(57) Claim

1. A method of making a rough classification of objects according to shape, comprising:

    passing the objects in succession through a viewing zone;

    in the viewing zone, sensing the presented area of each object with at least three viewers which view along angularly spaced axes; and

    comparing signals dependent upon the presented area from each respective viewer which are dependent upon the presented area, to make a rough determination of the shape of the object.

2. The method of Claim 1, wherein a rough determination of the size of the object is also made.

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11. Apparatus for making a rough classification of objects according to shape, comprising:

means defining a path of the objects through a viewing zone;

at least three viewers for sensing the presented area of each successive object when it is in the viewing zone, along angularly spaced axes; and

means for comparing the presented areas as sensed by the respective viewers and thereby giving a signal according to the shape of the object.

12. The apparatus of Claim 11, wherein the means for comparing the presented areas is also arranged to make a rough determination of the size of the object.

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TO BE COMPLETED BY APPLICANT

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Complete Specification for the invention entitled:

     CLASSIFYING OBJECTS

The following statement is a full description of this invention,
including the best method of performing it known to me/us:-

7850A:rk

CLASSIFYING OBJECTS

Background of the Invention

EP-A-0 22 404 describes a way of sorting objects according to shape, which can provide an accurate sort.
5 However, such accuracy is not always required, and it is desirable to be able to make a rough sort using less expensive equipment.

The Invention

The present invention provides a method and apparatus in
10 which the objects are passed in succession through a viewing zone in which the presented area of each object is sensed with at least three viewers which view along at least three respective angularly-spaced axes, and the signals dependent upon the presented area from each
15 respective viewer which are dependent upon the presented area are compared to make a rough determination of the shape of the object.

Fundamentally, it has been realised that the arrangement of GB-A-2 165 943 can be used for making a rough sort
20 according to shape, employing only the part of the arrangement which senses the reduction in flux along the axis of projection, thereby detecting the presented

area. The detector which senses the forward-scattered illumination is not employed.

The invention also provides a method and apparatus for making a rough determination of the size, by summing the signals from each viewer, or selecting the signal representing the largest or smallest presented area sensed.

It is desirable to substantially prevent cross-talk, which can be a significant source of inaccuracy. There would be optical cross-talk if the same wave-lengths were used simultaneously for detecting area in different directions, for instance due to reflection from the surfaces of the objects, and, if the objects are translucent or transparent, due to refraction within the objects. Cross-talk can be prevented by using different wave-lengths, or by viewing in rapid succession. The advantage of using different wave-lengths is that the object can be viewed simultaneously with each wave-length, avoiding inaccuracy due to say spinning of the object. However, it is possible to obtain reasonable accuracy by viewing the object along the respective axes in succession; the object must be viewed by the different viewers in sufficiently rapid succession so that its orientation has not changed grossly between views; the rapidity of succession will depend on the amount that the object is expected to be

spinning or turning, but normally the views will be
taken in as rapid succession as possible and nearly
simultaneously.

Normally, the axes along which the object is viewed
would substantially intersect at the position of the
object when viewed.   There are preferably three axes in
orthogonal arrangement.

Although this not need necessarily be so, it is
preferred that the object be in free flight i.e.
unconstrained motion under gravity (preferably falling
vertically) when it is viewed; although the motion is
unconstrained, when viewed the object is preferably
projected by an accelerator to give greater throughput
and a better defined time interval between successive
objects (less time scatter).

Preferred Embodiment

The accompanying drawing reproduces Figure 2 of GB-A-2
165 943.   Just one source and detector are shown, but
there will be three such sources and detectors, viewing
along orthogonal axes.   GB-A-2 165 943 can be referred
to for details.

The apparatus of Figures 1-4 of GB-A-2 165 943 is used,
with the detector unit 32 switched off.   The object is

viewed in bright field illumination. It is preferred to
use different wave-length bands, rather than pulsing,
and the near infra-red is preferred for objects such as
diamonds, because of the reduction in signal absorption
due to diamond colour, all appearing grey under
infra-red; preferred band centres are 800, 900 and 1,000
nm. The microprocessor 41 is programmed to compare the
three areas as detected. If they are roughly equal, the
object can be sorted as a roughly cubic or spherical
object. If the areas are very unequal, the object can
be sorted as a flat.

If desired, the microprocessor 41 can also provide a
rough sort according to the size of the object, as
determined from the value of the presented area along
the orthogonal axes, for instance by summating the three
areas or by selecting the maximum or minimum size
presented i.e. one of the following, where A, B and C
are the three presented areas:-

a) $\dfrac{A + B + C}{3}$

b) Maximum of A, B and C.

c) Minimum of A, B and C.

The apparatus shown is primarily for sorting for
clarity, and is more complicated than it need be for the

present invention. For instance, the integrating
spheres 17 could be completely omitted.

Though diamonds are referred to above, and one use of
the invention is for sorting diamonds and boart, the
invention is also applicable for instance to sorting
foodstuffs to reject foreign matter – such foodstuffs
could be natural products such as peas or beans, or
manufactured items such as sweets.

The invention can be used for providing a physical sort,
ie separating out at least one category of the objects.
However, more generally, the sort can merely be a
classification – for instance an indication could be
given of the number of flats in a parcel of the objects,
without picking out the flats.

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The present invention has been described above purely by
way of example, and modifications can be made within the
spirit of the invention.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of making a rough classification of objects
according to shape, comprising:

passing the objects in succession through a viewing
zone;

in the viewing zone, sensing the presented area of
each object with at least three viewers which view along
angularly spaced axes; and

comparing signals dependent upon the presented area
from each respective viewer which are dependent upon the
presented area, to make a rough determination of the
shape of the object.

2. The method of Claim 1, wherein a rough determination
of the size of the object is also made.

3. A method of making a rough classification of objects
according to size, comprising:

passing the objects in succession through a viewing
zone;

in the viewing zone, sensing the presented area of
each object with three viewers which view along

orthogonal axes, while substantially preventing cross-talk; and

summing signals dependent upon the presented area from each viewer which are dependent upon presented area, to make a rough determination of the size of the object.

4. A method of making a rough classification of objects according to size, comprising:

passing the objects in succession through a viewing zone;

in the viewing zone, sensing the presented area of each object with three viewers which view along orthogonal axes; and

selecting the signal from the viewers representing the largest or smallest presented area sensed.

5. The method of Claim 3 or 4, wherein the method of Claim 1 is also performed.

6. The method of either Claim 1 or 2, wherein there are three said axes, in orthogonal arrangement.

7. The method of any one of the preceding Claims, wherein, to enable the viewers to sense the respective presented areas, radiation is projected towards the viewer and is interrupted in part by the object.

8. The method of any one of the preceding Claims, wherein near infra-red radiation is used to sense the presented areas.

9. The method of any one of the preceding Claims, wherein cross-talk is substantially prevented by using radiation of a different wave-length for each viewer, to sense the respective presented area.

10. The method of any one of Claims 1 to 7, wherein cross-talk is substantially prevented by viewing with each viewer in succession.

11. Apparatus for making a rough classification of objects according to shape, comprising:

    means defining a path of the objects through a viewing zone;

    at least three viewers for sensing the presented area of each successive object when it is in the viewing zone, along angularly spaced axes; and

means for comparing the presented areas as sensed by the respective viewers and thereby giving a signal according to the shape of the object.

12. The apparatus of Claim 11, wherein the means for comparing the presented areas is also arranged to make a rough determination of the size of the object.

13. Apparatus for making a rough classification of objects according to size, comprising:

means defining a path of the objects through a viewing zone;

at least three viewers for sensing the presented area of each successive object when ⌐t is in the viewing zone, along orthogonal axes;

means for substantially preventing cross-talk; and

means for summing the presented areas as viewed by the respective viewers and thereby giving a signal according to the size of the object.

14. Apparatus for making a rough classification of objects according to size, comprising:

means defining a path of the objects through a viewing zone;

at least three viewers for sensing the presented
area of each successive object when it is in the viewing
zone, along orthogonal axes; and

means for selecting the largest or smallest
presented area sensed and thereby giving a signal
according to the size of the object.

15. The apparatus of Claim 13, wherein the means for
summing the presented areas is also arranged to give a
signal according to the shape of the object.

16. The apparatus of Claim 14, wherein the means for
selecting the largest or smallest presented area sensed
is also arranged to give a signal according to the shape
of the object.

17. The apparatus of Claim 11 or 12, wherein there are
three said axes, in orthogonal arrangement.

18. The apparatus of any one of Claims 11 to 17, wherein,
to enable the respective viewers to sense the presented
areas, radiation is projected towards the viewer and is
interrupted in part by the object.

19. The apparatus of any one of Claims 11 to 18, wherein
near infra-red radiation is used to sense the presented
areas.

20. The apparatus of any one of Claims 11 to 19, wherein cross-talk is substantially prevented by using radiation of a different wave-length for each viewer, to sense the respective presented area.

21. The apparatus of any one of Claims 11 to 19, and arranged to view with each viewer in succession, to thereby substantially prevent cross-talk.

22. The apparatus of any one of Claims 11 to 21, and comprising means for receiving the shape and/or size signal and for physically sorting the objects according to shape and/or size.

23. A method of making a rough sort of objects according to shape and/or size, substantially as herein described with reference to the accompanying drawing.

24. Apparatus for making a rough sort of objects according to shape and/or size, substantially as herein described with reference to the accompanying drawing.

DATED this 14th day of October 1991

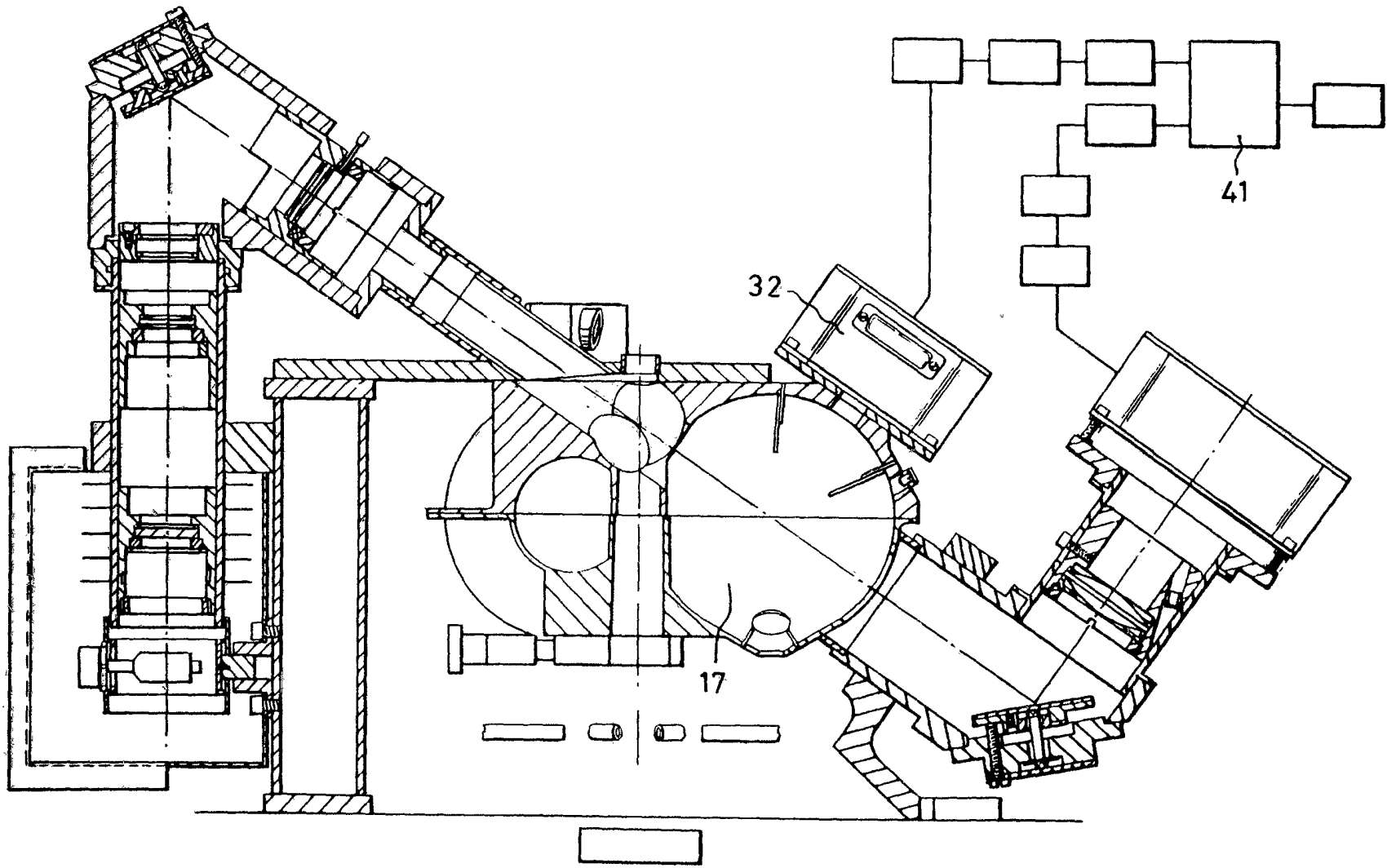SPANDREL ESTABLISHMENT
By their Patent Attorneys
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