

March 31, 1964

G. M. BAIGENT
SORTING OF ARTICLES

3,127,016

Filed March 6, 1961

5 Sheets-Sheet 1

Fig. 1.

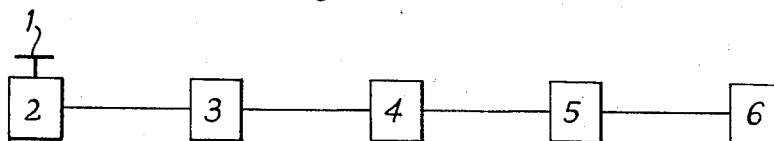
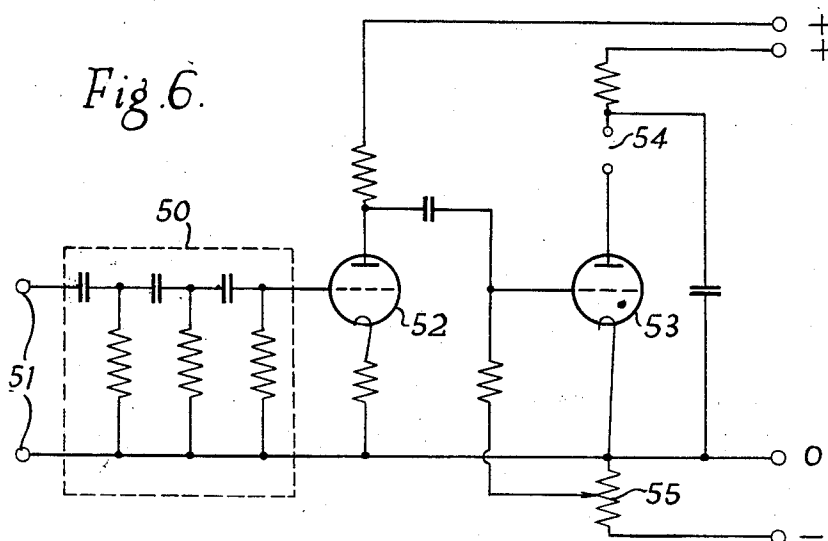


Fig. 6.



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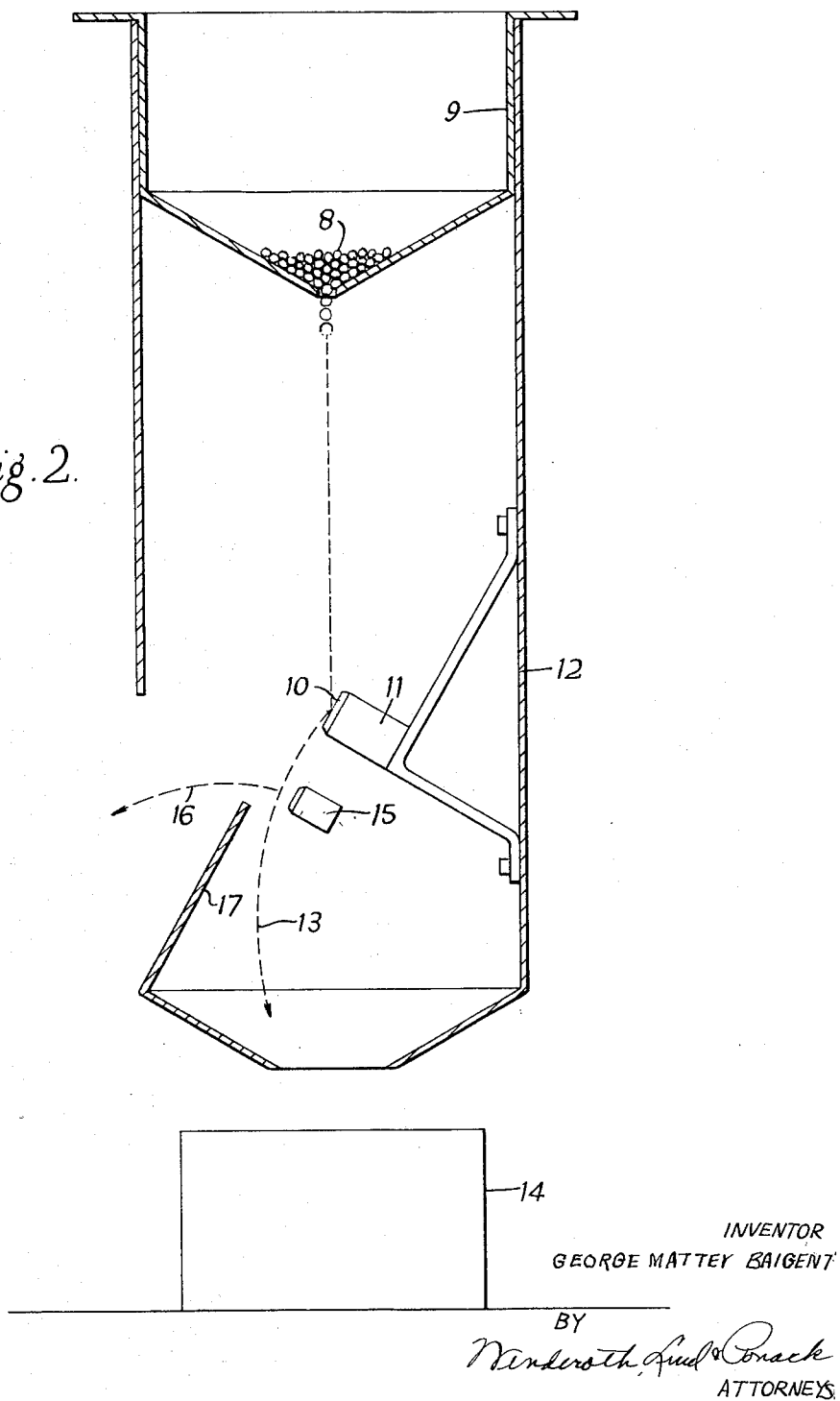
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Fig. 2.



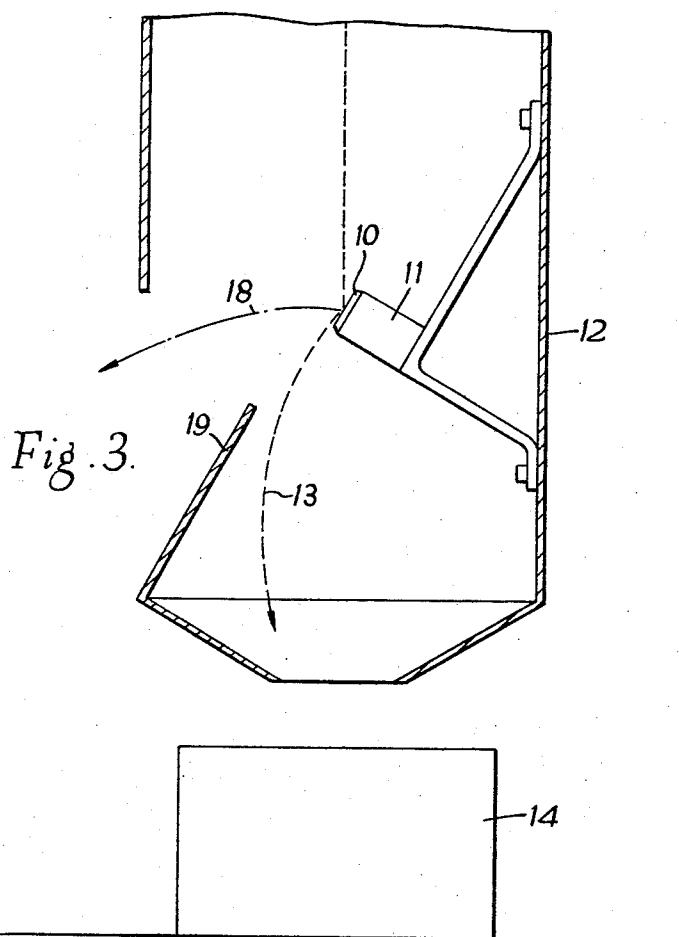
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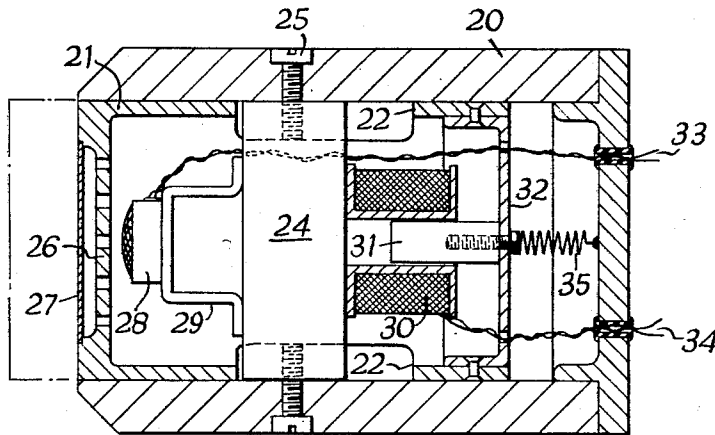


Fig. 4.

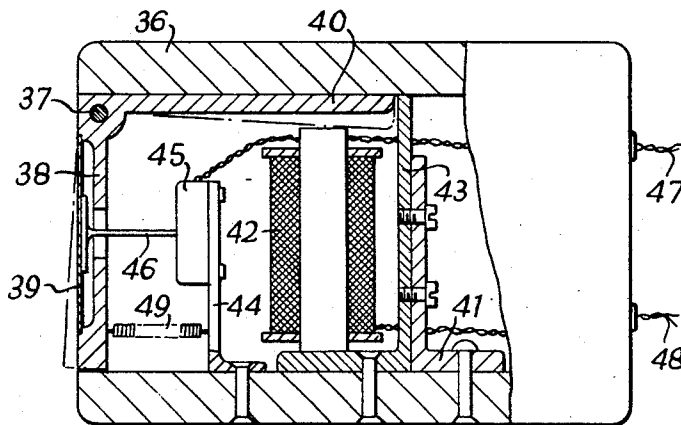


Fig. 5.

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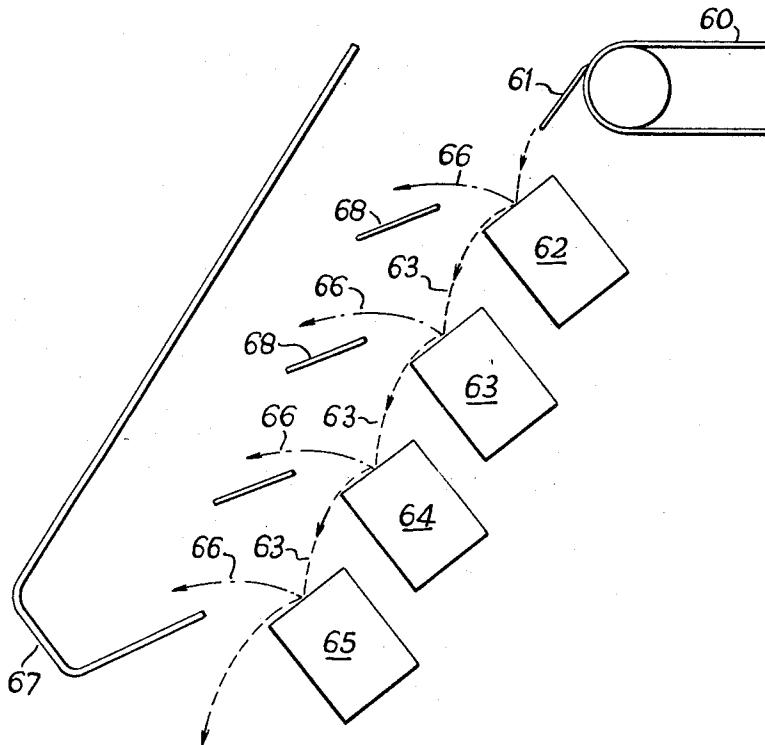
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Fig. 7.



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SORTING OF ARTICLES

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14 Claims. (Cl. 209-74)

This invention relates to the sorting of articles and more particularly to the case in which the articles to be sorted are delivered in a stream past an inspection point where they are examined and non-standard articles are separated from standard articles.

It is an object of the present invention to provide an improved method and apparatus for sorting articles in which sorting is effected in accordance with variation in a physical property of the articles such as hardness, density or elasticity.

The improved method of sorting articles according to the present invention consists in sensing the quality of impact as each article impinges on a target element and determining the path of movement of each article as it leaves the target element according to its quality of impact.

The invention also provides apparatus for sorting articles in accordance with a physical property thereof which comprises means for directing a stream of articles on to a target element, means for sensing the quality of impact of each article as it strikes the target element, and means for determining the path of movement of each article as it leaves the target element in accordance with the response of the sensing means.

As an illustration of the operation of the invention, reference may be made to the sorting of articles some of which are hard and some of which are soft, and it will be readily perceived that the quality of impact on the target element of a hard article will be different from that of a soft article. Likewise variation of density, or variation of elasticity e.g. because an article is cracked, may produce a difference in the quality of impact. It is by sensing such differences in the quality of impact that the path of movement of the articles on leaving the target element may be determined, the sensing means operating, for example, to cause an impulse to be applied to articles having a non-standard quality of impact so as to cause them to move over a path which is different from that taken by articles having a standard quality of impact.

In order that the invention may be clearly understood some forms thereof will now be described with reference to the accompanying drawings, in which:

FIGURE 1 is a diagrammatic representation of one sorting system of this invention,

FIGURE 2 is a diagrammatic view of one form of sorting apparatus in accordance with the invention,

FIGURE 3 is a diagrammatic view showing a modification of the apparatus of FIGURE 2,

FIGURES 4 and 5 are diagrammatic sectional views of alternative forms of a combined target element and path determining means,

FIGURE 6 is a wiring diagram, and

FIGURE 7 is a diagrammatic view of a further form of sorting apparatus in accordance with this invention.

Referring firstly to FIGURE 1, the articles to be sorted are arranged to impact a target element 1. The quality of impact of an article on the target element is sensed by means of a transducer 2 which is arranged so as to produce an electric signal pulse as each article impinges on the target element. The transducer 2 may be of the electromechanical kind and is coupled with, or may form part of, the target element 1 so that the movement of the target element produced by the impact of an article thereon will

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generate a signal pulse. Alternatively, the transducer 2 may take the form of a microphone which is arranged adjacent the target element 1 so that the sound produced by impact will generate the signal pulse.

In either case the waveform of the signal pulse produced by impact will be representative of the quality of impact and hence of the physical property under examination since, considering for example the case of hard and soft articles, a hard article impinging on the target element 1 will produce a higher acceleration of the target element, or a sound of higher pitch, than will a soft article. Accordingly, by discriminating between signal pulses of different waveform, control signals may be derived which may be applied to determine whether the article is to be passed or rejected.

The signal pulses from the transducer 2 are accordingly fed to a discriminator 3 which is responsive to the steepness or rise time of the wavefront of the signal pulse. In one simple arrangement the discriminator 3 may consist of a filter network which, for example, may be arranged to transmit components of the signal pulse which have a frequency above a certain predetermined value. In another form of discriminator, the signal pulse may be differentiated and the resultant so obtained selected according to its amplitude. In a further form of discriminator, the time taken by the wavefront of the signal pulse to reach a certain magnitude may be measured and selection effected on the basis of the time so measured.

The output from the discriminator 3 is applied to an amplifier 4 which may if necessary include pulse shaping means, and the output of the amplifier is applied to control a gating, or trigger, circuit 5. Depending on the arrangement of the discriminator 3, this trigger circuit is effective, for example when an article is to be rejected, to provide a control signal which is capable of actuating a means 6 for determining the path of movement of an article after it leaves the target element 1. The path-determining means 6 may comprise an electromechanical or electropneumatic device of known kind which may be actuated to deflect the article to be rejected from the main stream leaving the target element.

FIGURE 2 shows diagrammatically one form of the sorting apparatus of this invention. Articles 8 to be sorted are arranged in a hopper 9 and are fed therefrom by means, not shown, so as to fall on to the target element 10 of a sensing device 11 which is mounted in a housing 12 in the path of the falling articles. Those articles having one quality of impact leave the target element 10 along the path 13 and fall through the open bottom end of the housing into a bin 14. Arranged below the target element 10 and adjacent the path 13 is a path-determining means 15 which may be an electromechanical or electropneumatic device and which operates on articles having another quality of impact to deflect them from the path 13 and into a new path 16 which takes them over the upper edge of a baffle 17 and out of the housing. Suitable electromechanical or electropneumatic path-determining means are known in the art and since the nature of their construction is unimportant they will not be described in detail herein, it being sufficient to point out that a control signal from the trigger circuit 5 of FIGURE 1 causes an electromechanical device to move so as to strike a passing article and thereby deflect it on to the path 16 or causes the valve of an electropneumatic device to open to release a blast of air with the same result.

In another form of the invention illustrated diagrammatically in FIGURE 3 the device 15 of FIGURE 2 is omitted and the path-determining means is constituted by the target element 10 itself. In such an arrangement, when an article to be rejected impinges upon the target element 10, the sensing means operates to cause the target element to be subjected immediately to a mechanical im-

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pulse which causes the article to rebound therefrom and move over the path 18 so that it again leaves the housing 12 over the top of a baffle 19.

Two examples of this latter form of the invention are shown diagrammatically in FIGURES 4 and 5. Referring firstly to FIGURE 4, the sensing and path-determining device comprises a hollow casing 20 within which there is slidable a sleeve 21. This sleeve has diametrically opposed slots 22 therein which provide clearance for a mounting pillar 24 secured with the casing by screws 25. The left-hand end of the sleeve 21 is closed by perforated wall 26 and the outer face thereof is recessed to provide clearance limiting the movement of a resilient diaphragm 27. Behind wall 26 is positioned a microphone 28 carried by bracket 29 on pillar 24. On the other side of the pillar a solenoid winding 30 is secured and an armature 31 for this winding is mounted on cross member 32 secured on the right-hand end of sleeve 21. Leads 33 connect the microphone 28 with the discriminator 3 (FIGURE 1) and leads 34 connect the solenoid winding 30 with the output of the trigger circuit 5 (FIGURE 1). In use, the application of a signal pulse to winding 30 will cause the sleeve to move suddenly towards the left in the drawing and thus to apply an impulse to an article in contact with diaphragm 27. The sleeve 21 is returned to its initial position by spring means 35.

Referring now to FIGURE 5, the device there shown comprises a casing 36 in which there is pivotally mounted at 37 a member 38 having diaphragm 39 and a rearwardly extending arm 40. Within the casing 36 is mounted by bracket 41 an electromagnet comprising a coil 42 and yoke member 43, the upper end of this yoke member being closely adjacent the free end of arm 40, and by bracket 44 an electromechanical transducer 45. The diaphragm 39 is connected with the transducer 45 by a push rod 46 one or both ends of which are located in a sleeve so that while movement of the diaphragm to the right is communicated to the transducer, movement to the left is not. In use, the output of the transducer 45 is applied over leads 47 to the discriminator and the signal pulses are applied to the electromagnet over leads 48 to cause the arm 40 to be attracted towards the coils 42 and hence the member 38 to move to the left to the position shown in dotted lines so as to apply an impulse to an article in contact with the diaphragm 39. The member 38 is normally retained in the position shown in full lines by a spring 49.

It will be appreciated that the devices of FIGURES 4 and 5 are required to respond to a signal pulse very quickly if an article is to be rejected since the signal pulse is created by impact of the article on the diaphragm 27 or 39 and if the response is too slow the article may have moved too far away from the diaphragm to be struck by it when it moves in response to the signal pulse. Accordingly the construction of these devices must be such as to minimize the inertia of the moving parts. It will also be appreciated that although the device of FIGURE 4 has been described as using a microphone, it may if desired use an electromechanical transducer and similarly the device of FIGURE 5 may use a microphone instead of an electromechanical transducer.

FIGURE 6 shows a wiring diagram of electronic equipment suitable for use with the devices of FIGURES 4 and 5. As shown, the equipment comprises a high pass filter 50, to the input terminals 51 of which the output from the microphone 28 of FIGURE 4 or transducer 45 of FIGURE 5 is applied, an amplifier 52 and a thyatron or cold cathode trigger tube 53 arranged in a self-extinguishing circuit, the output terminals 54 being connected with leads 34 and winding 30 of FIGURE 4 or leads 48 and coil 42 of FIGURE 5. As shown, an adjustable source of bias 55 is provided for tube 53 to control the level at which it fires.

In the operation of the invention when using the arrangement of FIGURE 3 with a device as shown in FIG-

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URE 4 or FIGURE 5 and the circuit of FIGURE 6, for example to sort out stones from a quantity of beans, the mixture will be arranged as described with reference to FIGURE 3 so that the beans and stones fall on to the target element 10, that is the diaphragm 27 of FIGURE 4 or 39 of FIGURE 5. Since the beans are relatively soft compared with stones, there will be a marked difference in the quality of impact and the wavefront of the signal pulse generated by the transducer when the target element is struck by a bean will be much less steep than it will be in the case of a stone. By suitable adjustment of the cutoff of the high pass filter 50, it may be arranged that there is little or no output from the filter when a bean impacts the target element and the trigger circuit will therefore not be operated. However, if a stone impacts the target element, the signal pulse will include higher frequency components which will be transmitted by the high pass filter and will cause the trigger circuit to operate. The sudden movement of the target element consequent on energization of the electromagnet by the trigger circuit will follow immediately on impact and will, as it were, kick the stone out of the path 13 normally followed by the beans and so that the stone passes along the path 18 and out of the housing.

The arrangement and mode of operation of the sorting apparatus of this invention will be dependent on the nature of the sorting which is to be effected. In some cases the articles to be sorted might be arranged to impinge on the target element one by one but in other cases this is not necessary. For example when sorting stones from a bulk of beans or peas it is highly important that all the stones are removed but it is unimportant if beans or peas are removed at the same time. Accordingly in such application it is practicable to shower the peas or beans to be sorted on to the target element since the signal pulse effecting rejection will only occur if a stone strikes the target element and it does not matter if a number of peas or beans are also rejected with the stone.

One example of a sorting apparatus embodying the invention and for use in such application is shown in FIGURE 7. Here, the articles to be sorted, for example peas with some stones, are carried on a conveyor 60 which may be of the belt or vibrator type to a short chute 61 down which they fall in a curtain and on to a first row 62 of target elements and path-determining means. From here the peas rebound and travel on the path 63 on to three more rows 64, 65 and 66 of target elements and path-determining means to fall from the last row into a hopper or into means which feed them to the next machine of a processing plant. The impact of stones on the target elements on the other hand causes the path-determining means to operate as previously described to apply an impulse to the stones which causes them to move on paths 66 and into a hopper 67 and the path 63 of the peas and the paths 66 of the stones are separated by baffles 68 which are suitably arranged having regard to the fact that the stones are usually irregularly shaped and may accordingly travel on a variety of paths when they leave the target elements. The construction and operation of the individual target elements and path-determining means may be as described above with reference to FIGURES 4 and 5. The target elements themselves are preferably rectangular in shape and arranged side by side to form a row of the required length.

It will be appreciated that the invention is not confined to the sorting of stones from beans or peas or even to the sorting of hard articles from soft articles. Obviously if it were desired to remove soft articles from a bulk of hard articles exactly the same apparatus could be used except that in this case the path-determining means would be actuated in response to signal pulses having a wavefront which is less steep than normal and if a filter network is used as a discriminator a low pass filter instead of a high pass filter would be required. It will also be appreciated that if articles having different qualities of

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impact impinge simultaneously on the target element, all of them will move on the same path away from the element. This, however, will normally be immaterial if the number of articles having one quality of impact is relatively small.

I claim:

1. Apparatus for sorting articles in accordance with a physical property thereof, comprising a target element, means for directing a stream of articles on to said target element, means for sensing the quality of impact of each article on said target element, and means for determining the path of movement of each article as it leaves said target element in accordance with the response of said sensing means.

2. Apparatus as claimed in claim 1, wherein said sensing means is an electromechanical transducer which is responsive to the movement of said target element on impact of an article thereon.

3. Apparatus as claimed in claim 1, wherein said sensing means is an electro-acoustic transducer which is responsive to the sound of impact of an article on said target element.

4. Apparatus for sorting articles comprising a target element, means for directing a stream of articles on to said target element, means associated with said target element for sensing the quality of impact of said articles thereon, and means operative in response to said sensing means for diverting from the stream of articles leaving said target element articles having a predetermined quality of impact.

5. Apparatus according to claim 4, in which said diverting means is an electromechanical device operative to strike articles having a predetermined quality of impact out of the main stream of articles.

6. Apparatus according to claim 4, in which said diverting means is an electropneumatic device operative to blow articles having a predetermined quality of impact out of the main stream of articles.

7. Sorting apparatus comprising a target element, means for feeding articles to be sorted so as to impinge said target element and so as to be deflected therefrom on to a first path, a transducer associated with said target element providing electric signals representative of the quality of impact of said articles on said target element, and means operative in response to electric signals representative of a predetermined quality of impact for applying an impulse to said target element whereby to deflect articles adjacent thereto on to a second path.

8. Sorting apparatus comprising a target element, means for feeding articles to be sorted in a stream on to said target element so as to be deflected thereby a transducer associated with said target element for providing electric signals representative of the quality of impact of said articles on said target element, waveform discriminating means, means connecting the output of said transducer with said discriminating means, electromagnetic means operatively connected with said target element and means connecting the output of said discriminating means with said electromagnetic means.

9. Sorting apparatus comprising a movable target element, electromagnetic means coupled with said target element for movement thereof, means for feeding articles to be sorted so as to impact said target element, a transducer associated with said target element for providing electric signals representative of the quality of impact of said

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articles on said target element, waveform discriminating means connected with said transducer, a trigger circuit receiving output from said discriminating means and means connecting the output of said trigger circuit with said electromagnetic means.

10. Sorting apparatus including a target element adapted to be disposed in the path of a stream of articles to be sorted, said target element comprising a diaphragm, a transducer, means connecting said diaphragm and said transducer for transmitting to said transducer movement of said diaphragm occasioned by the impact of an article thereon, and electromagnetic means operatively connected with said diaphragm for effecting a bodily movement thereof.

11. Sorting apparatus including a target element adapted to be disposed in the path of a stream of articles to be sorted, said target element comprising a diaphragm pivotally mounted at one edge thereof, electromagnetic means for moving said diaphragm about said pivotal mounting, an electromechanical transducer and means operatively connecting said diaphragm and said transducer.

12. Sorting apparatus including a target element adapted to be disposed in the path of a stream of articles to be sorted, said target element comprising a diaphragm, an electro-acoustic transducer adjacent said diaphragm and responsive to the sound of impact of an article thereon, and electromagnetic means operatively connected with said diaphragm for effecting when energized a bodily movement thereof.

13. A method of sorting articles which consists of feeding the articles in a stream onto a target element, sensing the quality of impact of the articles as they impinge on the target element, and, when the quality of impact is other than a quality of a predetermined nature, acting on the target element itself substantially at the moment of impingement of the article on the target element with a force which is independent of the force applied to the target element by the impingement of the article for changing the path of movement which the article takes as it leaves the target element to a path other than the path the article would take were it not acted upon by said independent force.

14. A method of sorting articles which consists of feeding the articles in a stream onto a target element, sensing the quality of impact of the articles as they impinge on the target element, and, when the quality of the impact is other than a quality of a predetermined nature, acting on the article after it has struck the target element and has left the target element to change the path of movement which the article takes as it leaves the target element to a path other than the path the article would take were it not acted upon.

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