the coins at least a second chance). If, however, it has been determined that the coin is valid, then it is allowed to pass on to the sorting ramp 12.

The coin-separator sorting ramp 12 takes the coins 14 supplied to it by the rotary ramp-feed disc 11 and then causes them to be separated, and thus sorted, into the several predetermined denominations as they roll therealong and are deflected thereoff into one or other of a corresponding number of delivery chutes 18 positioned adjacent the ramp. First, each coin rolling down the ramp passes a counter (21) near the start of the ramp (and thus shortly after the coins fall through the pocket 13); the purpose of this is to provide some indication if coins erroneously fall off the ramp before they can be sorted (the logic system maintains a count, so if the logic count differs from the counter's count something odd must have happened).

Next, the coins roll down the ramp "under" a series of height-adjustable finger-like deflector means (as 22) each having a body portion (as 22b) and a "nail" portion (as 22n). These deflector means 22 are adjustably mounted by means of slots and screws (as 23,24), and the height of each is adjusted such that each coin rolls along until it is deflected off only when it arrives opposite the chute 18 for coins of its type, where it meets the deflector means that matches its size and is knocked off the ramp by the "nail" 22n. To ensure proper sorting, the deflector means are at heights that get progressively less so that the smaller coins roll further (under the deflectors for the larger coins) until they meet the one deflector matching their diameter.

There are at least as many deflectors 22 and associated chutes 18 as there are valid coin sizes (in the embodiment shown there is in fact one more chute, as is explained hereinafter), and at the bottom of each chute is a receptacle (as 24) - here shown as a simple sliding drawer - in which the sorted coins are collected.

In operation the sorter of the invention keeps feeding the coins 14 in its hopper 15 to the disc 11 - and then perhaps to the ramp 12 - until either there are no more coins in the hopper or all the coins therein are invalid (which latter can be judged on a statistical basis: if all the coins in a long sequence of coins are rejected, then the chances are high that all the remaining coins are invalid). At that point it can be arranged for the sorter of the illustrated embodiment to direct all these invalid coins into a storage container - the appropriate one of the receptacles 24 - by reversing the direction of rotation of the disc 11, making it go anti-clockwise, each invalid coin being picked up in a pocket and delivered not to the main ramp 12 but to a secondary ramp (25) disposed under the main one, which secondary ramp 25 leads directly to the invalid coins receptacle 24 at the end of the set (in this embodiment this receptacle is shown at the further end, but it could equally be at the nearer end).

Figure 3 shows a block schematic for the control of the coin sorter of Figure 1, Figure 4 shows waveforms and a block schematic for the alloy sensing system used in the coin sorter of Figure 1, and Figure 5 shows a flow diagram for the eject mechanism logic of the coin sorter of Figure 1.

The Figure 3 schematic shows that the control system is, as with most modern devices, built around a microprocessor. This provides means for performing the several arithmetical operations required on the data accumulated from the several sensor apparatus, and particularly from the disc position reference arrangement of light 111, sensor 112 and notches 113 (see Figures 1 and 2), which furnishes the synchronising signal that indicates when all other measurements should be made.

The Figure also shows the presence of a number of other components that may be employed as part of the sorter of the invention, namely a keyboard etc allowing the microprocessor to be programmed *in situ,* a printer to which may be output the sorter's findings, and links to a note counter and other computing devices (both personal and mainframe).

In Figure 4 are shown details of the phase comparison system used for "dud" coin detection. A master sine wave is generated using a precision sine wave generator, and applied *via* an amplifier to an open ferrite core inductor positioned adjacent the pocketed coin. The focused and rapidly-changing magnetic field is monitored by the phase comparator the output of which is used to control a stream of pulses generated by a 40MHz clock. The accumulated count gives a direct relationship between the material - the alloy - of which the coin is made (and the physical distance from the ferrite core to the coin); it is latched and read into the microprocessor, and there used to assess, by a comparison with previously-derived values for known valid coins, the validity of the coin under test.

Finally, a simple high level flow diagram for the logic operations to decide whether any particular coin is valid or not is shown in Figure 5. Once timing synchronisation is achieved, and a coin is known to be in the identified pocket (from the output of the first sensor station), the size measurement taken is checked, by comparison with stored allowable values, and if valid the magnetic properties value is checked, again by comparison with stored allowable values. If either size or properties (or both) is invalid then the coin is automatically ejected as it arrives at the reject station, whereas if both are valid it is permitted to pass to the position where it falls through the pocket onto the sorting ramp.

Claims

1. A coin sorter (10) having both a pocketed feed disc (11) and a sorting ramp (12),

   the disc (11) being to gather the coins (14) from an associated feed hopper (15) and to deliver them to the ramp (12) *via* one or more detector station (16,17) at which one or more of the coin's physical parameters is measured, at least one such parameter being the coin's size, measured using a linear CCD detector system (161d,162d) onto which is cast the shadow of the coin being validated, the CCD's output being used to determine whether the coin is proper or improper, and thus to validate the coin,
   the detector station(s) (16,17) being positioned adjacent the disc (11) and around the peripheral area thereof, each coin (14) picked up by the disc being carried thereby past or through each station,
   and the ramp (12) being to separate the coins (14) into their various size-defined denominations and feed them to an associated set of delivery chutes (18), and thus to sort the coins.

2. A coin sorter as claimed in Claim 1, which comprises the combination of:

   a coin feed hopper (15), into which the mixture of coins (14) to be sorted is placed;
   a rotary validating ramp-supply disc (11) as defined hereinafter, which is fed with coins (14) by the coin feed hopper (15) and then rotates to remove coins therefrom, these removed coins then being carried around on the disc (11) as it rotates, there being one or more detector station (16,17) positioned adjacent the disc and around the peripheral area thereof, past or through which station each coin picked up by the disc is carried, at which station one or more of the physical parameters of each such coin is measured, as the coin passes thereby, to determine whether the coin is proper or improper, and thus to validate the coin, at least one such parameter being the coin's size, measured using a linear CCD detector system (161d,162d) onto which is cast the shadow of the coin being validated, the CCD's output being used to validate the coin; and
   a coin-separator sorting ramp (12) as defined hereinafter, which is supplied with coins (14) by the rotary ramp-feed disc (11) and then causes them to be separated, and thus sorted, into the several predetermined denominations as they roll therealong and are deflected thereoff, there being a corresponding number of delivery chutes (18) positioned adjacent the ramp to receive the deflected coins.

3. A sorter as claimed in either of the preceding Claims, wherein the hopper (15) is a scoop (19) into which the coin mixture may be poured, which scoop feeds the coins to the bottom of the disc (11) so that they can be picked up by the pockets (13) along the disc's bottom edge.

4. A sorter as claimed in any of the preceding Claims, wherein each pocket (13) has a V-shape on its outside edge.

5. A sorter as claimed in any of the preceding Claims, wherein, with a clockwise turning disc (11), the or each detector station (16,17) is arranged at or along the top edge of the disc, somewhere between the 10 o'clock and 12 o'clock positions.

6. A sorter as claimed in any of the preceding Claims, wherein at one detector station (16) each coin's diameter is measured, while at another station (17) each coin's magnetic properties are tested.

7. A sorter as claimed in any of the preceding Claims, wherein, to determine whether the coin (14) is properly seated in the pocket (13), there is inspected the output of the detector (16) both on the top side and on the bottom side.

8. A sorter as claimed in any of the preceding Claims, wherein a CCD detector (162d) is also employed to measure a non-diametrical chord of the coin (14).

9. A sorter as claimed in any of Claims 6 to 8, wherein to determine each coin's magnetic nature there is generated a regularly varying (sine wave) magnetic field adjacent the test object, the resultant field induced into the coin (14) is examined, and the phase difference between the two is used to indicate the coin's magnetic nature, and thus the material of which the coin is made.

10. A sorter as claimed in any of the preceding Claims, wherein each parameter measured by the relevant validating station (16,17) is compared with acceptable values for each such parameter as previously determined for the proper coins (14) in the set being sorted, the thus-sorted coin being rejected or not on the basis of whether its parameter matches or not, and this comparison is effected using a mixture of computer hardware and software.

11. A sorter as claimed in Claim 10, wherein the computer hardware/software system is programmed to have a learning mode in which known coins (14) can be inserted into the sorter and the system caused to store the obtained parameter values for future use when checking "unknown" coins.

12. A sorter as claimed in any of the preceding Claims, wherein, to prevent a coin (14) reaching the sorting ramp (12) *via* an exit port in the disc backing plate (100), it is mechanically ejected from its pocket using an appropriately-synchronised solenoid-operated piston (20) that is caused to project through the backing plate into the pocket, thrusting the coin out, on receipt of a suitable activating signal from the validating system.

13. A sorter as claimed in any of the preceding Claims, wherein coins (14) that are rejected are initially sent back into the hopper (15) for a re-run through the disc (11) when they are next picked up, but when the only coins left are improper coins the sorter then enters a "purge" cycle mode in which the coins are sent into a special "improper coin" collection box (24), and that improper-coin box is chute-connected (25) to a second exit port from the disc below and after that port supplying the sorting ramp (12), which second port no coins can ever reach when the disc is rotating normally but which all coins will reach if the disc's direction of rotation is reversed, and the purge cycle is begun by reversing the disc's rotation.

14. A sorter as claimed in any of the preceding Claims, wherein the sorting ramp (12) has or is associated with a sensor device (21) that notes when a coin (14) has been delivered thereto by the disc ramp feeder (11).

Patentansprüche

1. Münzsortiervorrichtung (10) mit einer mit Taschen versehenen Zustellscheibe (11) und einer Sortierrampe (12),

wobei die Scheibe (11) die Münzen (14) von einem zugehörigen Zuführungstrichter (15) sammelt und sie der Rampe (12) über eine oder mehrere Detektorstationen (16, 17) zuführt, bei denen ein oder mehrere physikalische Parameter der Münze gemessen wird/werden, wobei wenigstens ein solcher Parameter die Größe der Münze ist, die mit einem linearen CCD-Detektorsystem (161d, 162d) gemessen wird, auf das der Schatten der überprüften Münze fällt, wobei der CCD-Ausgang benutzt wird, um zu ermitteln, ob die Münze echt oder unecht ist, und um sie somit zu überprüfen,
wobei die Detektorstation(en) (16, 17) neben der Scheibe (11) und um deren Umfangsbereich positioniert ist/sind, wobei jede Münze (14) dadurch aufgenommen wird, daß die Scheibe an ihr vorbei oder durch die einzelnen Stationen transportiert wird,
und wobei die Rampe (12) die Münzen (14) nach ihren verschiedenen größendefinierten Werten trennt und sie einem zugehörigen Satz von Zuführrutschen (18) zuführt, um so die Münzen zu sortieren.

2. Münzensortiervorrichtung nach Anspruch 1, umfassend die folgende Kombination:

einen Münzzuführungstrichter (15), in den das Gemisch von zu sortierenden Münzen (14) ge-

legt wird;
eine rotierende Überprüfungs-Rampenzuführungsscheibe (11) wie nachfolgend definiert, die über den Münzzuführungstrichter (15) mit Münzen (14) gespeist wird und dann rotiert, um Münzen daraus zu entfernen, wobei diese entfernten Münzen dann während der Rotation der Scheibe (11) um diese herum transportiert werden, wobei sich neben der Scheibe und um deren Umfangsbereich ein oder mehrere Detektorstationen (16, 17) befinden, an der/denen vorbei oder durch die jede von der Scheibe aufgenommene Münze transportiert wird, wobei an dieser Station ein oder mehrere der physikalischen Parameter jeder dieser Münzen bei deren Passieren gemessen wird, um zu ermitteln, ob die Münze echt oder unecht ist und um auf diese Weise die Münze zu überprüfen, wobei wenigstens ein solcher Parameter die Größe der Münze ist, die mit einem linearen CCD-Detektorsystem (161d, 162d) gemessen wird, auf das der Schatten der überprüften Münze fällt, wobei der CCD-Ausgang zum Überprüfen der Münze benutzt wird, und
eine Münztrenn-Sortierrampe (12) wie nachfolgend definiert, die über die rotierende Rampenzuführscheibe (11) mit Münzen (14) gespeist wird und deren nachfolgende Trennung und somit Sortierung in mehrere vorbestimmte Werte bewirkt, wenn sie darüberrollen und von ihr abgelenkt werden, wobei eine entsprechende Anzahl von Zuführrutschen (18) neben der Rampe positioniert sind, um die abgelenkten Münzen aufzunehmen.

3. Sortiervorrichtung nach einem der vorhergehenden Ansprüche, wobei der Trichter (15) eine Schöpfkelle (19) ist, in die das Münzengemisch geschüttet werden kann, wobei diese Schöpfkelle die Münzen zum Boden der Scheibe (11) transportiert, so daß sie von den Taschen (13) entlang der Unterkante der Scheibe aufgenommen werden können.

4. Sortiervorrichtung nach einem der vorhergehenden Ansprüche, wobei die Tasche (13) an ihrem Außenrand V-förmig ist.

5. Sortiervorrichtung nach einem der vorhergehenden Ansprüche, wobei bei einer im Uhrzeigersinn drehenden Scheibe (11) die bzw. alle Detektorstation (en) (16, 17) am oder entlang des oberen Rand(es) der Scheibe etwa zwischen der 10-Uhr-Position und der 12-Uhr-Position angeordnet ist/sind.

6. Sortiervorrichtung nach einem der vorhergehenden Ansprüche, bei der an einer Detektorstation (16) der Durchmesser jeder Münze gemessen wird, während an einer anderen Station (17) die magnetischen Eigenschaften aller Münzen geprüft werden.

7. Sortiervorrichtung nach einem der vorhergehenden Ansprüche, bei der zur Ermittlung, ob die Münze (14) richtig in der Tasche (13) sitzt, der Ausgang des Detektors (16) an der Oberseite und an der Unterseite inspiziert wird.

8. Sortiervorrichtung nach einem der vorhergehenden Ansprüche, wobei auch ein CCD-Detektor (162d) benutzt wird, um eine nicht-diametrische Kreissehne der Münze (14) zu messen.

9. Sortiervorrichtung nach einem der Ansprüche 6 bis 8, bei der zur Ermittlung der magnetischen Natur jeder Münze ein regelmäßig variierendes (sinuswellenförmiges) magnetisches Feld neben dem Testobjekt generiert, das resultierende, in die Münze (14) induzierte Feld untersucht und die Phasendifferenz zwischen den beiden benutzt wird, um die magnetische Natur der Münze und somit das Material anzuzeigen, aus dem die Münze besteht.

10. Sortiervorrichtung nach einem der vorhergehenden Ansprüche, bei der jeder in den entsprechenden Überprüfungsstationen (16, 17) gemessene Parameter mit akzeptablen Werten für jeden dieser Parameter gemäß vorheriger Bestimmung für die echten Münzen (14) in dem sortierten Satz verglichen wird, wobei die auf diese Weise sortierten Münzen auf der Basis abgelehnt werden oder nicht, ob ihre Parameter übereinstimmen oder nicht, und dieser Vergleich erfolgt mit Hilfe einer Mischung aus Computer-Hardware und -Software.

11. Sortiervorrichtung nach Anspruch 10, bei der das System aus Computer-Hardware/-Software so programmiert ist, daß es einen Lernmodus hat, in dem bekannte Münzen (14) in die Sortiervorrichtung eingegeben werden können und das System veranlaßt werden kann, die erhaltenen Parameterwerte für die zukünftige Verwendung zu speichern, wenn "unbekannte" Münzen überprüft werden.

12. Sortiervorrichtung nach einem der vorhergehenden Ansprüche, bei der zum Verhindern, daß eine Münze (14) die Sortierrampe (12) über eine Ausgangsöffnung in der Scheibenrückwand (100) erreicht, diese von einem entsprechend synchronisierten, magnetspulenbetriebenen Kolben (20) mechanisch aus ihrer Tasche ausgestoßen wird, der durch die Rückwand in die Tasche vorstößt, um die Münze nach Empfang eines geeigneten Aktivierungssignals von dem Überprüfungssystem auszustoßen.

13. Sortiervorrichtung nach einem der vorhergehenden Ansprüche, bei der abgelehnte Münzen (14) zu-

nächst für einen erneuten Durchlauf durch die Scheibe (11) beim nächsten Aufnehmen zurück in den Trichter (15) geleitet werden, aber wenn die einzigen verbleibenden Münzen unechte Münzen sind, die Sortiervorrichtung in einen "Säuberungs"-Zyklusmodus eintritt, in dem die Münzen in einen speziellen Sammelkasten (24) für "unechte Münzen" geleitet werden, und dieser Kasten für unechte Münzen ist über eine Rutsche (25) mit einer zweiten Ausgangsöffnung aus der Scheibe verbunden, die sich unterhalb und hinter dieser die Sortierrampe (12) versorgenden Öffnung befindet, wobei diese zweite Öffnung niemals von Münzen erreicht werden kann, wenn die Scheibe normal rotiert, aber von allen Münzen erreicht werden kann, wenn die Drehrichtung der Scheibe umgekehrt wird, und der Säuberungszyklus wird durch Umkehren der Drehrichtung der Scheibe begonnen.

14. Sortiervorrichtung nach einem der vorhergehenden Ansprüche, bei der die Sortierrampe (12) eine Sensorvorrichtung (21) aufweist und mit dieser verbunden ist, die erfaßt, wenn eine Münze (12) durch den Scheibenrampenzuführer (11) zugeführt wurde.

Revendications

1. Une trieuse de monnaie (10) possédant à la fois un disque d'alimentation à cases (11) et une rampe de triage (12),

le disque (11) servant à extraire les pièces (14) dans un godet d'alimentation associé (15) et à les acheminer vers la rampe (12) par l'intermédiare un ou plusieurs poste(s) de détection (16,17) au niveau duquel/desquels un ou plusieurs paramètre(s) physique(s) de la pièce est/sont mesuré(s), au moins de ces paramètres étant la taille de la pièce, mesurée par un système de détecteur CCD linéaire (161d, 162d) sur lequel l'ombre de la pièce à valider est projetée, la sortie du CCD étant utilisée pour déterminer si cette pièce est bonne ou non et, par conséquent, pour la valider,
le(s) poste(s) de détection (16,17) étant positionnés à côté du disque (11) et sur sa périphérie, chaque pièce (14) prise par le disque est passée le long ou au travers de chaque poste de détection par ce disque,
et la rampe (12) servant à séparer les pièces (14) suivant leurs valeurs calculées par leurs tailles et à les envoyer à un jeu de goulottes de déchargement (18), et par conséquent à trier la monnaie.

2. Une trieuse de monnaie telle que revendiquée à la revendication 1, combinant les éléments suivants :

un godet d'alimentation (15) où on place la monnaie en vrac (14) à trier ;
un disque rotatif alimentant la rampe de validation (11) tel que défini ci-après, auquel la monnaie (14) est fournie par le godet d'alimentation de pièces (15) et qui tourne afin de prendre les pièces et de les acheminer tout autour du disque (11) pendant qu'il tourne, un ou plusieurs poste(s) de détection (16,17) étant positionné (s) à côté du disque et sur sa périphérie, chaque pièce prise par le disque passant le long ou au travers dudit poste de détection, au niveau duquel un ou plusieurs paramètre(s) physique(s) de chaque pièce est/sont mesuré(s) lors de son passage dans le but de déterminer si la pièce est bonne ou non et de la valider, au moins un de ces paramètres étant la dimension de la pièce, mesurée grâce à un système de détecteur CCD (161d,162d) sur lequel l'ombre de la pièce à valider est projetée, la sortie du CCD étant utilisée pour valider cette pièce ; et une rampe de triage/séparation de monnaie (12) telle que définie ci-après, dans laquelle des pièces sont fournies (14) par le disque rotatif alimentant la rampe (11), réalisant leur séparation et, par conséquent, leur tri suivant plusieurs valeurs prédéterminées au fur et à mesure que les pièces la parcourent et qu'elles en sont défléchies, un nombre correspondant de goulottes (18) étant positionné le long de la rampe pour recevoir les pièces défléchies.

3. Une trieuse de monnaie dans l'une ou l'autre des revendications précédentes où le godet (15) a la fonction d'une "pelle" (19) dans laquelle on peut verser la monnaie en vrac, cette "pelle" mettant les pièces au fond du disque (11) pour qu'elles puissent entrer dans les cases (13) situées au pourtour du fond du disque.

4. Une trieuse de monnaie telle que revendiquée dans les revendications précédentes où chaque case (13) a la forme d'un V sur son rebord extérieur.

5. Une trieuse de monnaie telle que revendiquée dans les revendications précédentes où, grâce à un disque qui tourne dans le sens horaire (11), le ou chaque poste de détection (16,17) est agencé sur ou le long du bord supérieur du disque, à une position située entre "10 heures" et "midi".

6. Une trieuse de monnaie telle que revendiquée dans les revendications précédentes où, au niveau d'un poste de détection (16), le diamètre de chaque pièce est mesuré, tandis qu'à un autre poste (17) les propriétés magnétiques sont testées.

7. Une trieuse de monnaie telle que revendiquée dans

les revendications précédentes où, la sortie du détecteur (16) est inspectée à la fois sur le côté supérieur et inférieur en vue de déterminer si la pièce (14) est bien logée dans sa case (13).

8. Une trieuse de monnaie telle que revendiquée dans les revendications précédentes où un détecteur CCD (162d) est également employé pour mesurer la corde non diamétrale de la pièce (14).

9. Une trieuse de monnaie telle que revendiquée dans les revendications 6 à 8 où, pour déterminer la nature magnétique de chaque pièce, un champ magnétique à variation régulière (onde sinusoïdale) est appliqué à côté de l'objet à tester, le champ résultant induit dans la pièce (14) étant examiné et la différence de phase entre les deux champs étant utilisée pour indiquer la nature magnétique de la pièce et par conséquent la matière dont elle est faite.

10. Une trieuse de monnaie telle que revendiquée dans les revendications précédentes où la valeur de chaque paramètre mesuré par le poste de validation correspondant (16,17) est comparée à des valeurs acceptables pour chaque paramètre tel que déterminé précédemment pour les bonnes pièces (14) dans le jeu trié, les pièces ainsi triées étant rejetées ou non sur la base de la (non)correspondance avec ces paramètres, cette comparaison étant réalisée par une combinaison de composants matériels et logiciels.

11. Une trieuse de monnaie telle que revendiquée à la revendication 10, où le système informatique matériel/logiciel est programmé avec un mode apprentissage permettant de mettre des pièces connues dans la trieuse et d'enregistrer les valeurs obtenues pour les paramètres en vue de les réutiliser à l'avenir lors de la vérification de pièces "inconnues".

12. Une trieuse de monnaie telle que revendiquée dans les revendications précédentes où, pour éviter qu'une pièce (14) atteigne la rampe de triage (12) par l'intermédiaire un trou de sortie dans la plaque d'appui du disque (100), cette pièce est éjectée mécaniquement de sa case au moyen d'un doigt (20) actionné par électroaimant et synchronisé en fonction qui dépasse au travers de la plaque d'appui dans la case et éjecte la pièce quand le système de validation lui envoie un signal d'activation.

13. Une trieuse de monnaie telle que revendiquée dans les revendications précédentes où les pièces (14) rejetées sont, au départ, renvoyées au godet (15) pour un deuxième passage sur le disque (11) qui les prend à nouveau, toutefois quand il ne reste que des mauvaises pièces, la trieuse se met en mode de cycle de "purge" et envoie les pièces dans une tirelire spéciale "mauvaises pièces" (24) elle-même reliée par une goulotte (25) à un deuxième trou de sortie du disque sous et après celui qui alimente la rampe de triage (12) et qu'aucune pièce ne peut atteindre tant que le disque tourne normalement mais par lequel toutes les pièces peuvent passer si le sens de rotation du disque est inversé et le cycle de purge lancé par inversion de la rotation du disque.

14. Une trieuse de monnaie telle que revendiquée dans les revendications précédentes où la rampe de triage (12) a, ou est associée à, un capteur (21) détectant quand une pièce (14) lui a été fournie par le disque d'alimentation de cette rampe (11).

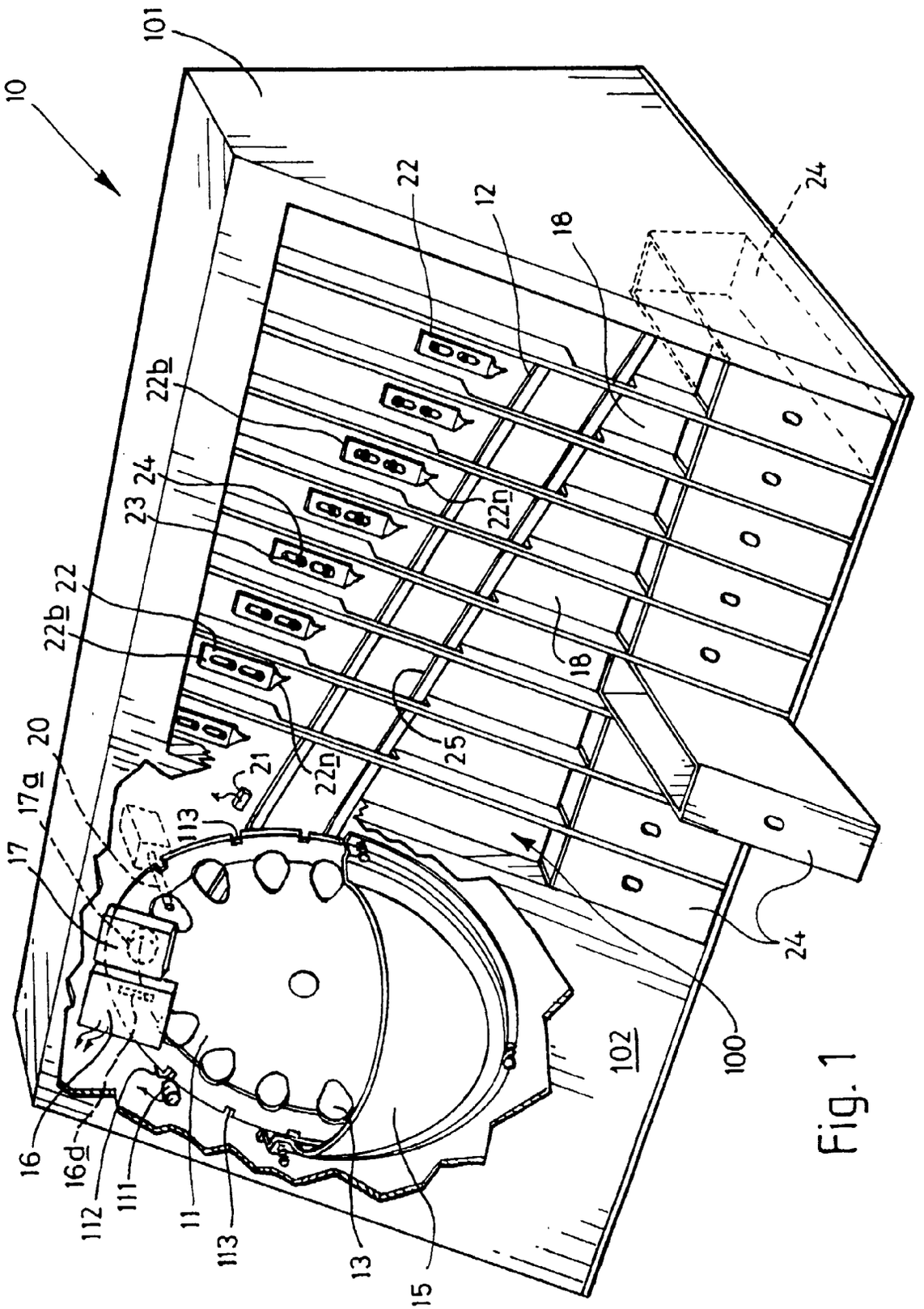

10
101
22
12
18
24
22b
23
22n
25
20
17a
17
21
113
16
16d
112
111
11
13
15
102
100

Fig. 1

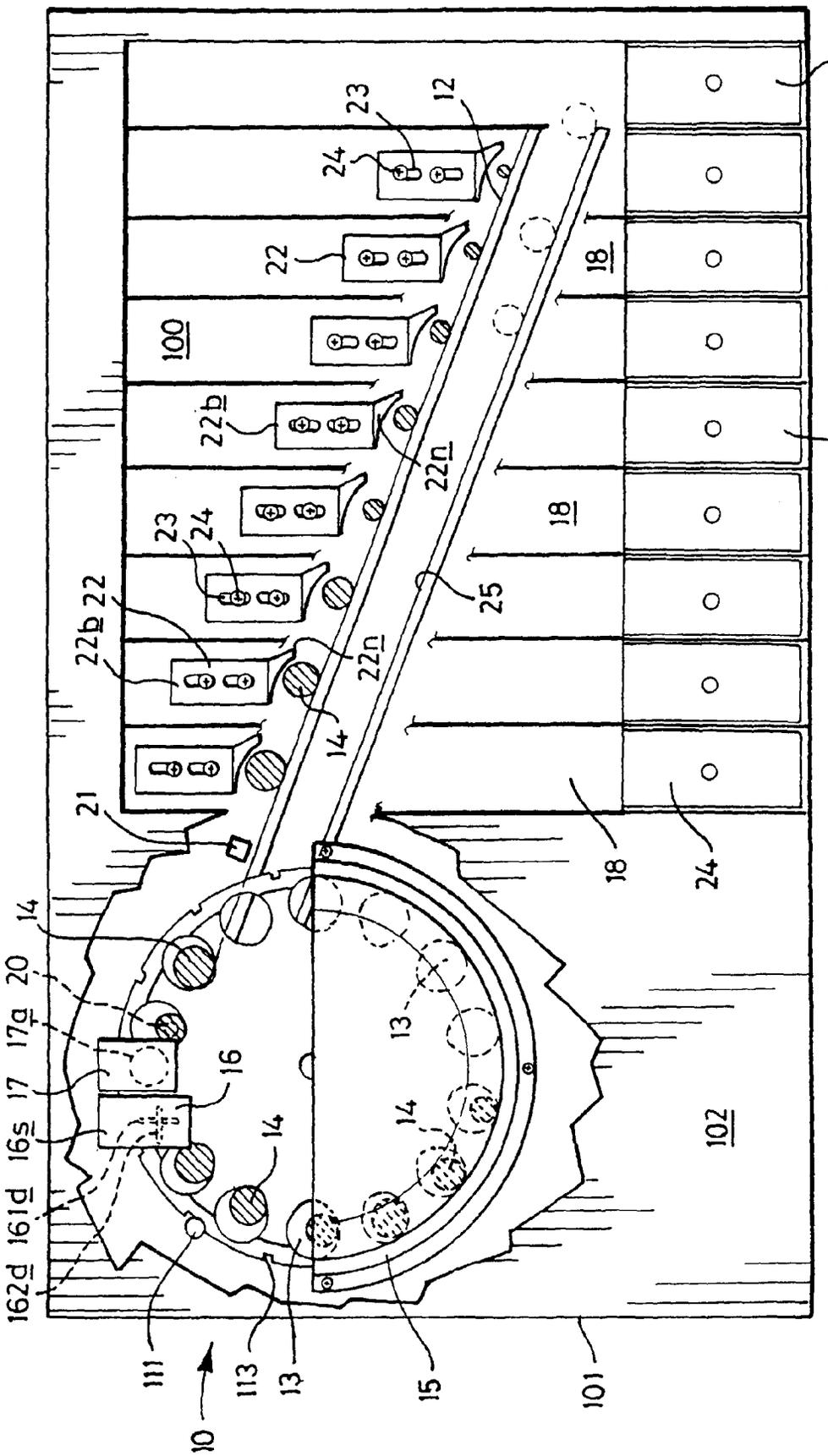

10
100
101
102
111
113
12
13
14
15
16
16s
161d
162d
17
17a
18
20
21
22
22b
22n
23
24
25

Fig. 2A

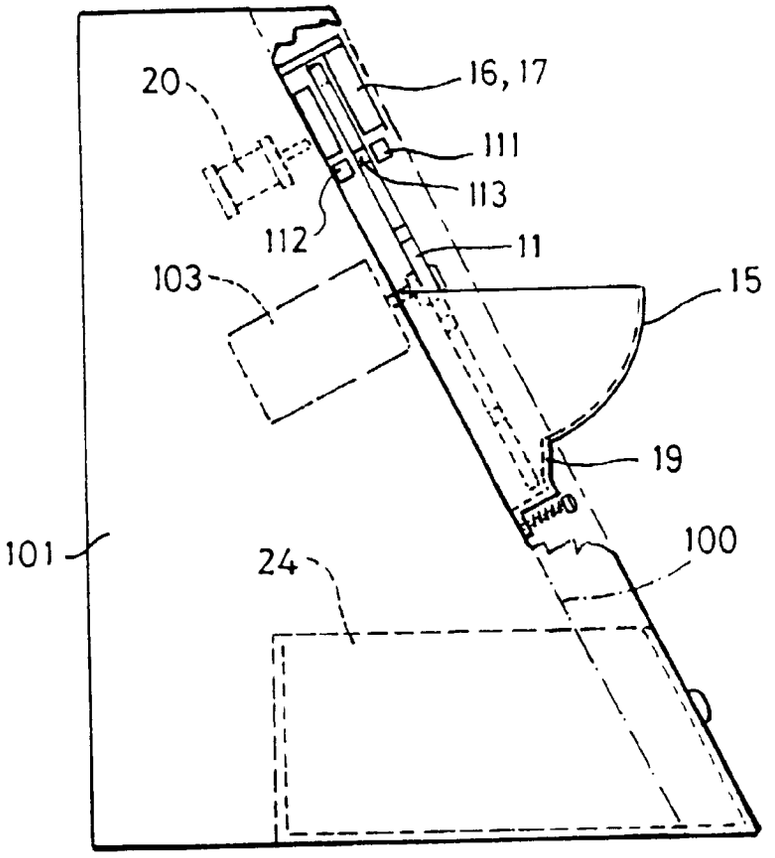

20
16, 17
111
113
112
11
103
15
19
101
24
100

Fig. 2B

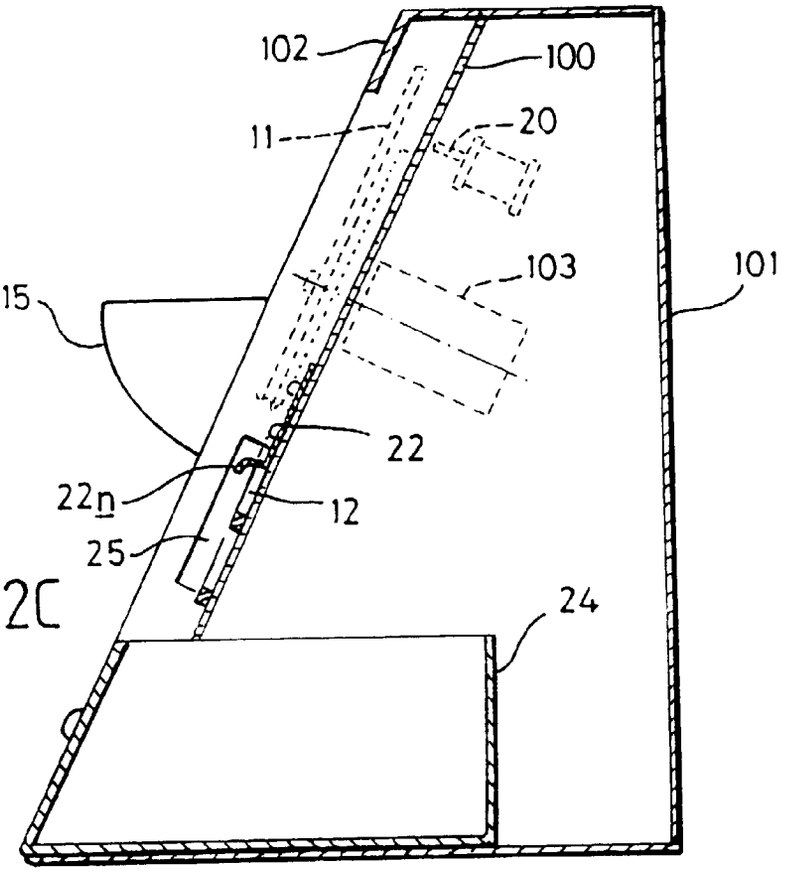

102
100
11
20
103
101
15
22
22n
12
25
24

Fig. 2C

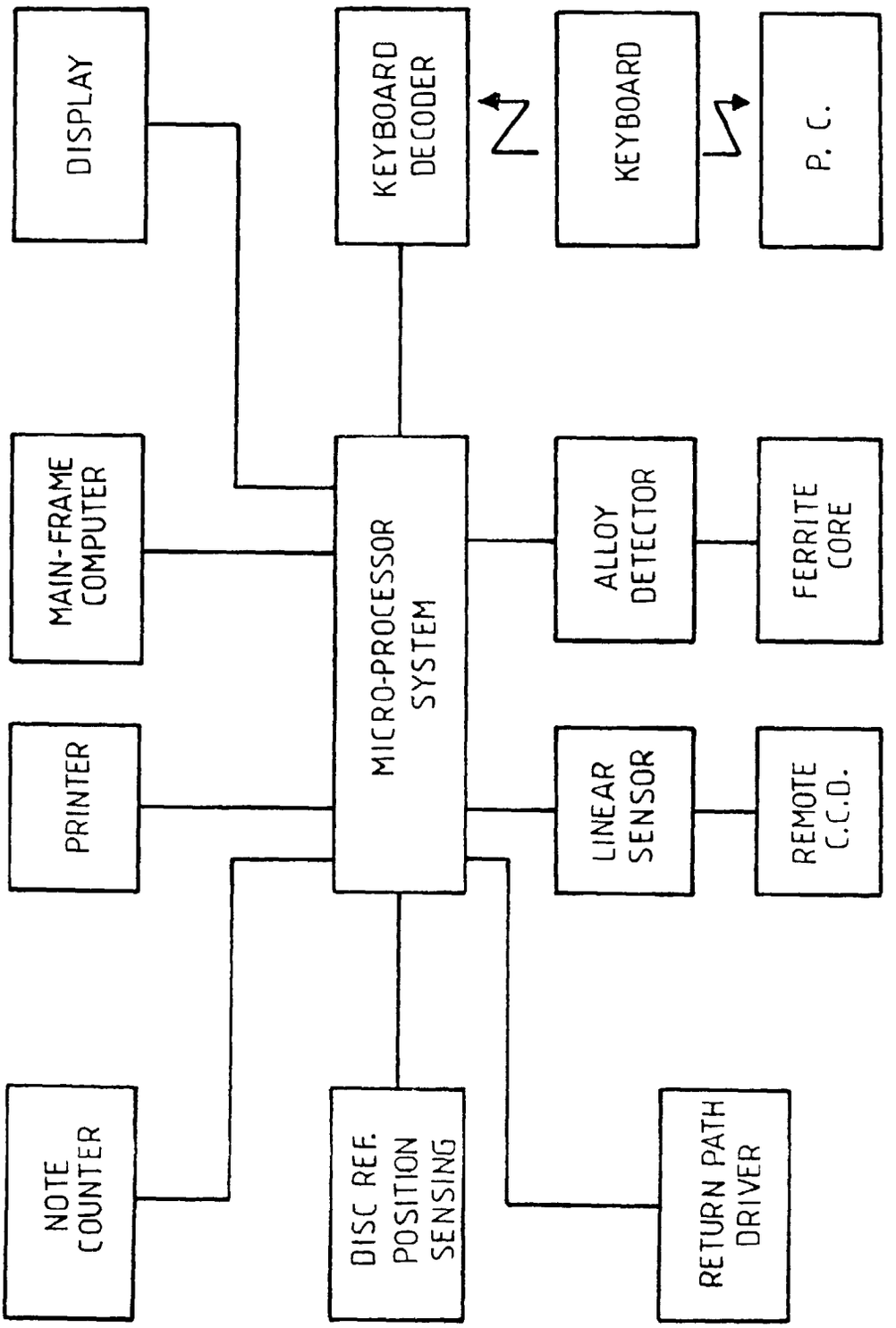

DISPLAY
KEYBOARD DECODER
KEYBOARD
P. C.
MAIN-FRAME COMPUTER
MICRO-PROCESSOR SYSTEM
ALLOY DETECTOR
FERRITE CORE
PRINTER
LINEAR SENSOR
REMOTE C.C.D.
NOTE COUNTER
DISC REF. POSITION SENSING
RETURN PATH DRIVER

Fig.3

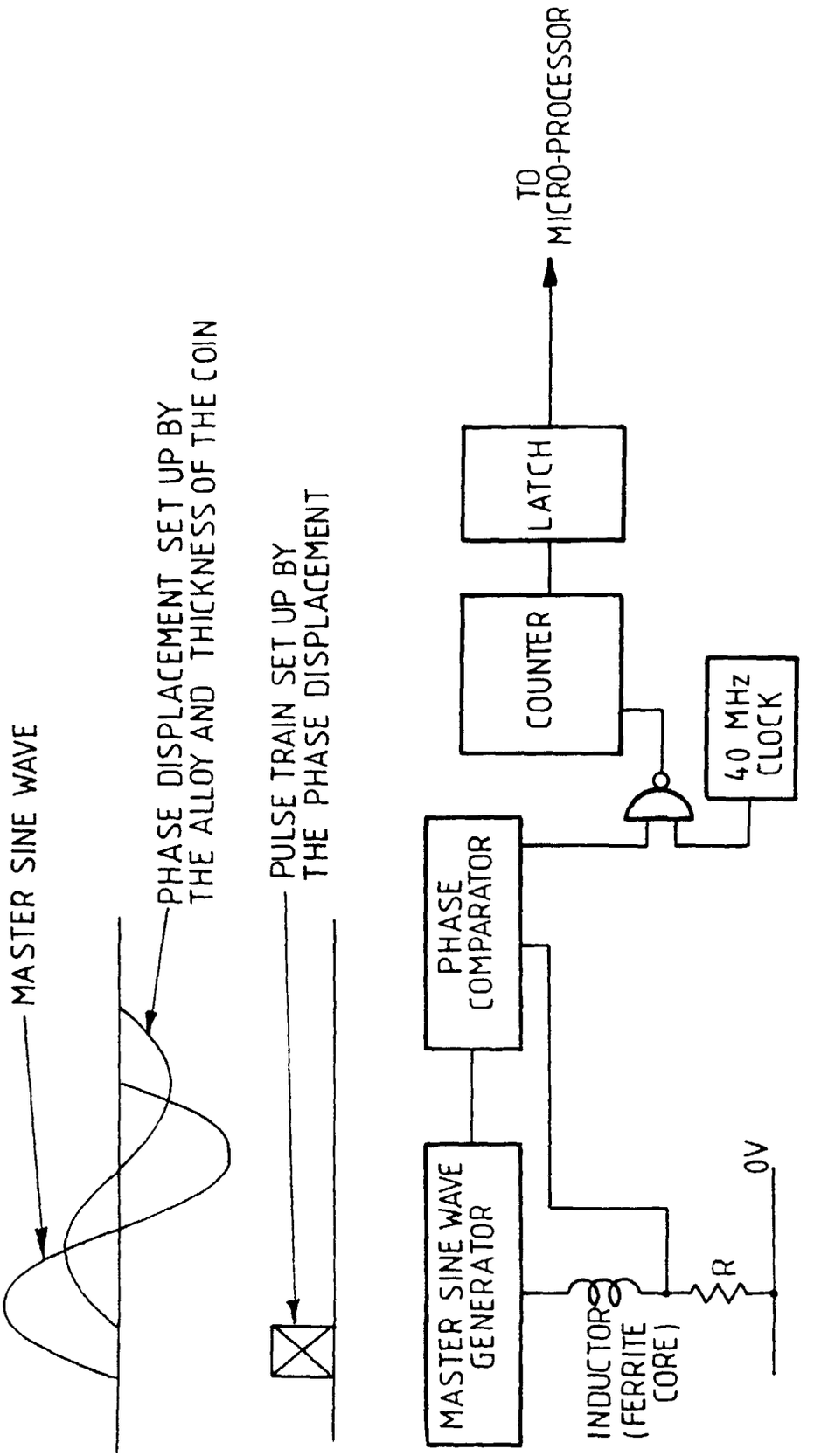

MASTER SINE WAVE
PHASE DISPLACEMENT SET UP BY THE ALLOY AND THICKNESS OF THE COIN
PULSE TRAIN SET UP BY THE PHASE DISPLACEMENT
TO MICRO-PROCESSOR
LATCH
COUNTER
40 MHz CLOCK
PHASE COMPARATOR
MASTER SINE WAVE GENERATOR
INDUCTOR (FERRITE CORE)
R
0V

Fig. 4

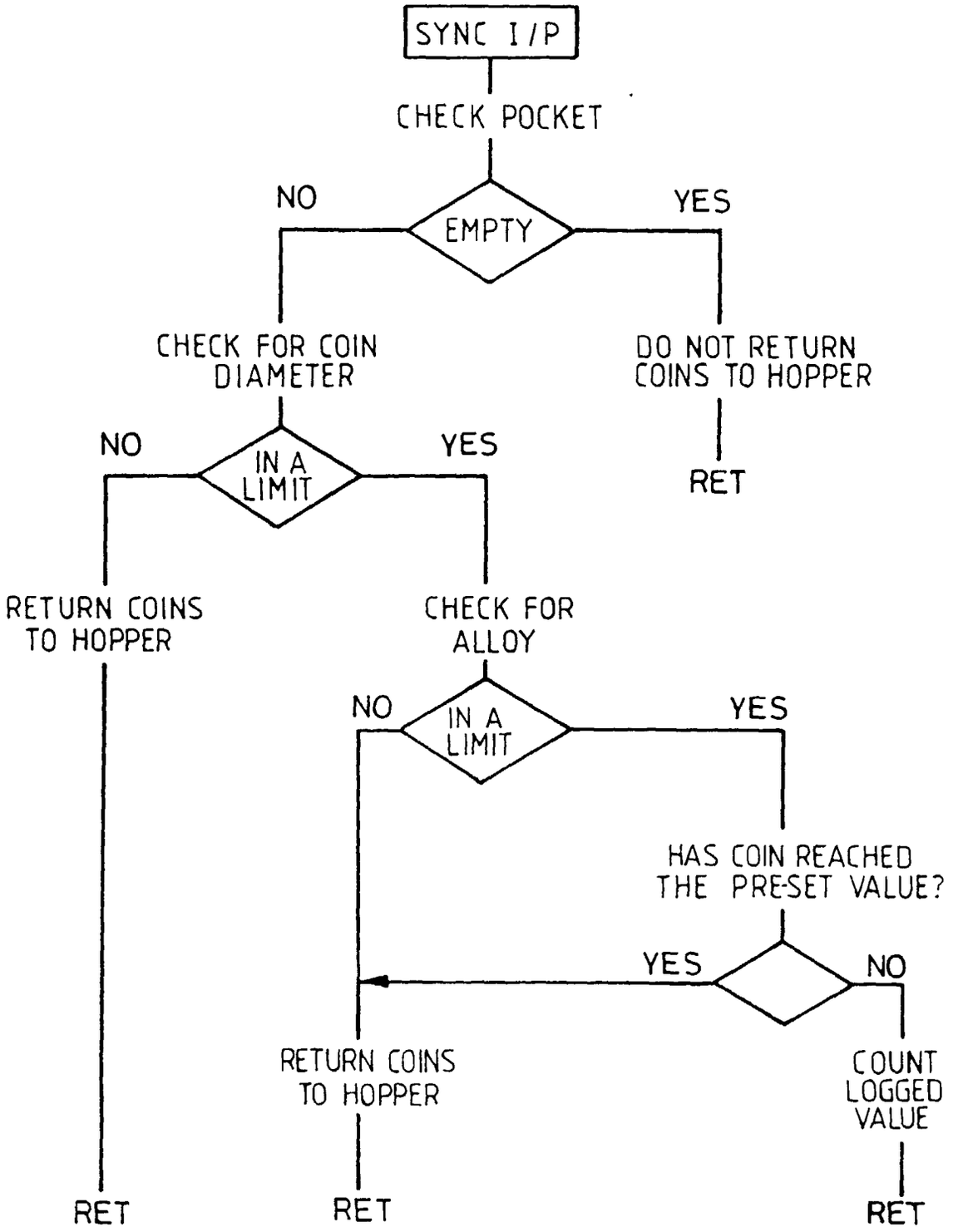

SYNC I/P
CHECK POCKET
NO
EMPTY
YES
CHECK FOR COIN DIAMETER
DO NOT RETURN COINS TO HOPPER
NO
IN A LIMIT
YES
RET
RETURN COINS TO HOPPER
CHECK FOR ALLOY
NO
IN A LIMIT
YES
HAS COIN REACHED THE PRE-SET VALUE?
YES
NO
RETURN COINS TO HOPPER
COUNT LOGGED VALUE
RET
RET
RET

Fig. 5