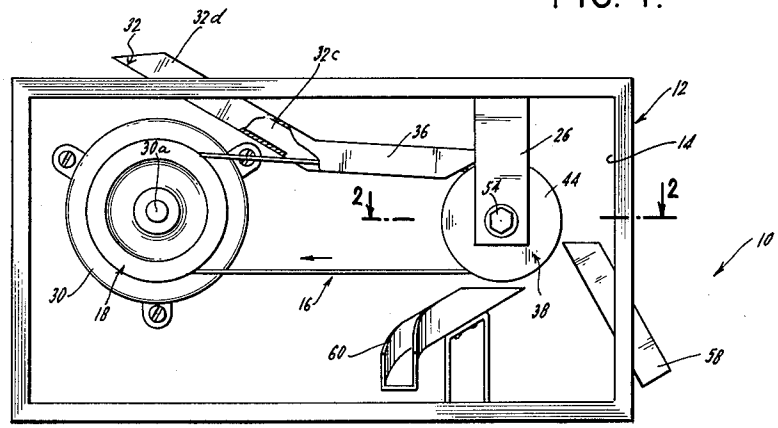
Oct. 9, 1962 M. RAPPAPORT 3,057,477

PILL SORTING APPARATUS

Original Filed May 27, 1958

FIG. 1.



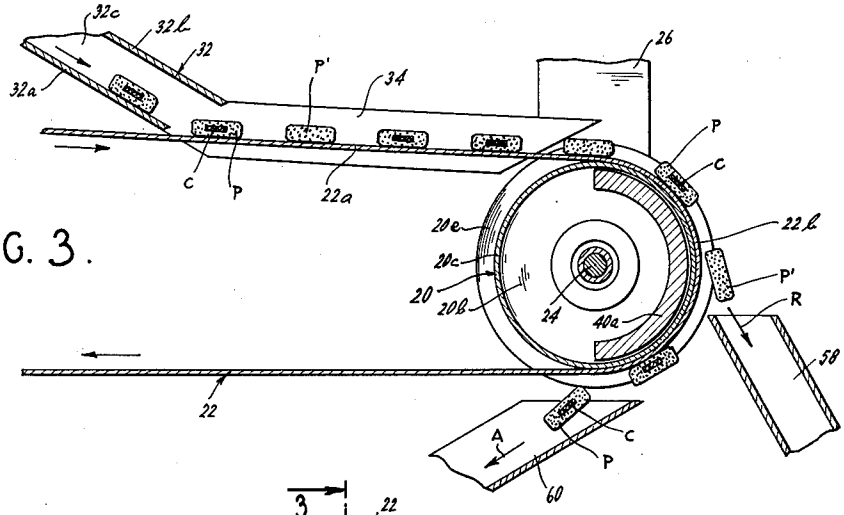


FIG. 3.

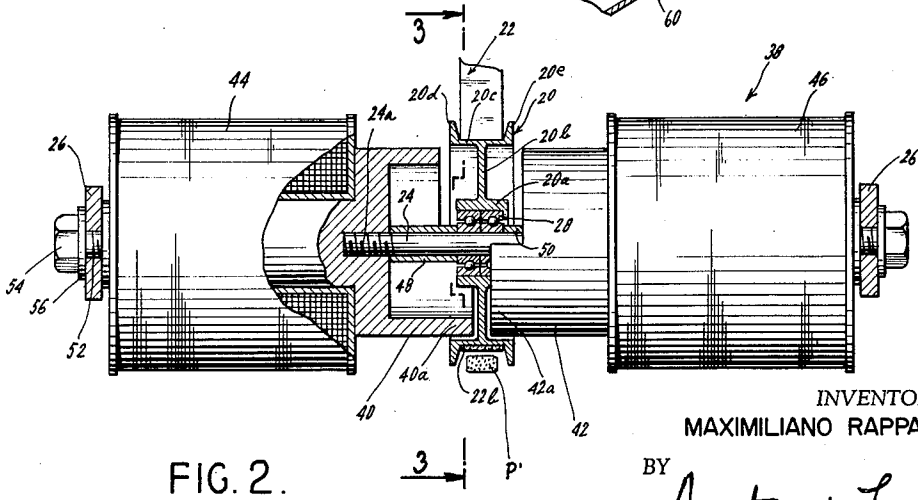


FIG. 2.

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PILL SORTING APPARATUS

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3 Claims. (Cl. 209—223)

The present invention relates to apparatus for the sorting of tablets or pills, and in particular to improved methods and apparatus for sorting pills of the type which include a core contained within an outer coating or shell. This application is a continuation of my pending United States patent application entitled "Sorting Apparatus," Serial No. 738,173 filed May 27, 1958, now forfeited.

In the dispensing of medication, many situations arise wherein it is necessary to incorporate a pill within a pill, usually in the form of a core contained within an outer shell or coating. The purpose of such multiple layer or core-containing pills or tablets is to achieve delayed action in dispensing the medication and/or to separate the ingredients where the ingredients may be incompatible for one reason or another.

With the widespread use of this type of pill or tablet, a problem has been presented to the pharmaceutical industry of testing for the presence or absence of the core or inner layer of the pill such that pills which do not contain the core or inner layer may be sorted out from those containing the core or inner layer. A high order of reliability in selection or sorting of such pills is essential, for the failure to detect those pills which do not contain a core or inner layer ultimately would result in the administering of improper medication to the patient. Heretofore, one practice has been to X-ray successive pills to determine whether or not the pills contained the necessary core or inner layer. However this method of inspection has been found to be somewhat expensive and time consuming.

It is broadly an object of the present invention to provide an improved apparatus for sorting of pills of the type which include a core, which core is normally hidden from view by an outer layer or coating of the pill. Specifically, it is within the contemplation of the present invention to provide a relatively inexpensive high speed for ascertaining whether or not pills contain a core or inner layer, and for rejecting such pills which do not contain the necessary core or inner layer.

It is a further object of the present invention to provide an improved apparatus for sorting pills which exhibits a high order of reliability and requires substantially no attendance for the rapid and reliable sorting of core-containing pills from those which do not contain a core.

I have found that a new approach, as to apparatus, may be realized for the sorting of core-containing pills by the incorporation of a quantity of magnetically susceptible or paramagnetic material into the core of the pill whereby the presence or absence of the magnetically susceptible material gives an indication as to the presence or absence of the core for the sorting function. In connection with the use of such magnetically susceptible material in the core of the pill, investigation reveals that the presence of such material in the ultimate medication will have no deleterious or harmful effects upon the person receiving the medication.

In accordance with the present invention, pills of the aforesaid type are sorted by incorporating into the core thereof a traceable amount of magnetically susceptible material followed by the steps of estabilshing a magnetic field in the sorting zone, providing a sorting path for the pills including a prescribed course through the sorting zone from which pills do not contain the core will tend

to deviate to a rejection path diverging from said prescribed course, and moving successive pills through the sorting zone, whereby pills which do not include a core will be deviated to the rejection course and pills which do include a core will move along the prescribed course to a location at which the acceptable pills may be collected for final inspection and packaging.

In accordance with apparatus aspects of the invention, a pill-sorting device comprises conveying means which move the pills along a sorting path including a substantially linear path and a curved course merging into the linear course, a drive for the conveying means to move the conveying means at a rate such that the successive pills approaching the curved course are exposed to tangential and gravitational forces which tend to move the successive pills away from the curved course, and means which establish a magnetic field in the region of the curved course having a field strength sufficient to maintain successive core-containing pills along the curved course as a result of the magnetic attraction between the magnetic field and the paramagnetic material incorporated in the core of the pill. Advantageously, rejection means may be provided in the form of a chute positioned relative to the conveying means to receive pills that tend to move away from the curved course and indicate the absence of a core. Further acceptance means may be provided in the form of a chute positioned relative to the conveying means to receive core-containing pills which move along the curved course as a result of the magnetic attraction and the presence of the core within the pills.

The above brief description as well as further objects, features and advantages of the present invention will be best understood by reference to the following detailed description of the present invention when taken in conjunction with the accompanying drawings wherein:

FIGURE 1 is a front elevational view of a pill-sorting device demonstrating features of the present invention, with the front cover thereof removed in the interest of simplicity and clarity;

FIG. 2 is a sectional view taken substantially along the line 2—2 of FIG. 1, on an enlarged scale and with parts broken away and sectioned in the interests of clarity, showing the means for establishing the magnetic field in the sorting zone of the device; and

FIG. 3 is a sectional view taken substantially along the line 3—3 of FIG. 2 looking in the direction of the arrows and illustrating the sorting function at the sorting zone, with a number of pills (some of which contain cores and others which do not contain cores) shown on the conveyor belt.

Referring now specifically to the drawings, there is shown a pill-sorting device, generally designated by the reference numeral 10, suitable for the sorting of successive pills P which contain cores C from pills P' which are deficient in that they do not contain a core. The pill or tablet P shown in the drawings is purely illustrative of the many different types of multiple layer medicant-dispensing means which are now in the market and may be sorted in accordance with the apparatus herein. For the purposes of sorting in accordance with the present invention, the cores C of the pills P have incorporated therein traceable small quantities of paramagnetic or magnetically susceptible material. A typical material which may be employed is iron oxide which is incorporated into the pill in an amount as little as 1 milligram per core, with an upper limit of the order of 25 milligrams per core. The incorporation of such iron oxide within the range disclosed herein is sufficient to achieve the sorting function, as will be detailed, yet is harmless when introduced into the human body. It is desirable to achieve the sorting function with as little magnetic material in the core as practical to avoid the introduction of this foreign sub-

stance into the body. Accordingly, the lowest content of magnetic material is to be employed commercially, consistent with achieving the sorting function.

The pill-sorting device 10 includes a housing 12 which may take many different forms, but is shown herein as being rectangular with an opening 14 in the front wall thereof. This opening is normally closed by a removable front cover (not shown) which provides ready means for access into the interior of the housing 12 for the purposes of servicing and/or replacement of the parts of the sorting device.

Mounted within the housing is a conveyor generally designated by the reference numeral 16, which includes a pair of pulley elements 18, 20 which are identical in structure and are fabricated of non-magnetic material. Since the pulleys are substantially identical in structure, it will suffice to describe the pulley 20 in detail. As seen best in FIGS. 2 and 3, the pulley 20 includes a central supporting hub 20*a* and a radially-extending body portion 20*b* which carries at the outer periphery thereof the rim 20*c* bounded at each of its sides by guide flanges 20*d*, 20*e*. The rim 20*c* and the guide flanges 20*d*, 20*e* cooperate to define a channelway or guideway in which the belt 22 is confined, with the flanges 20*d*, 20*e* providing lateral confining walls for the pills P as they enter the sorting region. As seen in FIG. 2, the lateral breadth of the pill guideway, as determined by the spacing between the flanges 20*d* and 20*e*, is between one and two pill diameters, so as to feed the pills through the sorting region single file. The belt 22 is likewise fabricated of non-metallic material and provides an upper horizontal or linear course 22*a* which receives the successive pills to be sorted which upper horizontal or linear course merges into a curved end course 22*b* which establishes the sorting zone or region in which the selection and rejection function takes place, as will be described hereinafter. The pulley 20 is journaled on a fixed shaft or spindle 24 of non-magnetic material which is supported to extend horizontally and transversely of the housing 14 by depending brackets 26. The pulley 20 is journaled on the spindle or shaft 24 by an appropriate ball bearing 28 (see FIG. 3) which has its inner race fixed to the shaft 24 and has its outer race fixed to the hub 20*a* of the pulley.

Drive is imparted to the conveyor 16 by turning the pulley 18, for example, by the use of an electric motor 30 which is shown herein to be bolted to the rear wall of the housing 12 and has the pulley 18 mounted on the motor shaft 30*a*. Although not shown, provision is made for varying the speed of the motor, for example by employing a variable speed motor, speed reduction gearing or the like such that the rate of linear travel of the belt 22 of the conveyor may be established at different values for the sorting function as will be described hereinafter.

Positioned along the upper run 22*a* of the belt 22 of the conveyor 16 is a delivery member 32 which is arranged to deliver the pills P one at a time to the upper course of the conveyor. The delivery member 32 is shown herein as an inclined chute which includes a lower wall 32*a*, an upper wall 32*b*, and opposite side walls 32*c*, 32*d*. The side walls 32*c*, 32*d* include integral continuations or extensions 34, 36 which serve as guide flanges at the opposite sides of the upper run or linear course 22*a* of the conveyor. The guide flanges 34, 36 terminate contiguous to the outer periphery of the pulley 20 at which the guiding function is taken over by the guide flanges 20*d*, 20*e* of the pulley. Although not illustrated, the pills are delivered one at a time into the delivery chute 32 at the required rate by means of a conventional hopper feeding mechanism of known structure so as to descend in spaced relationship. As indicated by the directional arrows, the pulley 18 is driven in a direction appropriate to move the successive pills from the delivery chute 32 toward the pulley 20, that is from left to right along the upper course in FIGS. 1 and 3. As seen in FIG. 3, the pills are maintained in spaced-apart relationship as they are deposited on the belt 22 so as to be moved by the belt along the remainder of the sorting course in a plane of unit, or single pill, thickness.

Appropriate means are disposed relative to the pulley 20 to establish a magnetic field substantially along the curved end course 22*b* about the belt 22. In this form of the invention this means incorporates an electromagnet assembly generally designated by the reference numeral 38. The electro-magnet assembly which is seen best in FIG. 2 includes pole pieces 40, 42 which are disposed at opposite sides of the pulley 20 with the pole pieces 40, 42 carrying respective coils 44, 46. The pole pieces 40, 42 include shoe portions 40*a*, 42*a* which extend within the limits of the pulley 20, that is within the outer rim portion 20*c* thereof and terminate short of the centrally disposed radially extending supporting body 20*b*. As seen best in FIG. 3 the respective shoe portion 40*a*, 42*a* of the pole pieces 40, 42 extend for approximately 180° of the pulley circumference, starting from a leading edge along a vertical central line through the spindle in a clockwise direction to a trailing edge along said vertical center line, that is from a position corresponding approximately to 12 o'clock (if the pulley 20 in FIG. 3 be considered to be a clock face) to a position corresponding to 6 o'clock. Accordingly the pole pieces 40, 42 with their curved shoes which have an arcuate extent of approximately 180°, establish a magnetic field having lines of flux which link the pole pieces 40, 42 in the region of the supporting rim 20*c* of the pulley 20 substantially along the entire length of the curved course 22*b* about the pulley 20. The magnetic field includes a magnetic gap defined by the pole pieces 40, 42 which is disposed symmetrically of and bridging the curved end course 22*b* of the sorting path.

As seen in FIG. 2, a rather simple arrangement is provided for assembling the magnetic structure 38 with the pulley 20 with the entire magnetic structure being stationary and supported on the brackets 26 and the pulley being journaled for rotation on its bearing 28. To this end the opposite ends of the spindle or shaft 24 are threaded, as indicated at 24*a*, and are received in appropriate axially-disposed corresponding tapped holes in the pole pieces 40, 42 with spacer sleeves 48, 50 being supported on the spindle 24 to establish the requisite spacing of the pole pieces 40, 42 in relation to the pulley 20. The entire assembly is suspended between the brackets 26 by the use of appropriate mounting studs 52 at the outer extremities of the pole pieces with corresponding lock nuts and washers 54, 56 on the studs 52.

The field strength of the magnetic field is established in relation to the rate of travel of the pills such that pills P' which do not contain the core having the magnetically susceptible material are diverted from the curved path 22*b* and move along a rejection path, indicated by the letter R and the directional arrow. Positioned along this rejection path R is a rejection chute 58 which receives those pills P' which do not have a core. An appropriate receptacle may be arranged at the lower end of the rejection chute to receive the pills P' from the chute 58. A further chute 60 is arranged along an acceptance path, designated by the directional arrow and the letter A, to direct pills containing the cores to an appropriate receptacle (not shown). It should be appreciated that the acceptance path is determined by the location of the trailing end of the pole pieces which establish the limit of the field of magnetic attraction for pills B containing cores.

In a typical illustrative embodiment, the coils of the electromagnet are identical and each have a hundred turns appropriate to carry three amperes such as to establish a field strength of approximately three thousand ampere turns over the rim 20*c* of the pulley 20. The width of the rim is usually of the order of 5 millimeters. With this relatively high order of field strength, the pills may be advanced into the sorting zone at a rate of ap-

proximately 20 pills per second, with a separation between successive pills of approximately one half of an inch.

A typical sequence of operations will now be described to facilitate a more thorough understanding of the invention:

The sorting device **10** is placed into operation by appropriate energization of the drive motor **30** to the conveyor **16** with the rate of travel established in relation to the field strength of the magnetic field such that successive pills moving along the curved path or course *22b* through the sorting zone will assume one of the two paths, depending upon the presence or absence of the core C containing the magnetically susceptible material. In the absence of a core, the gravitational and tangential forces in the region *22b* will be sufficient to divert the pill P' from the curved course defined by the conveyor to move along the rejection path R into the rejection chute **58**. As to those pills P which contain a core, the lines of flux which link the magnetically susceptible material in the core will be sufficient to cause the pills to remain on the conveyor, despite the gravitational and tangential forces which tend to cause the pills to travel away from the conveyor whereby such pills move into a position along acceptance path A whereupon, after leaving the magnetic field, the gravitational forces acting thereupon will cause the acceptable pills P containing the cores C to move into the acceptance chute **60**.

Since the described structure causes the pills to proceed along the sorting path single file and in a plane of unit thickness, only one pill is scanned by the sorting zone at a time, thus avoiding variations in performing caused by the physical or magnetic interference of one pill with another, and giving rise to a greater degree of discrimination.

From the foregoing it will be appreciated that there is provided herein an exceptionally simplified and improved apparatus for the automatic sorting of pills on a high speed basis with a high order of reliability in the sorting function. By appropriate establishment of the rate of travel of the conveyor and of the strength of the magnetic field, it is possible to accurately direct those pills containing the cores along one path, with the diversion of those pills which do not have a core along another path, even when there is a relatively small amount of magnetic material incorporated into the core.

A latitude of modification, substitution and change is intended in the foregoing disclosure. In some instances, some features of the apparatus disclosed herein will be used without a corresponding use of other features. Accordingly, it is appropriate that the claims be construed broadly in a manner consistent with the spirit and scope of the invention.

I claim:

1. A pill-sorting device for core-containing pills which incorporate a quantity of magnetically susceptible material in the core thereof comprising a housing, a pair of pulleys rotatably mounted in said housing, means mounting said pulleys on said housing for turning movement, an endless belt of non-magnetic material trained about said pulleys and providing upper and lower horizontal courses and curved end courses about said pulleys, drive means operatively connected to one of said pulleys, delivery means positioned to deposit successive pills on said upper course contiguous to said one pulley for movement toward the other pulley, a pair of spaced brackets secured to said housing, pole pieces of paramagnetic material each having an end secured to said brackets, a shaft threaded at each end and terminally threadedly secured to said pole pieces and extending therebetween, bearing means rotatably mounting said other pulley on said shaft, spacers about said shaft and engaging said pole pieces and said bearing means to space said pole pieces from said other pulley, magnetic coil means operatively disposed on said pole pieces to establish a magnetic field substantially along the curved end course about said other pulley such that core-containing pills will follow said curved end course and core-deficient pills will be diverted from said curved end course, a rejection chute positioned relative to said curved end course to receive core-deficient pills, and an acceptance chute positioned relative to said curved end course to receive core-containing pills.

2. A pill-sorting device according to claim 1, wherein said other pulley is provided with a pair of spaced flanges to define a pill guideway about said curved end course, said belt extending between said flanges, said flanges being spaced apart between one and two pill diameters to conduct said pills therethrough single file.

3. A pill-sorting device for pills which incorporate a quantity of magnetically susceptible material therein comprising a housing, a pair of pulleys rotatably mounted in said housing, an endless belt of non-magnetic material trained about said pulleys and providing upper and lower courses and curved end courses about said pulleys, drive means operatively connected to one of said pulleys, delivery means positioned to deposit successive pills on said upper course contiguous to said one pulley for movement toward the other pulley, a pair of spaced brackets secured to said housing, pole pieces of paramagnetic material each having an end secured to said brackets, a shaft threaded at each end and terminally threadedly secured to said pole pieces and extending therebetween, bearing means rotatably mounting said other pulley on said shaft, spacers about said shaft and engaging said pole pieces and said bearing means to space said pole pieces from said other pulley, magnetic coil means on said pole pieces to establish a magnetic field substantially along the curved end course about said other pulley such that acceptable pills, containing said magnetically susceptible material will follow said curved end course and rejectable pills deficient in said magnetically susceptible material will be diverted from said curved end course, a rejection chute positioned relative to said curved end course to receive rejectable pills, and an acceptance chute positioned relative to said curved end course to receive acceptable pills.

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