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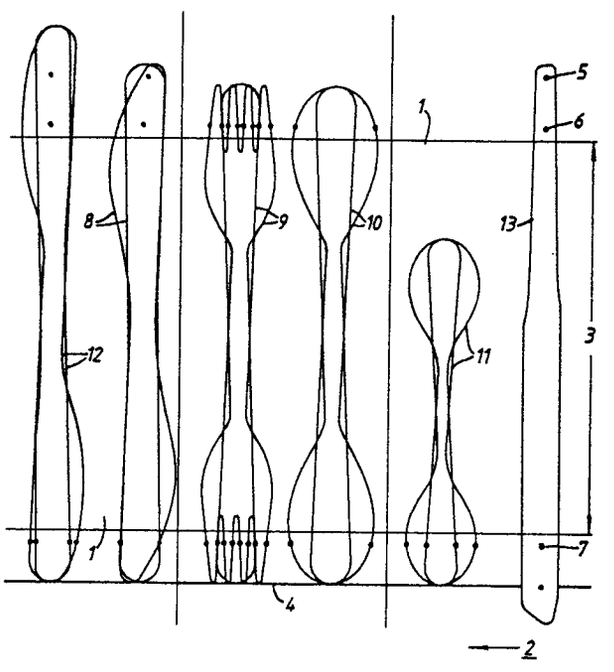
(54) **Method and apparatus for sorting articles.**

(57) A method of, and apparatus for, sorting elongate articles such as pieces of metallic cutlery (8, 9, 10, 11, 12, 13) comprising the provision of a belt (1) which is movable at a uniform speed in a predetermined direction (2) carrying such articles on its upper surface, the elongate articles each having one end abutting against a datum line (4) and being arranged to mask photo-electric cells or other energy receivers (5, 6, 7) spaced at different distances from said datum line (4) as they move along the belt (1) in said direction (2). The cells or other energy receivers (5, 6, 7) are linked to a programmable logic controller or other computer which is programmed to recognise the individual pieces of cutlery (8, 9, 10, 11, 12, 13) by way of the patterns of masking of the energy receivers (5, 6, 7) which they respectively produce, means governed by the programmable logic controller or other computer being provided to direct the individually recognised pieces of cutlery off the belt (1) to corresponding individual destinations. Preferably, the programmable logic controller or other computer is so programmed, and the energy receivers (5, 6, 7) are so arranged, that the disposition of each piece of cutlery on the belt (1) can be recognised so that any such piece disposed one way round can be displaced from the belt (1) to its destination via means which will reverse it end-for-end through substantially 180° while an identical piece of cutlery disposed on said belt (1) the opposite way round will be directed to its destination from the belt (1) without encountering the last mentioned means and thus not being reversed as regards its orientation.



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METHOD AND APPARATUS FOR SORTING ARTICLES

This invention relates to the sorting of articles and particularly, but not exclusively, to the sorting of mixed cutlery.

There are numerous organisations which themselves provide, or that furnish facilities for others to provide, meals for relatively large numbers of people. A good example of such an organisation is an airline which will usually serve at least one, and often several, meals on all but the shorter of its flights. It has, in the past, been the general practice for most airlines to use disposable synthetic plastics knives, forks and spoons, but these are not popular with the travelling public and constitute a considerable expense when each individual item is thrown away after a single use. As a consequence, the employment of traditional metallic items of cutlery is becoming popular since such items have a much higher prestige value than do plastics knives, forks and spoons, can readily carry a crest, logo, or other mark identifying the airline concerned, and generally speaking, have a vastly greater length of useful life than do their plastics equivalents. However, the re-use of the metallic cutlery necessitates the employment of metal detectors or other separation thereof from plates, bowls, food waste and the like after each flight and thorough washing in a commercial washing-up machine. After washing, the clean and dry cutlery is delivered from the machine in a mixed arrangement in which the knives, forks and spoons lie at random. Since knives, forks and spoons are all elongate articles, they can readily be moved from their random arrangement to one in which they all lie substantially parallel to one another merely by carrying them along a belt or the like so that they pass between progressively approaching walls and are delivered through a gate in the required substantially parallel disposition.

As is well known, each passenger taking a meal on an aircraft receives his/her cutlery in a wholly or principally transparent synthetic plastics bag accompanied by a selection of other items such as, for example, an absorbent paper napkin and sealed salt, pepper, sauce, sweetener and other containers. Obviously the bag must contain the correct selection of these items which will usually comprise, as regards the cutlery, at least one each of a knife, a fork, a dessert spoon and a teaspoon. Preferably, but not essential, these items of cutlery are all contained in the bag the same way round, that is to say, with the handle end of each item of cutlery directed towards the same end of the bag. It is thus necessary that, between the point at which the washed and dried knives, forks and spoons are delivered in relatively parallel relationship with one another and the point at which they are re-packed into fresh bags usually with at least some of the other items of which examples are mentioned above, there should be apparatus which will identify the individual pieces of cutlery and will sort them into knives, forks, dessert spoons, teaspoons and any other possible items for delivery to separate locations, preferably all similarly disposed as regards their handle and food-engaging ends, so that known machinery that is already in use can receive at least one article of cutlery from each of said locations and pack the correct selection of cutlery into a fresh bag together with appropriate other items and seal that bag ready for re-use by another passenger.

Various methods have been tried automatically to identify the various cutlery items and subsequently to sort them into their different catagories. Such methods include the use of a CCD camera, direct computer recognition and photo-matrix recognition, but they have proved to be too expensive and/or unreliable in operation. One disadvantage of purely visual recognition systems is that metallic cutlery, after having just been cleaned, is in a bright and shiny condition and, since the pieces of cutlery are not entirely planar, the reflections of the bright lights that are intended to aid the recognition actually prevent accurate recognition from occurring so that there is an unacceptably high level of errors. The present invention seeks to provide a method and apparatus for sorting cutlery and other elongate articles which is reliable, substantially error-free, relatively inexpensive as compared with prior art proposals and that can be operated or at least supervised by unskilled staff.

According to one aspect of the invention, there is provided a method of sorting elongate articles of dis-similar shape, which method comprises moving successive articles along a path with their longitudinal axes substantially perpendicular to their direction of travel and with one end of each article in register with a datum line extending lengthwise of said path, providing a plurality of energy receivers at different perpendicular distances from said datum line which distances are such that elongate articles of different lengths will mask corresponding numbers of those receivers as they travel past them, whereby the identity of each successive elongate article may be recognised, and providing sorting means responsive to the article identifying means to direct articles of each detected shape to a destination individual thereto. This method will identify and sort various articles, such as metallic knives, forks, dessert spoons and teaspoons, and apparatus embodying the method will direct them

to various storage locations but will not orientate each elongate article in the same way as regards its different opposite ends. This is desirable, although not absolutely essential, for items of metallic cutlery and, in accordance with further features of the invention, identification of the handle and food/drink engaging ends of the various items is possible in a basically similar manner to that which merely identifies their nature. By providing appropriately illuminated photo-electric cells or other energy receivers in a row which extends perpendicular to the aforementioned datum line and which cells or other receivers are spaced at appropriate distances from that datum line, the time of masking of the various cells can be related to a controlled speed of travel of the articles along said path in such a way that not only will the nature of each item be identified but also its orientation as regards its handle and food or drink engaging ends. For example, a dessert spoon will be identified by its length whilst its orientation will be identified by the fact that the width of its handle in a direction parallel to the direction of displacement along said path is considerably less than the width of its bowl. The blade and handle ends of knives are of different widths and the handle and tine or prong ends of forks are readily identifiable by the pattern of masking of appropriately disposed photo-electric cells or other receivers as the cutlery passes them at a controlled speed. The means which is responsive to the identification of the articles will direct each identified article orientated one way down one chute to a corresponding destination whereas each similar article which is orientated the other way round will be directed down an alternative chute to the same destination but by way of a mechanism that will turn it end-for-end through substantially 180° before it reaches that destination.

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawing which is a very diagrammatic plan view of part of an apparatus in accordance with the invention for sorting articles of cutlery.

In the use of an apparatus in accordance with the invention, thoroughly washed and dried but randomly mixed cutlery is fed from a bulk hopper onto a belt where it is visually inspected by staff who will detect any piece of cutlery that remains dirty even after the washing operation. Any such piece is manually removed from the belt for re-washing. The staff may also remove from the belt any broken or badly deformed piece of cutlery that may, for example, have been accidentally damaged by the handling machinery or that might have been vandalised by a child or some other user. Occasional "lost" articles, such as metallic spectacle cases, may also be removed from the belt during the visual inspection under discussion.

The overwhelming majority of the pieces of cutlery are clean, dry and undamaged and pass from the visual inspection belt onto a second belt which advantageously is moving in a direction perpendicular to the direction of movement of the first mentioned belt. This second belt has the reference 1 in the accompanying drawing. The transfer of the pieces of cutlery from the first belt to the second belt 1 is accomplished by known mechanism that separates said pieces and places them on said second belt 1 in dispositions in which their longitudinal axes are perpendicular, or substantially perpendicular, to the length of the supporting suface of the second belt 1 and to the direction 2 in which that belt travels at a strictly controlled speed.

The belt 1 has a width 3 of 120 mms and is spaced at its left hand edge, considered in the direction 2, by substantially 16 mms from a datum line 4 that also extends parallel to the direction 2. The datum line 4 may take the physical form of a planar wall and may advantageously but not essentially be arranged to move in the direction 2 at the same speed as the belt 1. To identify knives, forks and dessert spoons that are all of the same kind, it is necessary to provide three illuminated photo-electric cells 5, 6 and 7. The first cell 5 is located at 155 mms from the datum line 4 and the second cell 6 is located at 140 mms from that line, it being apparent from the drawing that these two cells 5 and 6 are both beyond the edge of the belt 1 that is remote from the edge thereof nearest to the datum line 4. The third cell 7, however, is located at only 12 mms from the datum line 4 and is thus in the 16 mms gap between that line 4 and the neighbouring edge of the belt 1.

In the metallic cutlery that is used by a large airline, each knife 8 is 161 mms in length, each fork 9 is 152 mms in length,. each dessert spoon 10 is also 152 mms in length and each teaspoon 11 is 106 mms in length. Thus, when the separated pieces of cutlery are moved in the direction 2 by the belt 1 with each of them substantially perpendicular to that direction 2 and one end of each piece against the datum line 4, a knife 8 will mask all three of the cells 5 , 6 and 7, either a fork 9 or a dessert spoon 10 will mask only the cells 6 and 7 but not the cell 5, whilst a teaspoon 11 will mask only the third cell 7 but neither of the two cells 5 and 6. This will occur in each case whether it is the handle end of the piece of cutlery that is against the datum line 4 or the opposite end of that piece.

Since the belt 1 is moving in the direction 2 at a controlled speed, the times during which the various cells, 5, 6 and 7 are masked can be employed to detect the difference between the equal length forks 9 and dessert spoons 10 and the disposition

of each piece of cutlery as regards whether its handle end, or its other end, is against the datum line 4. The blade of a knife 8 is 13 mms wide whereas the handle thereof is only 10 mms wide. The handle of a fork 9 is 12 mms wide whereas its opposite end has four tines or prongs with three spaces between them so that, as these tines or prongs are interposed between either the cell 6 or the cell 7 and the source of illumination, they will mask the cell concerned in a rapid four times off interposed between four times on pattern. A dessert spoon 10 has substantially the same handle width as does both a knife 8 and a fork 9 but its bowl end has a width of 27 mms and will thus mask either the cell 6 or the cell 7 for a length of time dependent upon the fixed speed of travel in the direction 2. A teaspoon 11 masks only the cell 7 but its handle has a width of substantially 9 mms whereas its bowl end has a width, in the direction 2, of substantially 22 mms. It will be apparent that the number of the cells 5, 6 and 7 that are masked by an individual piece of cutlery and the time and/or pattern of masking produces signals which both identify the piece concerned and also whether or not its handle end is against the datum line 4 and these signals are fed to a programmable logic controller (PLC) which has been programmed both to recognise the pieces of cutlery and their lengthwise orientations and to control displacement thereof to corresponding destinations.

There are located, downstream along the belt 1 from the cells 5, 6 and 7, the entrances to various chutes and means to displace the identified pieces of cutlery into appropriate chutes. Such means may be of known construction and may, for example, comprise solenoid-operated "pushers", electro-magnets which are powered momentarily and move the pieces of cutlery off the belt 1 whilst so powered, or other known displacing means. In the example that is being described, there may be eight chutes corresponding to the knives 8, the forks 9, the dessert spoons 10 and the teaspoons 11 orientated longitudinally either one way, or the other way, round. If it is desired that the handle ends of the various pieces of cutlery should enter storage receptacles first, then four of the chutes will lead directly to those storage receptacles whereas the other four chutes will include mechanisms for reversing the lengthwise orientation of each piece of cutlery after it has entered the chute concerned. After having been dealt with by such a mechanism, a piece of cutlery will be the same way round as other unreversed pieces entering the corresponding "direct" chute so that the two chutes may converge into a single delivery to the storage receptacle.

The mechanisms for reversing the lengthwise orientation of "wrongly" disposed pieces of cutlery may be of turntable formation with each "turntable" rotatable about a preferably horizontal or substantially horizontal axis. Purely for example, a wrongly disposed piece of cutlery entering a length of the corresponding chute carried by the respective "turntable" will have its presence sensed by a magnetic reed switch or by the masking of a further photo-electric cell and such sensing will initiate the immediate rotation of the "turntable" through 180°, preferably with the piece of cutlery held directly by an electro-magnet, or by an electro-magnetically operated clamp, in the displaceable portion of the chute only whilst such displacement takes place. As soon as the reversal of the movable chute portion has taken place, the piece of cutlery is freed and can continue its journey, under gravity, towards the storage receptacle having the same lengthwise orientation as do the similar unreversed pieces of cutlery. It is desirable that the portion of each chute which leads to each reversing mechanism should incorporate an electro-magnetically or otherwise operated gate or block arranged to prevent a second piece of cutlery from reaching the reversing mechanism whilst the latter is performing a reversing operation on a first piece of cutlery. Alternatively, in very large installations, the reversing mechanisms could be constructed and arranged to receive a plurality of identical pieces of cutlery and to reverse the lengthwise orientation of all them in a single operation.

Known machinery which is already in use takes an appropriate selection of cutlery from the storage receptacles, for instance, a knife, a fork, a dessert spoon and a teaspoon, delivers that cutlery to a plastics or other bag together with a paper napkin and sealed containers of salt, pepper, sugar, sauce and the like and finally seals the bag ready for delivery to an aircraft and use during a meal on a subsequent flight.

It is emphasised that what has been described with reference to the accompanying very diagrammatic drawing is purely by way of example. A fourth photo-electric cell could be incorporated at a distance from the datum line 4 which is greater than that of the first cell 5 to sense both the identity, and the lengthwise disposition, of a larger knife when, as is sometimes the case, two different larger and smaller sizes of knife are employed. Such a knife is given the reference 12 in the accompanying drawing. Under these circumstances, appropriate further chutes will be required together with means to displace the larger knives 12 into them. Instead of using photo-electric cells and appropriately positioned sources of light, ultrasonic emitters and receivers could be employed arranged in such a way that interruption of the reception of sound by any ultrasonic receiver would indicate the presence of an article between that

receiver and the sound source and the length of time and/or the pattern of the interruption would indicate the lengthwise orientation of the identified article in much the same way that has been described above. Signals or pulses generated by a shaft encoder or a linear transducer could be employed to detect the widths of the ends of the cutlery pieces to identify those pieces and/or to determine their lengthwise orientation, instead of using the pattern of masking of the photo-electric cells, 5, 6 or 7 or the pattern of masking of equivalent sound receivers.

The system could be expanded to detect significantly damaged pieces of cutlery and/or incorrect pieces and the accompanying drawing shows a long knife I3 which is not a "brand" companion of the pieces of cutlery 8 to I2 inclusive. The knife I3 is shown as overlapping the datum line 4 and it will be realised that, if a photo-electric cell or other detector were to be placed on the datum line 4 it would detect such a knife I3 and would enable the programmable logic controller to displace that knife I3 into a "reject" chute. Obviously, the tip of the knife I3 could move along the datum line 4 and an additional photo-electric cell or other receiver be positioned beyond both the first cell 5 and the additional fourth cell that has been mentioned above. Although the method and apparatus of the present invention is ideally suitable for sorting metallic cutlery, since it is simple and reliable in operation, without being too expensive, and can be supervised by unskilled staff, it will be appreciated that it could be employed in sorting and/or grading articles other than pieces of cutlery. Purely for example, it could be employed in grading root crops, such as carrots, that are classified by their length and by their crown diameters. Mixed bolts, screws, studs and the like could be sorted both as regards identification and lengthwise orientation using a system in accordance with the invention as could many other articles. Obviously, the numbers and dispositions of the photo-electric cells or other energy receivers that are used can readily be varied having regard to the size and nature of the articles to be sorted, only appropriate programming of the programmable logic controller also being required to suit the particular sorting operation that is to be undertaken.

It is not necessary that the surface of the belt I which carries the knives, forks, spoons and other articles should be horizontally disposed and it may be inclined to the horizontal in such a way that the various pieces of cutlery will all tend to slide downwardly over that surface into endwise engagement with a planar wall or the like embodying the datum line 4. If, as mentioned above, the planar surface that embodies the datum line 4 is the surface of a belt or the like that is movable in the direction 2 at the same speed as the belt I, then there will be no tendency for any piece of cutlery or other article to slip sideways provided that the inclination of the belt I to the horizontal is not too great.

Apparatus in accordance with the invention will operate reliably at a fast speed that will enable thousands, rather than hundreds, of pieces of cutlery or other articles per hour to be sorted.

Claims

I. A method of sorting elongate articles of dissimilar shape, characterised in that the method comprises moving successive articles along a path (I) with their longitudinal axes substantially perpendicular to their direction of travel (2) and with one end of each article in register with a datum line (4) extending lengthwise of said path (I), providing a plurality of energy receivers (5, 6, 7) at different perpendicular distances from said datum line (4) which distances are such that elongate articles of different lengths will mask corresponding numbers of those receivers (5, 6, 7) as they travel past them, whereby the identity of each successive elongate article may be recognised, and providing sorting means responsive to the article identifying means to direct articles of each detected shape to a destination individual thereto.

2. A method according to claim I, characterised in that said path (I) is afforded by the upper surface of a belt, and by the provision of means to drive said belt (I) at a uniform speed in said direction (2).

3. A method according to claim 2, characterised in that the upper surface of said belt (I) is horizontally or substantially horizontally disposed.

4. A method according to any preceding claim, characterised in that the energy receivers (5, 6, 7) are in the form of photo-electric cells which are normally illuminated but which are selectively masked by said elongate articles as the latter are moved lengthwise along said path (I).

5. A method according to any preceding claim, characterised in that the elongate articles are pieces of metallic cutlery (8, 9, I0, II, I2, I3) and that a programmable logic controller is programmed to recognise the masking patterns produced by the various pieces of cutlery (8, 9, I0, II, I2, I3), is linked to the energy receivers (5, 6, 7), and is arranged to operate means to direct the various pieces of cutlery (8, 9, I0, II, I2, I3) off said path (I) to destinations corresponding to their recognised identities.

6. A method according to claim 5, characterised in that said energy receivers (5, 6, 7) are so arranged, and said programmable logic controller is so programmed, as to recognise not only the identities of the pieces of cutlery (8, 9, I0, II, I2, I3) but also their dispositions on said path (I) as regards

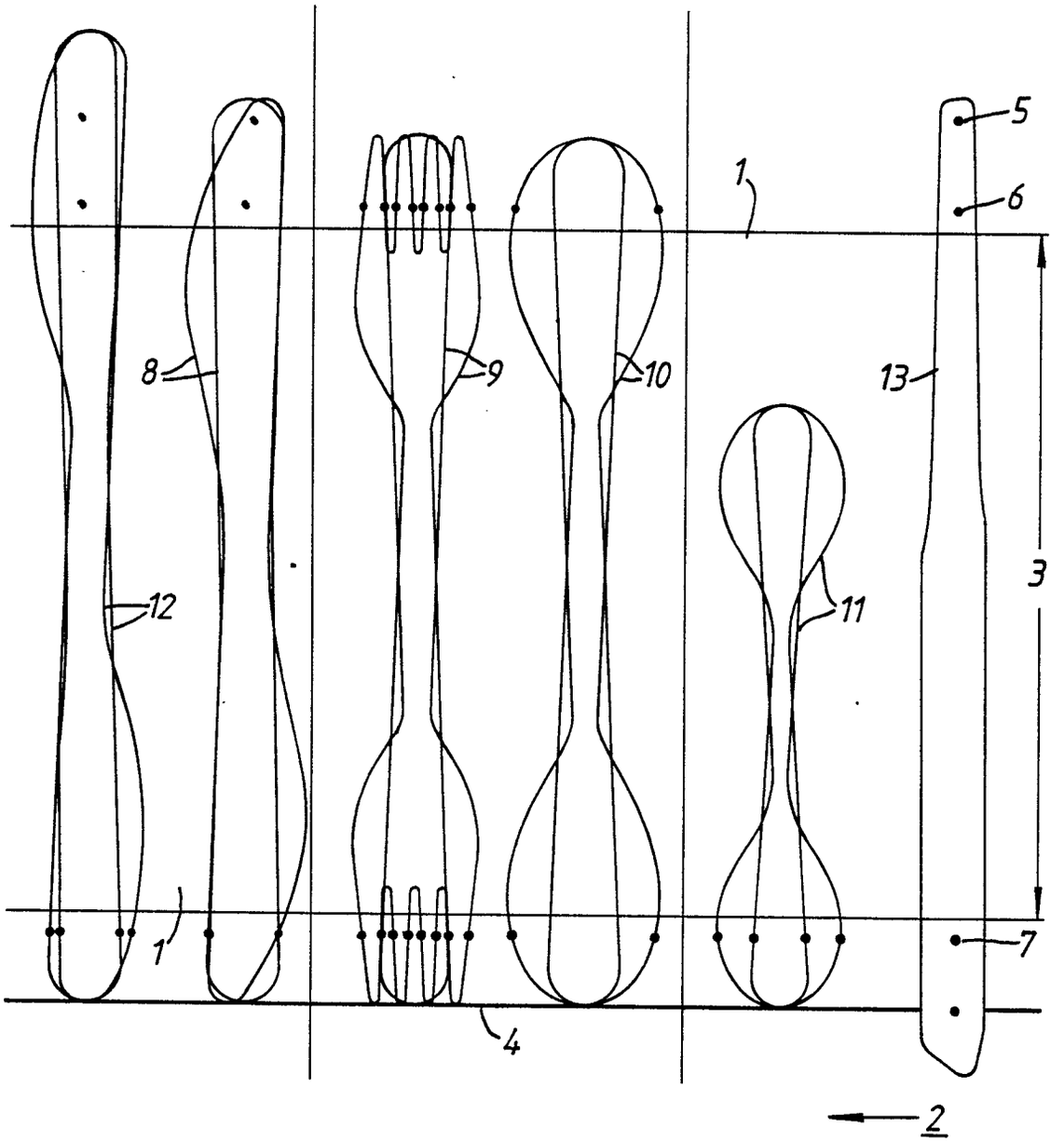
which end of each such piece registers with said datum line (4), the programmable logic controller also being so programmed as to direct a piece of cutlery (8, 9, 10, 11, 12, 13) off said path (1) to a different receiving station to that of an identical piece of cutlery disposed on said path (1) the opposite way round.

7. A method according to claim 6, characterised in that means is provided to turn each piece of cutlery (8, 9, 10, 11, 12, or 13) that is disposed one way round when it is displaced from said path (1) end-for-end through substantially 180° before it proceeds beyond this means to its destination, each identical piece of cutlery that is disposed the opposite way round on said path (1) being displaced from that path to its destination without such turning.

8. A method according to claim 2 or to claim 2 and any one of claims 3 to 7 inclusive, characterised in that said belt (1) has a width (3) of substantially 120mm, one edge thereof being spaced from said datum line (4) by substantially 16mm.

9. A method according to claim 5 or to claim 5 and any one of claims 6 to 8 inclusive, characterised in that means is provided to recognise and discard from said path (1) to a corresponding destination bent or otherwise damaged pieces of cutlery and/or pieces of cutlery which are not "brand" companions of those which the energy receivers and the programmable logic controller are arranged and programmed to deal with.

10. Apparatus for sorting pieces of metallic cutlery (8, 9, 10, 11, 12, 13) of dis-similar shape, characterised in that it comprises a belt (1) along which mixed pieces of cutlery are movable at a uniform speed with such pieces of cutlery arranged so that their longitudinal axes extends substantially perpendicular to their direction of travel (2) along the belt (1), the apparatus also comprising a datum line (4) arranged to have one end of each such piece of cutlery (8, 9, 10, 11, 12, 13) abutting thereagainst during movement in said direction (2) and a plurality of energy receivers (5, 6, 7) at different perpendicular distances from said datum line (4) which distances are such that the pieces of cutlery (8, 9, 10, 11, 12, 13) of different lengths will mask corresponding numbers of the receivers (5, 6, 7) as they travel past them, whereby the identity of each successive piece of cutlery may be recognised, and characterised in that sorting means responsive to the identification of said pieces of cutlery is provided to direct each such recognised piece to a destination individual thereto.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