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(54) **Coin discrimination.**

(57) Discrimination between two coin-denomination (Xp, Yp) of equal diameter but different thicknesses, is made in a coin-sorter (Figures 1 to 4) by sweeping the coins round an annular plate (10) in abutment with the inner edge (13) of an upstanding rim (11) which in the region of a sizing aperture (143) for receiving the thinner denomination (Xp) is undercut to admit coins of that denomination, but not of the other, thicker denomination (Yp), into abutment with an outer auxiliary edge (17) such that only coins of the thinner denomination (Xp) will be accepted within the diametral threshold set for that aperture (143) from the auxiliary edge (17). The thicker coins (Yp), because they abut the undercut edge (13), lie outside this threshold but are accepted within the same threshold set from that edge (13) at the next aperture (144). In another sorter (Figures 5 and 6) coins are tipped from an inclined and slotted shoulder (30) by deflectors (35 to 37) depending upon diametral thresholds set from the top (38) of the shoulder (30) or the bottom (40) of the slot (39) according to coin thickness, whereas in other apparatus (Figure 7) discrimination is made photoelectronically in response to coins which run along different rails (60, 61) according to their thicknesses (or other characteristics).

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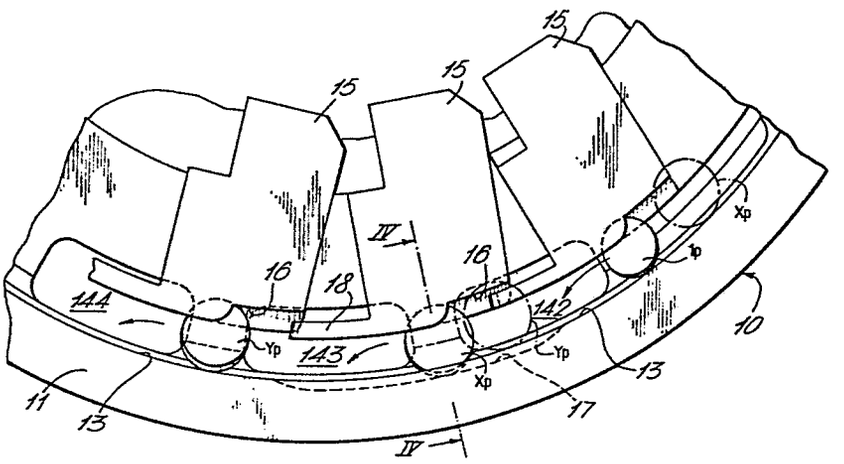
Fig.3.



Coin Discrimination

This invention relates to methods and apparatus for discriminating between coins of different denominations, of the kind in which discrimination is effected by determining whether each individual coin lies within or outside a threshold of diametral size that is related to a reference abutment for the coin.

Methods and apparatus of coin discrimination of the above-specified kind are known and are applied more especially in regard to coin sorting. Sorting of coin in this respect is commonly performed by driving or otherwise causing the coin to run in abutment along a reference edge that extends past a series of apertures which are of progressively increasing size according to the increments in diameter from one denomination to another. Each aperture is located and dimensioned with respect to the reference edge to establish a diametral threshold for the selection of coins of one denomination only. More particularly the aperture is of a size and extends from the reference edge such that any coin of the respective denomination running along the reference edge

will just fall through that aperture. Any coins of larger diameter will pass over the aperture to be accepted in general by later, larger apertures of the series appropriate to other denominations, whereas coins of smaller diameter will not reach this aperture, having in general been accepted by earlier, smaller apertures of the series.

Although the above technique has been used successfully for denomination-discrimination purposes, it does depend on distinct differences in diameter as between one denomination and another. Such differences do exist in the principal coinage systems, but proposals have been made to depart from this and to introduce one or more new denominations of coin having diameters which whilst different from those of other, existing denominations, are the same or only slightly different from one another. Some other basis for discrimination between such denominations for sorting and other discrimination purposes will accordingly be necessary.

In sorting, for example, it would be possible to sort and collect the two denominations of the same or slightly-differing diameter together and then submit the collected coins of those two denominations to a further stage of sorting based on a characteristic, other than of diameter, that is distinctive as between those two denominations. However the introduction of this further sorting stage would have practical and economic disadvantages, and it is an object of the present invention to provide a method and aparatus for discrimination that would avoid it.

According to the present invention there is provided a method or apparatus of the above-specified kind characterised in that determination of the relationship of each coin to the diametral threshold is carried out with the coin abutting one or the other of two reference abutments in dependence upon whether or not that coin has a characteristic, other than of diameter, which as between two denominations is distinctive of one denomination or the other, the two abutments being displaced with respect to one another such that a coin of a predetermined diameter lies within or outside the said threshold in dependence upon which of the two abutments the coin abuts during said determination.

The said characteristic may be thickness, and in this respect the two abutments may be located such that a coin abuts one or the other of them in dependence upon the coin thickness. The present invention enables discrimination between coins of the same or slightly-differing diameter, and therefore sorting of such coins, to be carried out in one step. More especially the invention has the particular advantage that it can be put into effect in existing sorting or other apparatus with a minimum of modification; this is especially so in the circumstances in which the characteristic for discrimination between the two denominations is thickness.

Methods and appratus for coin discrimination in accordance with the present invention, will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is an exploded view of the main operating elements of a coin-sorting machine in accordance with the present invention;

Figure 2 is a plan view of part of a trap-plate of the machine of Figure 1;

Figure 3 is an enlarged plan view of part of the trap-plate of Figure 2;

Figure 4 is a section taken on the line IV-IV of Figure 3;

Figure 5 illustrates a second coin-sorting machine in accordance with the present invention;

Figure 6 is a section taken on the line VI-VI of Figure 5; and

Figure 7 illustrates electronic coin-recognition equipment in accordance with the present invention.

The methods and apparatus to be described are for use in coin-sorting and -recognition within a coinage system that includes two denominations of the same diameter as one another. For convenience the coinage system will be assumed to be that of the United Kingdom in the circumstances in which two new denominations of coin, of Xp and Yp say, are introduced having different thicknesses, but diameters which whilst different from those of other, existing denominations, are the same.

Referring to Figure 1, coin to be sorted is supplied to a hopper 1 of the machine to fall against an inclined sprocket-plate or wheel 2. The wheel 2 is mounted between a front cover-ring 3 and a back dividing-plate 4 for rotation about an axis inclined at an angle of forty-

five degrees to the horizontal. Twenty circular apertures 5 through the wheel 2 are distributed evenly around its periphery, each being of a diameter and depth (thickness of the wheel 2) that is sufficient to receive the largest of the coins to be sorted but is insufficient to retain two coins. As the wheel 2 is rotated (by a motor not shown), the apertures 5 pass successively through the coins in the hopper 1, picking them up singly to carry them upwards and round with the rotating wheel 2. The coins rest within the apertures 5 upon an annular face 6 of the stationary dividing-plate 4, each sliding round this face 6 as it is drawn on to pass with the wheel 2 beneath a shear-plate 7 mounted at the top of the plate 4. A gap 8 in the face is located beneath the shear-plate 7 so that the coins on reaching that location fall out of their respective apertures 5 through the gap 8 and onto the annular face 9 of a stationary trap-plate 10 mounted beneath the dividing-plate 4.

The face 9 of the trap-plate within an annular upstanding rim 11 of the plate 10, is swept by twenty finger-elements 12 that are attached to the back of the wheel 2 between the apertures 5. Each coin falling through the gap 8 from an aperture 5 is swept along by the finger-element 12 next following that aperture 5 so as to move with the rotating wheel 2 slidingly around the face 9 against the rim 11. More particularly each finger-element 12 is inclined along its leading edge such that engagement with the coin urges the coin quickly and firmly into abutment with the upstanding rim 11 and maintains it in such abutment as the coin is pushed round the face 9 with the rotating wheel 2.

The innermost edge 13 of the rim 11 of the trap-plate 10 defines a reference abutment with respect to which discrimination between coins of different diameters takes place for the purpose of sorting. In this respect diametral-sizing or gauging thresholds for the selection of different denominations of coin are established in a series of apertures 14 that are spaced from one another around the face 9 and broach the trap-plate 10 just within the rim 11. Accuracy of sizing of these thresholds is provided by actuator plates 15 that are inset into the face 9 of the plate 10 and are adjustable radially to establish the innermost, gauging edges 16 for the respective apertures 14. The adjustment is made in each case to set the edge 16 at a distance from the reference rim-edge 13 appropriate to the diameter of coin-denomination that is to be received through the respective aperture 14. Coins received through the apertures 14 fall into respective traps (not shown) of the machine for accumulation, bagging or wrapping as may be required, in the different, sorted denominations.

To the extent that the machine has so far been described it is of conventional construction. In such construction the reference edge 13 such that coins of different denominational-diameters are collected through them. In each case the edge 16 is set at a radial spacing from the rim-edge 13 such that a coin of one particular denomination abutting the edge 13 will just fall through the respective aperture 14, but coins of larger diameter will not; there is thus established in the positioning of the edge 16 a threshold of diametral size with respect to the reference abutment provided by the edge 13, for discriminating between coins of that one particular denomination and other denominations.

For sorting the current decimal coinage of the United Kingdom a series of six apertures 14 is required to be used with the innermost edges 16 of successive apertures 14 round the plate 10 set at spacings from the reference edge 13 very slightly larger than the denomination diameters of 17.55mm (½p), 20.32mm (1p), 23.59mm (5p), 25.91mm (2p), 28.50mm (10p), and 30mm (50p) respectively. The progression of the diametral thresholds in distinct steps readily enables sorting of the current denominations in one operation, but the addition of two new denominations (Xp and Yp) of the same diameter as one another, say, 22mm, would seem to necessitate the introduction of a second, distinct, stage of sorting. For example it would be possible to utilize a seventh aperture intermediate the second and third in the current progression and set to a diametral threshold of 22mm, in order to separate the two new denominations together from the others, and then to submit the collected coins of those two denominations to a further stage of sorting based on a characteristic other than of diameter that is distinctive as between those two denominations.

The two new denominations are distinct in regard to thickness, the Xp coin having a thickness of, say, 1.45mm, and the Yp coin a thickness of, say, 3mm. It is this difference of thickness that is used in the machine of Figures 1 to 4 for discrimination between the two denominations. However with this machine the process of discriminating between the two new denominations on thickness, is not carried out as a stage of operation added to that of diameter discrimination, but as one with it. To this end, eight apertures 14 - identified individually as 141 to 148 in Figure 2 - are provided in this machine for direct sorting and collection of the eight denominations respectively.

Referring especially to Figure 2 (from which the actuator plates 15 are omitted for clarity), the dimaetral thresholds at the first and second apertures 141 and 142 in the series of eight, are set as conventionally for collection of ½p and 1p coins respectively, and the fifth to eighth apertures 145 to 148 are set conventionally for collection of 5p, 2p, 10p and 50p coins respectively. The third and fourth apertures 143 and 144 are for collection of the Xp and Yp coins respectively.

With reference now also to Figure 3, the setting of the threshold at the aperture 144 is precisely as it would conventionally be for reception of the Yp coin, namely with the innermost edge 16 at the aperture 144 at a spacing from the reference edge 13 very slightly larger than 22mm. The innermost edge 16 at the aperture 143 is on the other hand set at a spacing from the edge 13 of the rim 11, less than this. But the rim 11 is undercut throughout a region extending from the second aperture 142 through towards the end of the third aperture 143 at least. This, as shown especially by Figures 3 and 4, establishes an auxiliary reference edge 17 outward of the reference edge 13, and it is from this that the edge 16 of the aperture 143 is set to have a spacing of 22mm. The undercutting which flares out from, and then back to, the edge 13, has a maximum depth of some 0.75mm throughout the sector including the aperture 143, and a height of some 2.16mm from the face 9 of the plate 10 so as to leave the edge 13 uninterrupted above this (to a height of some 3.7mm). Thus coins having a diameter of 22mm and a thickness less than 2.2mm, namely those of the Xp-denomination, will abut the auxiliary reference edge 17 in their passage to the aperture 143, whereas those of the same diameter and greater thickness, namely those of

the Yp-denomination, will remain in abutment with the main reference edge 13 throughout, and pass over, rather than under, the finger 18 of the actuator plate 15 for aperture 143. It is only therefore the Xp coins that, passing under this finger 18, will be received by the aperture 143, whereas the Yp coins will pass over the aperture 143 to be received by the aperture 144.

Coins of the 2p- and 5p-denominations (thicknesses of 1.80 and 1.73mm respectively) will approach the aperture 143 in abutment with the auxiliary reference edge 17, whereas those of the 10p- and 50p-denominations (thicknesses of 2.31 and 2.29mm respectively) will approach it in abutment with the main reference edge 13. Nonetheless they will all pass over the aperture 143, and also the aperture 144, since each has a diameter outside the diametral thresholds established at those apertures.

The present invention is applicable to coin-handling equipment other than of the particular kind described above. More especially it is applicable to equipment of the kind in which coins are fed in turn to roll down an incline for sorting or other selection. As with the machine described above with reference to Figures 1 to 4, the diametral thresholds for selection of the different denominations may be established in apertures through which the coins of the relevant denominations fall. However, such thresholds may alternatively be established in a series of deflectors which are spaced from one another down the incline and which serve to tip coins of the relevant denominations off the incline into appropriate chutes for collection; with this form of equipment coins of the larger diameters are selected first, the height setting of the deflectors above the incline decreasing progressively down the incline-

length. A machine of this specific form and incorporating provision in accordance with the present invention for discriminating between different coin-denominations of the same diameter, is illustrated in Figures 5 and 6; the deflectors and chutes appropriate for selection of coins of only the 5p-, Yp- and Xp-denominations are shown in these figures.

Referring to Figures 5 and 6, coins roll under gravity down an inclined shoulder 30 of a plate 31 that is tipped back slightly out of the vertical so that the rolling coins rest against the plate 31 to maintain them in positive abutment with the shoulder 30. The shoulder 30 extends over coin-chutes 32, 33 and 34 that are to receive coins of the 5p-, Yp- and Xp-denominations respectively, tipped from the shoulder 30 by individual deflectors 35,36 and 37. Each deflector 35,36 and 37 is of shaped sheet-metal and serves to lift any rolling coin that comes into contact with it, up from the plate 31 through the vertical so that such coin falls from the shoulder 30 into the respective chute 32,33 or 34. The deflectors 35 and 36 are set to heights above the shoulder 30 (of slightly less than 23.59mm and 22mm respectively) at which they will just be contacted by coins of the 5p- and Yp-denominations respectively. Thus coins of these two denominations will be deflected to fall into the chutes 32 and 33 in the conventional way.

Coins of the Xp-denomination will roll down the shoulder 30 past the deflector 35 without making contact with it, and indeed will pass the deflector 36 also without making contact. In this latter respect the abutment surface 38 of the shoulder 30 is recessed in the region of the deflector 36 so as to establish a narrow, inner slot 39 that is wide enough to receive easily coins

having the thickness (1.45mm) of the Xp-denomination, but is too narrow to receive coins have the thickness (3mm) of the Yp-denomination. Accordingly, whereas coins of the Yp-denomination do not enter the slot 39 in their approach to the deflector 36 and are therefore tipped from the surface 38 into the chute 33 by that deflector 36, coins of the Xp-denomination roll past the deflector 36 within the slot 39, and having cleared it, pass on to the deflector 37. The slot 39, which is flared at its upper end to ease coin entry, is in this case not confined to the region of the deflector 36 but extends throughout the remaining length of the incline below the deflector 36. Thus coins of the Xp-denomination are in abutment with the bottom 40 of the slot 39 on reaching the deflector 37; the threshold for tipping these coins into the chute 34 is therefore set by positioning the deflector 37 with respect to this auxiliary reference rather than to the reference established by the abutment surface 38.

The deflectors (not shown) lower down the incline will be set to denomination-size thresholds appropriately related to one or the other of the reference abutments, 38 and 40, according to whether the relevant denomination has a characteristic thickness smaller or larger than the width of the slot 39. If the slot-width is in excess of 1.52mm, coins of the 1p- as well as of the ½p-denomination will run in the slot 39 and deflectors for them will accordingly be set to the appropriate diametral-thresholds with respect to the slot-bottom 40.

The slot 39 need not run the length of the incline but can be confined to the region of the deflector 36 above, so that in reaching the deflector 37 coins of the Xp-

denomination (and any other) are again in abutment with the surface 38. The deflector 37 will then be set to a height of slightly less than 22mm above the surface 38 at which it will just be contacted by such coins to tip these into the chute 34.

The present invention is also applicable to equipment in which one or more sensors, in particular photo-sensors, are used to discriminate between coin-denominations on the basis of diametral size. Where photo-sensors are used, two or more are commonly located at positions spaced from a reference abutment in accordance with the relevant coin-diameter, such that the edge of the coin interrupts passage of light to one sensor when the light to the other is also just interrupted. If in accordance with the present invention provision is made for coins of different denominations to be submitted to the sensors against one or the other of two reference abutments in dependence upon their thickness, then as with the machines described above, discrimination between coins of the Xp- and Yp-denominations can readily be achieved. An example of equipment operative in this way, is illustrated in Figure 7.

Referring to Figure 7, coins pass through light that illuminates an array of photodetector devices 50 to 59 so that each such coin interrupts incidence of the light on a certain combination of those devices according to its diameter. However the particular combination to which the light is in this way interrupted also depends on which of two rails 60 and 61 the coin abuts in its passage past the array. Thus if coins are caused to run on the rail 60 or the rail 61 in dependence upon their thickness (or some other distinguishing characteristic), it is possible to discriminate between coins of

different denominations but equal diameter, simply by reference to the particular combination of devices 50 to 59 from which a transitory change in output signal occurs. More especially in the particular case illustrated, discrimination can be achieved simply by detecting in an electronic recognition unit 62 connected to all the devices 50 to 59, whether or not there is change in output of the one device, the device 57, when change in output of one or more of other devices, specifically the devices 50 to 56, occurs.

The present invention has the especial advantage that it readily allows existing equipment to be modified to discriminate between coins of the same diameter but different denominations. In most cases such modifications will only necessitate the machining of a groove in, or otherwise undercutting, a rim or shoulder of the equipment. However, although the invention has been described above with reference to Figures 1 to 6 in terms of an undercut or groove to accommodate the thinner coin, the invention is not limited in this respect; as with the embodiment described with reference to Figure 7, two separate tracks or other surfaces, one to provide an abutment for the thicker coin and the other to provide an abutment for the thinner, may be utilized. Also, although the invention has been described above in relation to currency of the United Kingdom, it is equally applicable to discrimination between coins of other currencies. Moreover, the present invention is not limited to circumstances in which discrimination between coins of equal diameter but different denomiantions is related to thickness; it is possible to discriminate on the basis of weight or some other distinguishing characteristic and utilize this to determine which abutment is effective for each coin.

Furthermore the present invention may be applied to discrimination between denominations of unequal coin diameter, and as such may be of especial advantage where the diameter difference between the two denominations is insufficient to enable that to be utilized for sure discrimination between them.

CLAIMS

1. A method for discriminating between coins of different denominations in which discrimination is effected by determining whether each individual coin lies within or outside a threshold (143; 36; 57) of diametral size that is related to a reference abutment (13; 38; 60) for the coin, characterised in that the determination of the relationship of each coin to the said threshold (143; 36; 57) as aforesaid is carried out with the coin abutting one or the other of two reference abutments (13, 17; 38, 40; 60, 61) in dependence upon whether or not that coin has a characteristic, other than of diameter, which as between two denominations is distinctive of one denomination or the other, the two abutments (13, 17; 38, 40; 60, 61) being displaced with respect to one another such that a coin of a predetermined diameter lies within or outside the said threshold (143; 36; 57) in dependence upon which of the two abutments (13, 17; 38, 40; 60, 61) the coin abuts during said determination.

2. A method according to Claim 1 characterised in that said characteristic is thickness, the individual coins abutting one or the other of the two abutments (13, 17; 38, 40; 60, 61) during said determination in dependence upon their thickness.

3. A method according to Claim 1 or Claim 2 characterised in that the threshold is established in the size of an aperture (143) through which a coin of the predetermined diameter will pass only when in abutment with one (17) of the two reference abutments (13, 17).

4. A method according to Claim 1 or Claim 2 characterised in that the threshold is established in the spacing of a deflector device (36) from one (38) of the two reference abutments (38,40) such that a coin of the predetermined diameter will be deflected by the deflector device (36) only when in abutment with this one (38) of the two reference abutments (38,40).

5. A method according to Claim 1 or Claim 2 characterised in that the threshold is established in the location of a sensor device (57) with respect to one (60) of the two reference abutments (60, 61) such that a coin of the predetermined diameter is sensed by the sensor device (57) only when in abutment with this one (60) of the two reference abutments (60, 61).

6. Apparatus for discriminating between coins of different denominations in which a threshold (143; 36; 57) for gauging coin diameter is established with respect to a reference abutment (13; 38; 60), and coins are presented to the threshold (143; 36; 57) abutting the reference abutment (13; 38; 60) for determining whether they lie within or outside the said threshold, characterised in that a second reference abutment (17; 40; 61) displaced from the first-mentioned reference abutment (13; 38; 60) is provided, and that each individual coin is presented to the threshold (143; 36; 57) in abutment with one or the other of the two reference abutments (13, 17; 38, 40; 60, 61) in dependence upon whether or not that coin has a characteristic, other than of diameter, which as between two denominations is distinctive of one denomination over the other, the displacement of the two abutments (13, 17; 38, 40; 60, 61) from one another

being such that a coin of a predetermined diameter lies within or outside the said threshold (143; 36; 57) in dependence upon which of the two abutments (13, 17; 38, 40; 60, 61) the coin abuts during said determination.

7. Apparatus according to Claim 6 characterised in that said characteristic is thickness, that the two reference abutments (13, 17; 38, 40; 60, 61) are being arranged such that all coins are urged towards abutment with the same one (17; 40; 61) of the reference abutments (13, 17; 38, 40; 60, 61) at the location of said threshold (143; 36; 57), and that any coin of more than a predetermined thickness is obstructed at that location from abutment with the said one reference abutment (17; 40; 61) by the other reference abutment (13; 38; 60).

8. Apparatus according to Claim 7 characterised in that a surface (9; 31) against which coins lie in movement into the location of said threshold (143; 36), and a recessed element (11; 30) upstanding from said surface (9, 31) to provide the two reference abutments (13, 17; 38, 39) .

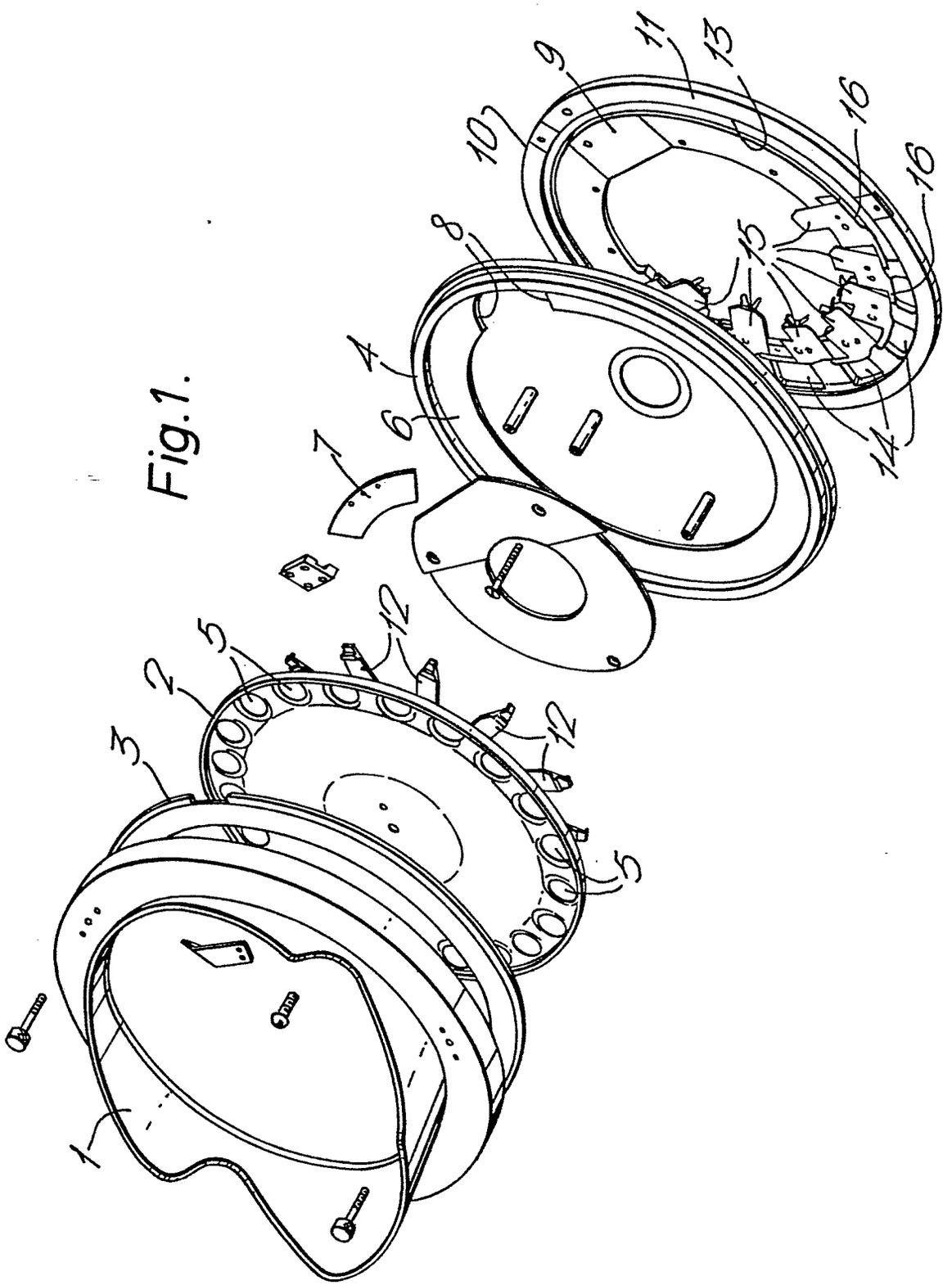


Fig.1.

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Fig.2.

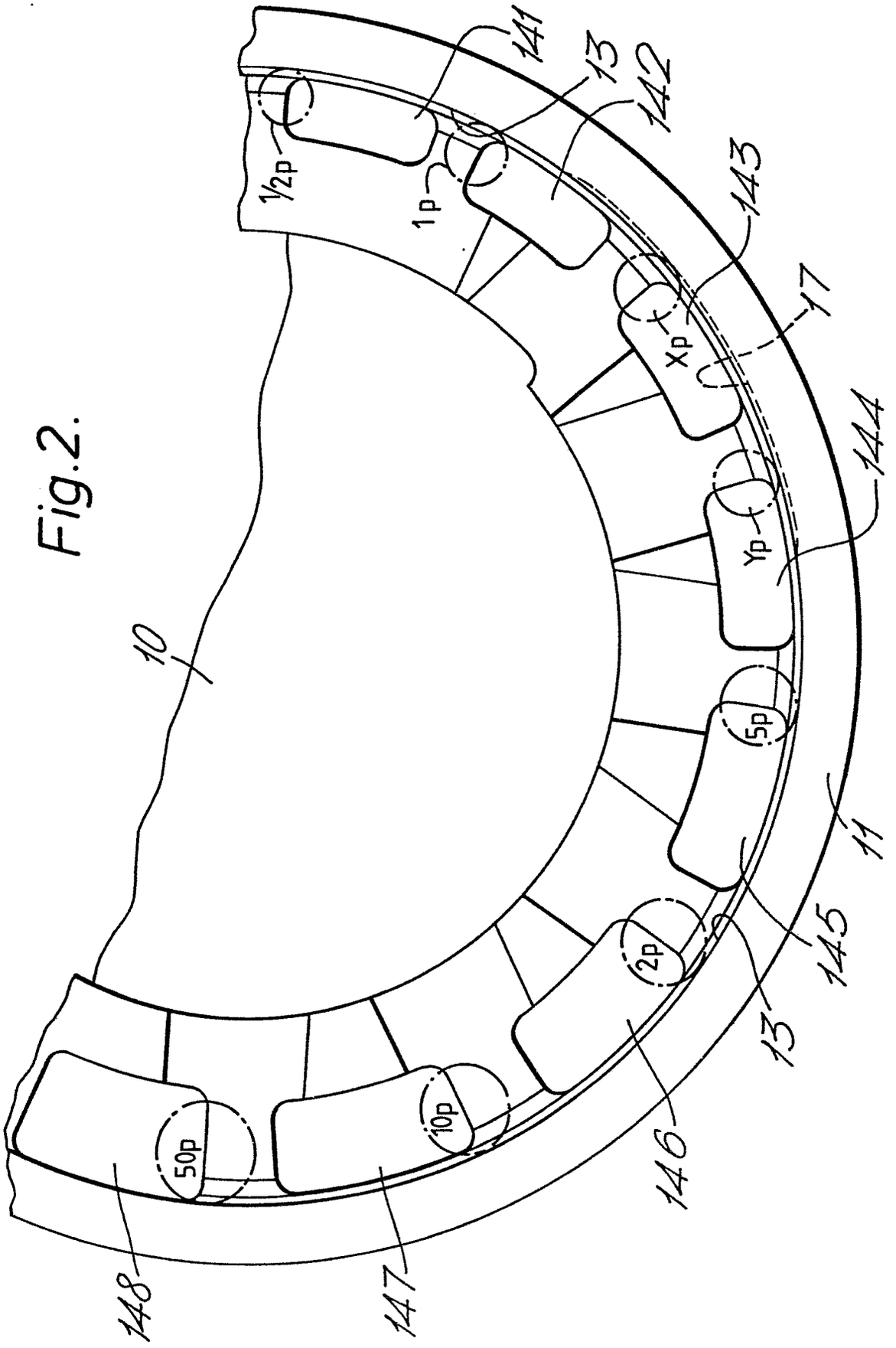

Fig.3.

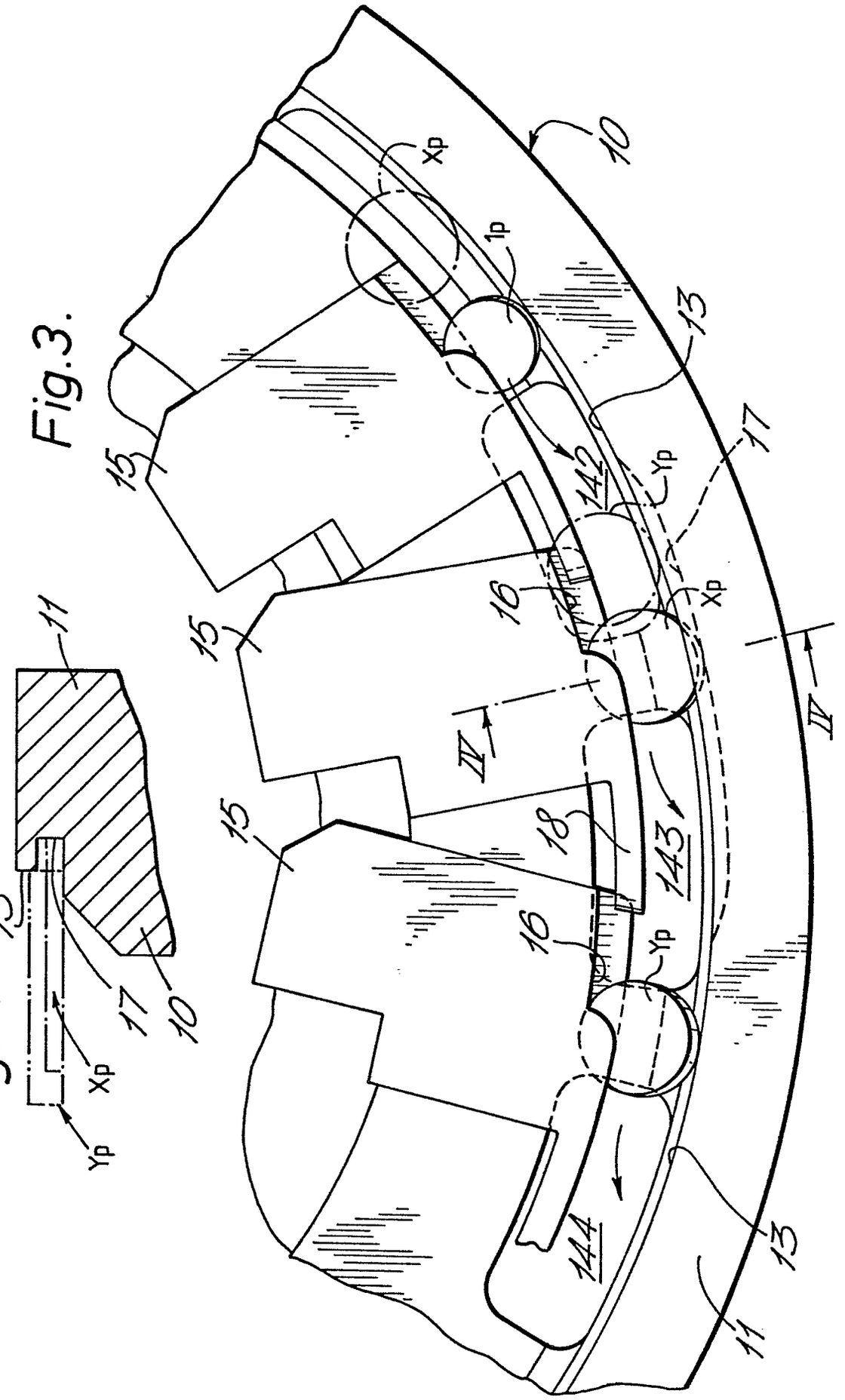
10
Xp
1p
13
15
142
Yp
17
16
Xp
IV
IV
15
18
143
16
Yp
144
13
11

Fig.4.

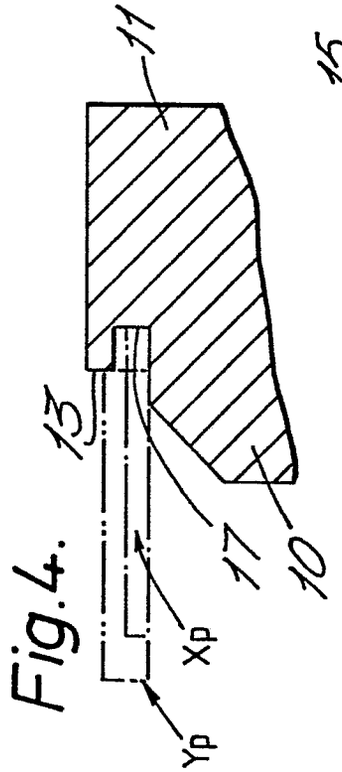
11
13
17
10
Xp
Yp

Fig.5.

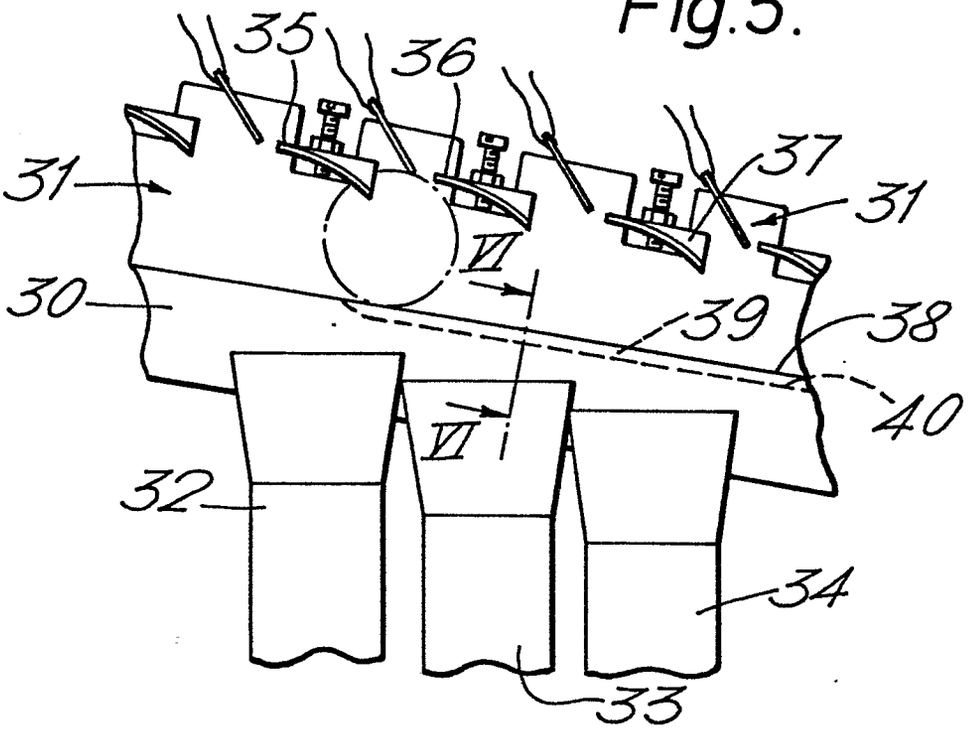

Fig.6.

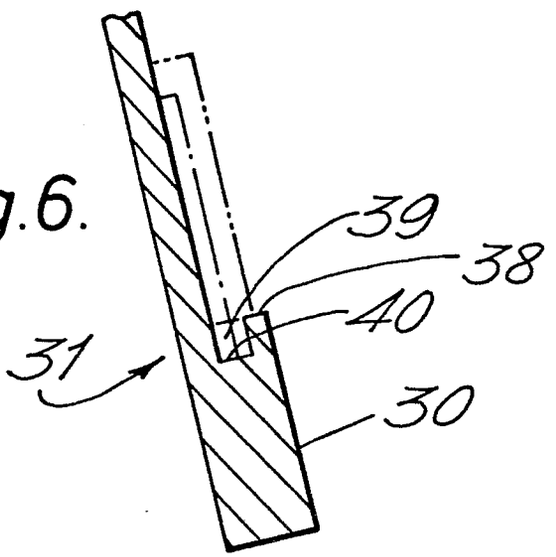

Fig.7.