United States Patent [19]

Lehmann

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[54] **METHOD AND APPARATUS FOR SEPARATING SELECTED CIGARETTES OR ANALOGOUS ROD-SHAPED ARTICLES FROM A SERIES OF RAPIDLY MOVING EQUIDISTANT ARTICLES**

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[21] Appl. No.: **555,621**

[30] **Foreign Application Priority Data**

Mar. 5, 1970 Germany 2010392

Related U.S. Patent Documents

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Appl. No.: **120,293**
Filed: **Mar. 2, 1971**

[52] **U.S. Cl.** ..... **209/74 M;** 73/45.2
[51] **Int. Cl.²** **B07C 3/04**
[58] **Field of Search** ..... 209/73, 74, 74 M; 73/37.6, 45.2, 45.3, 45.1

[56] **References Cited**

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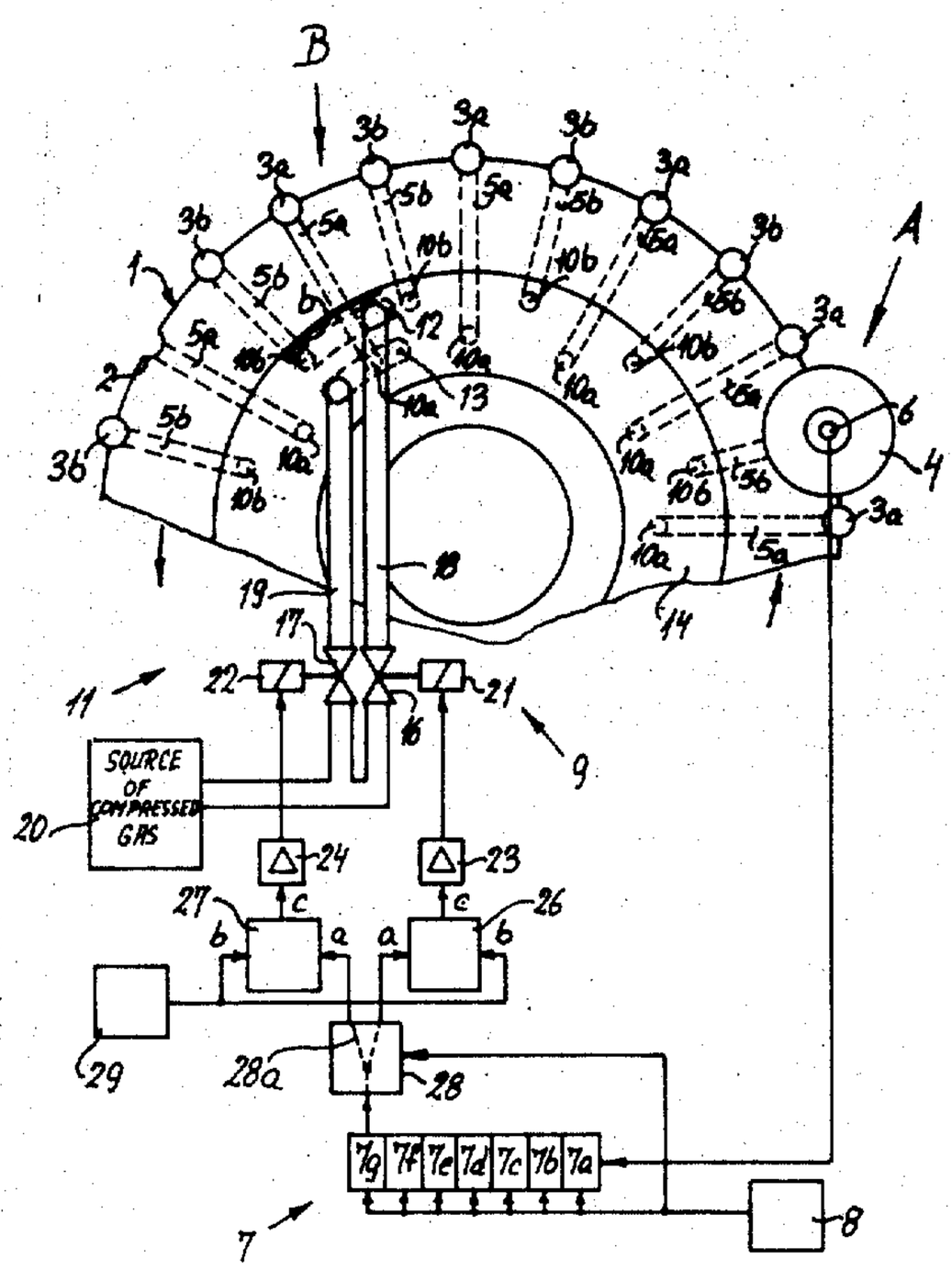
[57] **ABSTRACT**

Cigarettes or like rod-shaped articles are conveyed sideways in equidistant flutes of a rotary drum at a speed of at least one thousand articles per minute and along an ejecting station having a width which substantially exceeds and can be a multiple of the distance between a pair of neighboring flutes. Selected articles are ejected from their flutes in response to electric or pneumatic signals by being subjected to the action of a mechanical force and/or to the action of a force produced by a stream of gaseous fluid whereby the point of application of the force moves with the flute which contains the respective selected article while such flute travels through the ejecting station. The articles can be held in their flutes by suction or by mechanical means, and the suction or the mechanical retaining action is terminated when a selected article reaches the ejecting station so that the selected articles are separated under the action of gravity and/or under the action of centrifugal force. The action of gravity and/or centrifugal force can be assisted by directing against selected articles in the ejecting station one or more streams of a compressed gaseous fluid which are caused to move with the respective flutes at the same speed and in the same direction while such flutes travel along the ejecting station.

45 Claims, 12 Drawing Figures



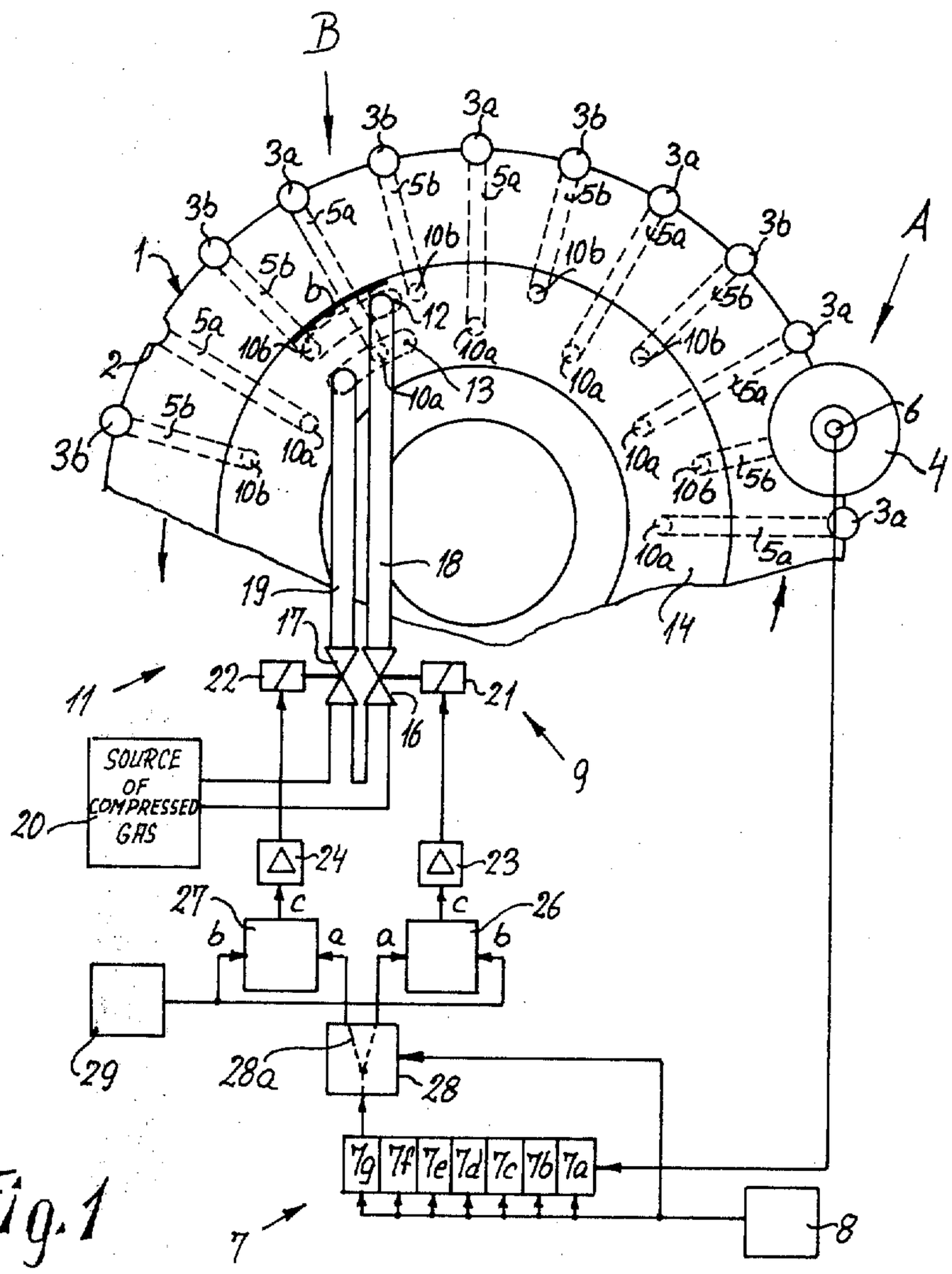


Fig. 1

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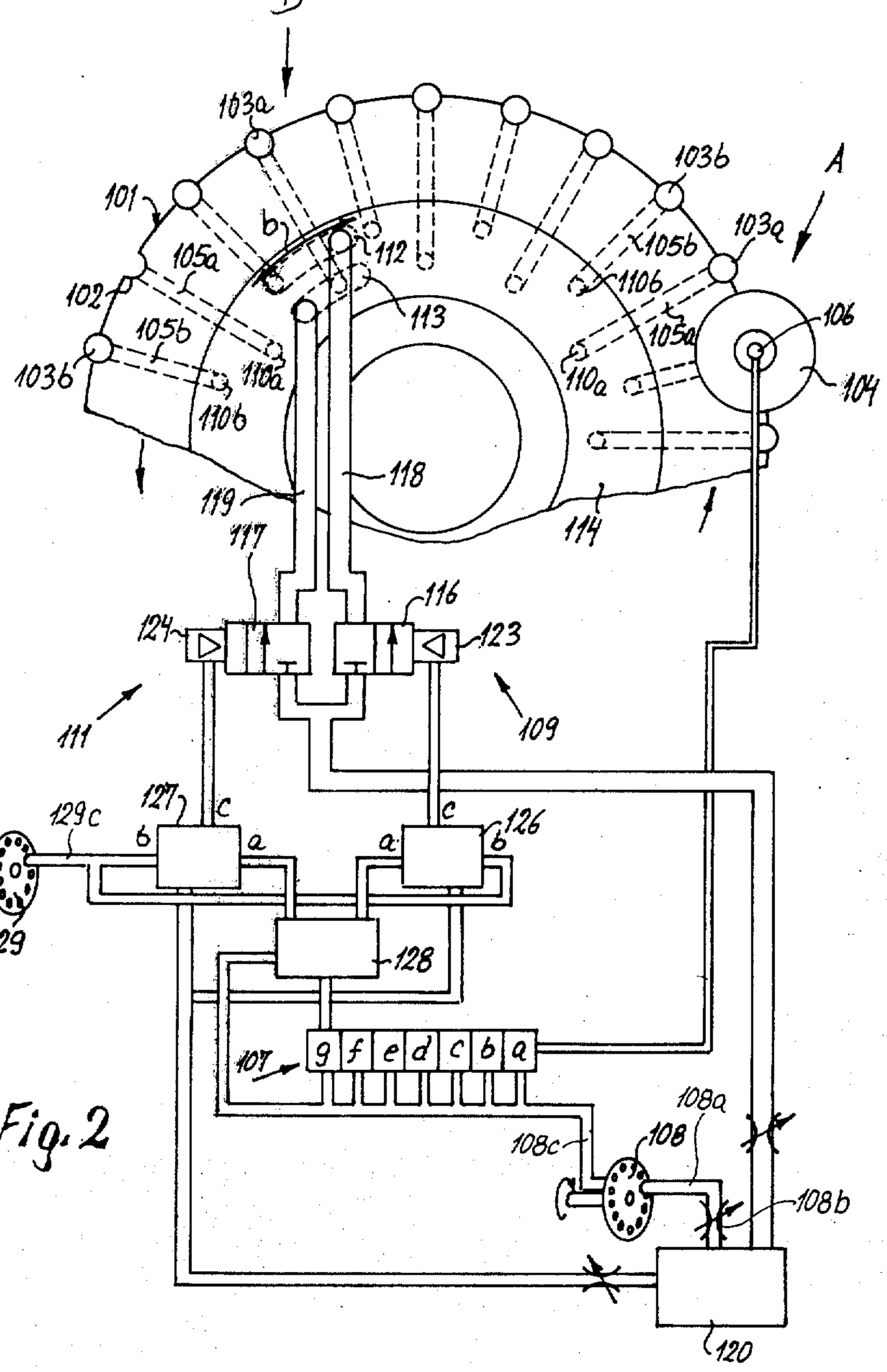

Fig. 2

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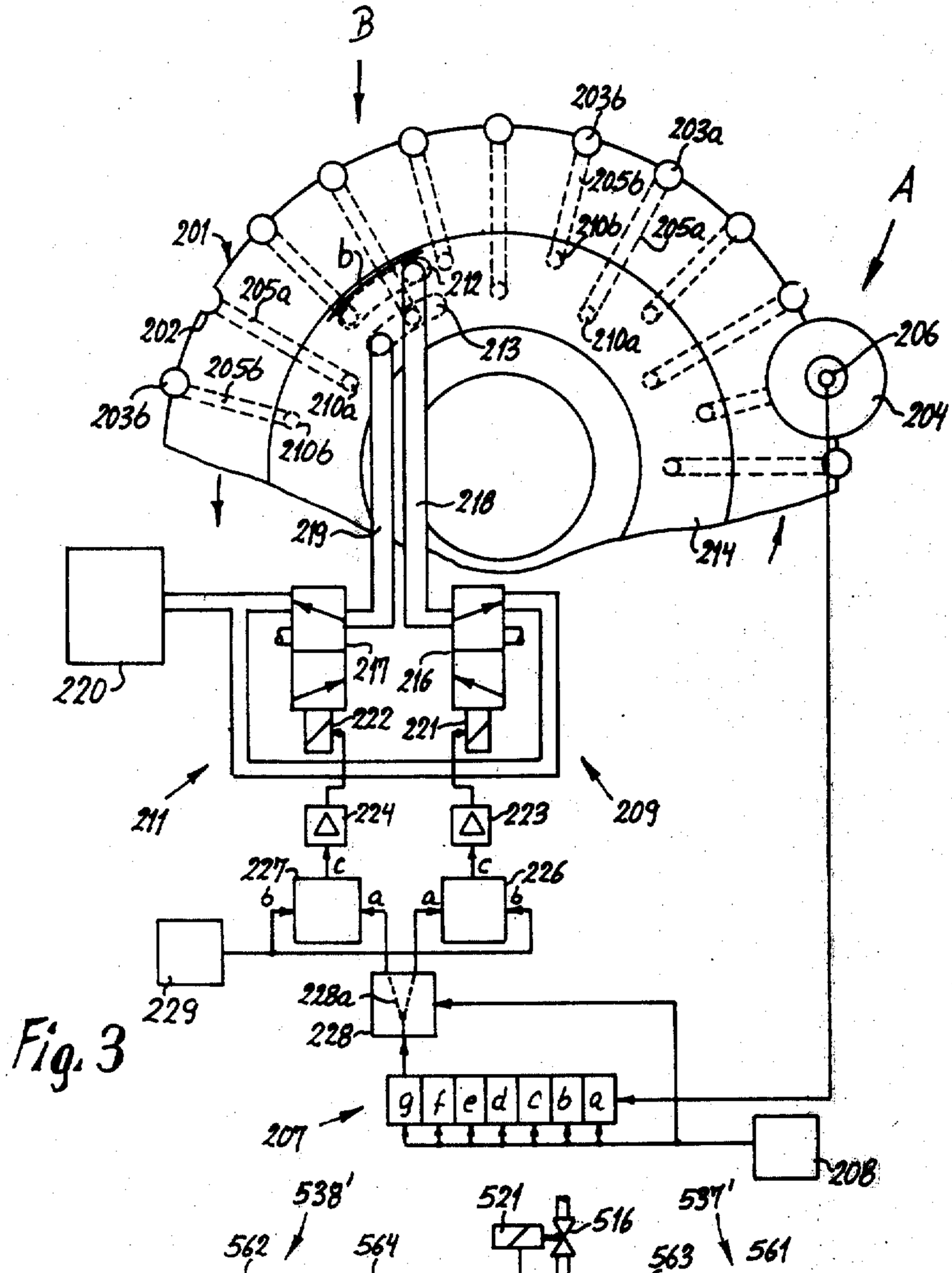

Fig. 3

Fig. 9b

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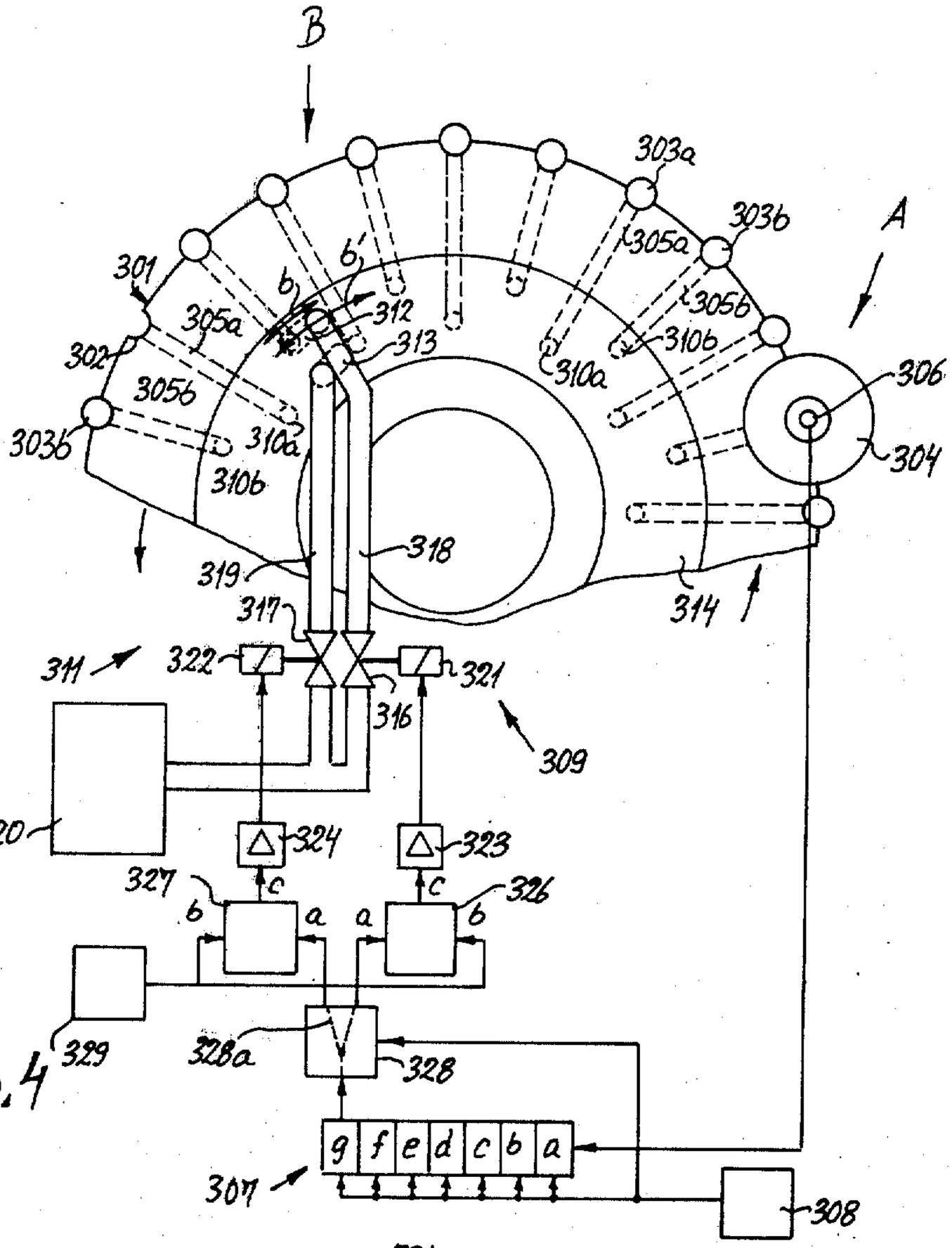

Fig. 4

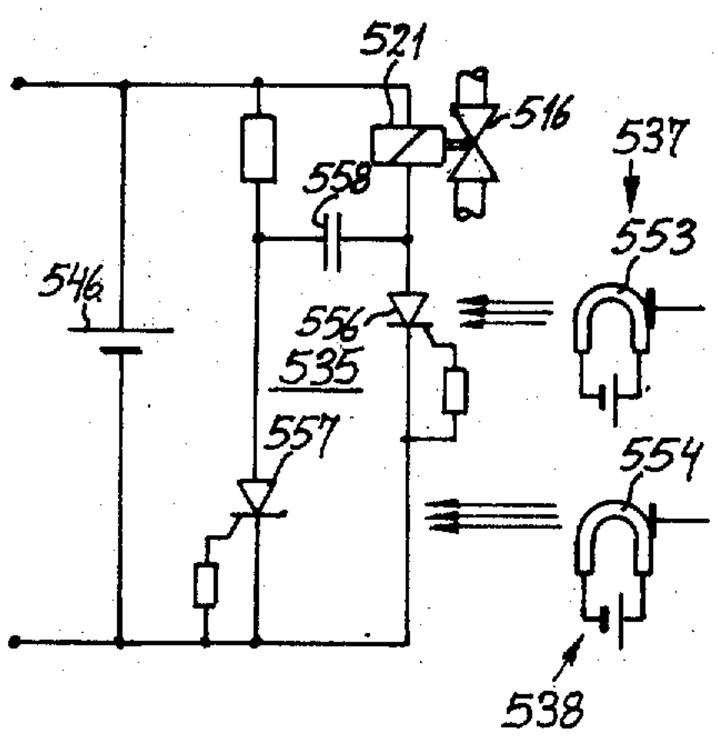

Fig. 9a

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Fig. 5

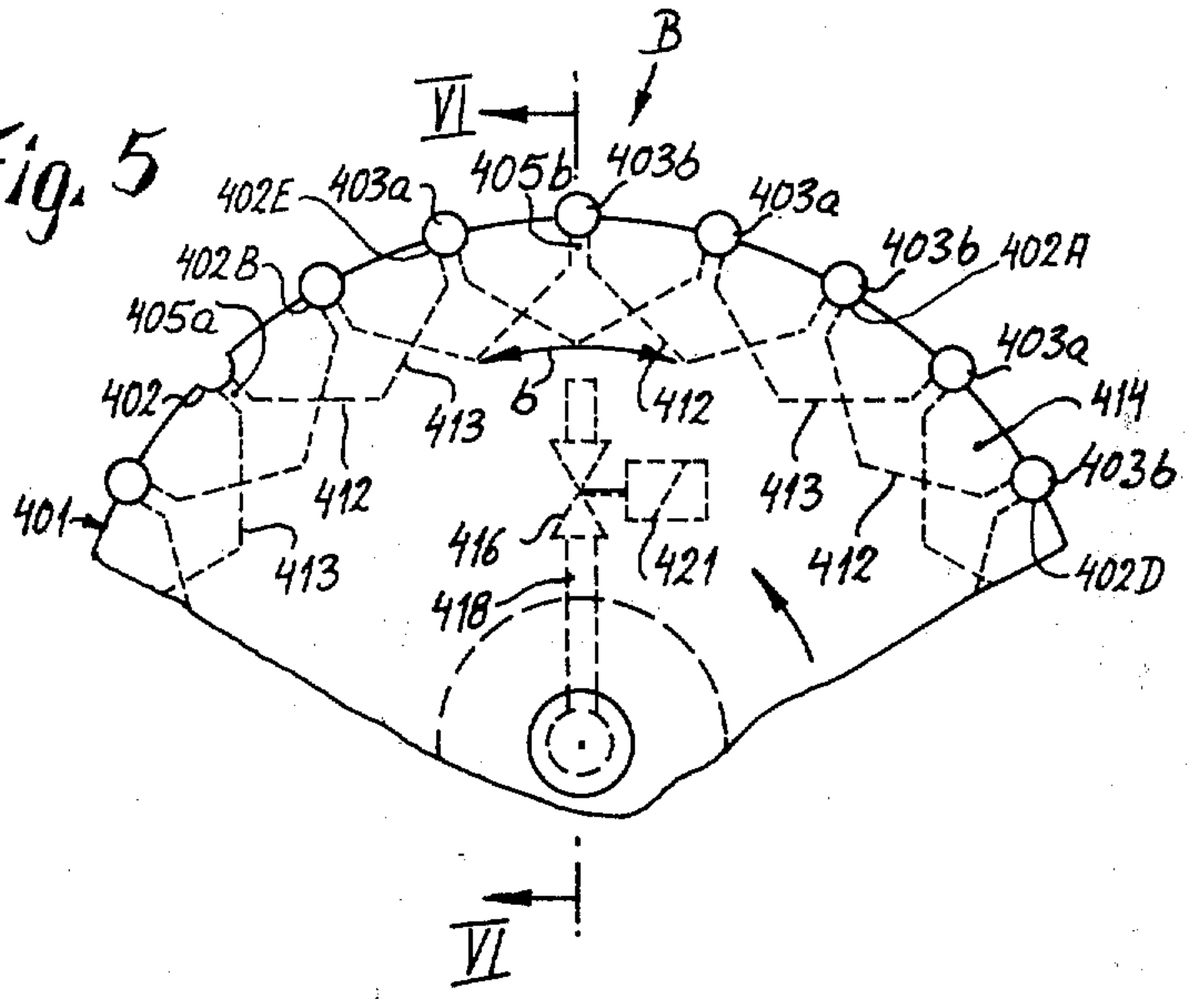

Fig. 6

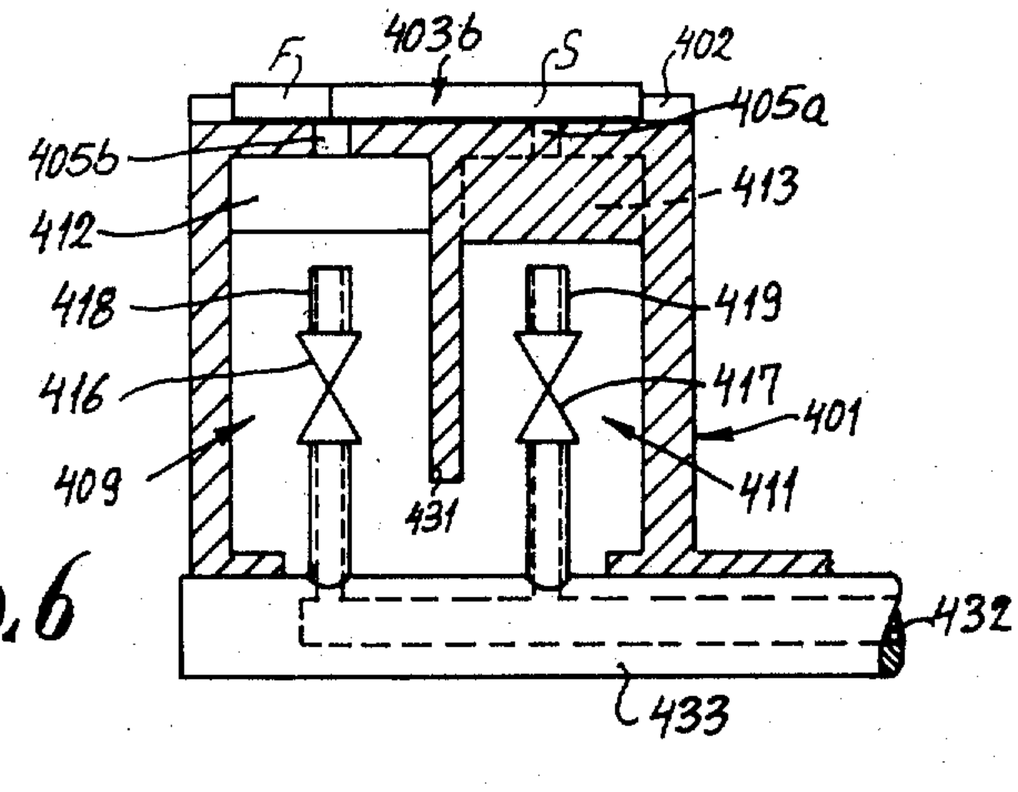

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Fig. 8

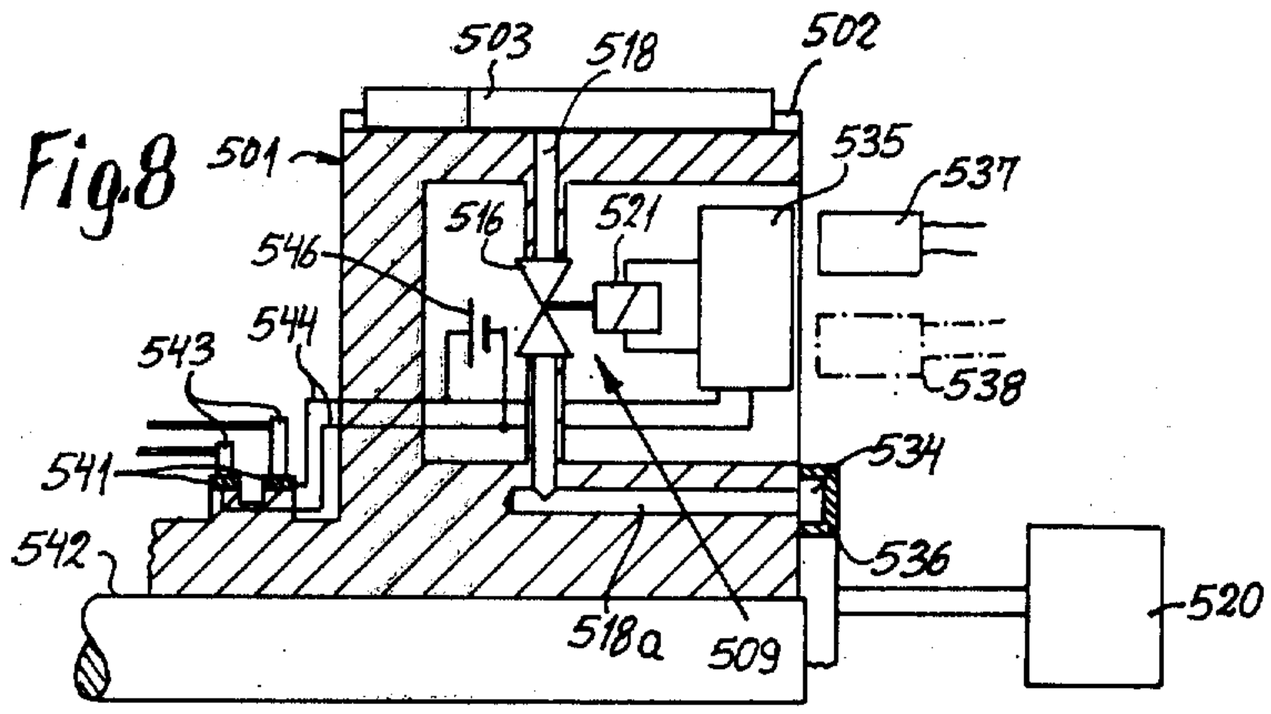
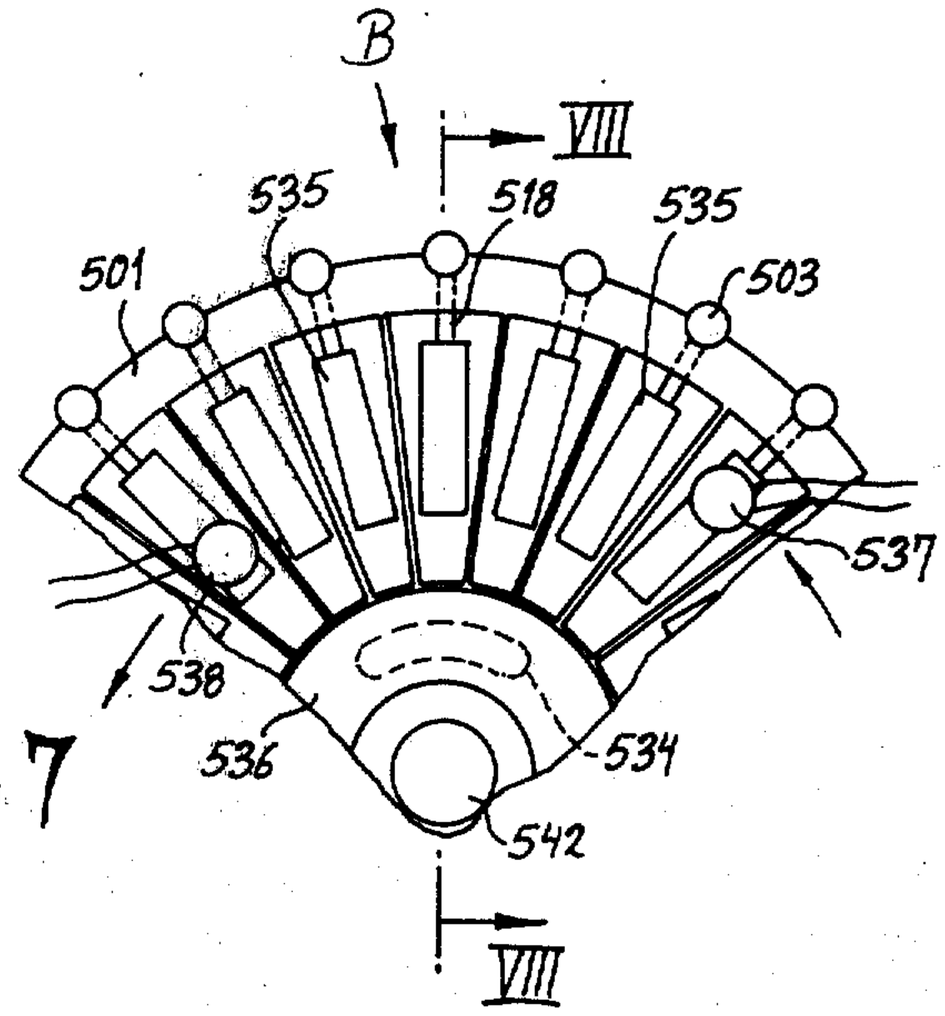


Fig. 7



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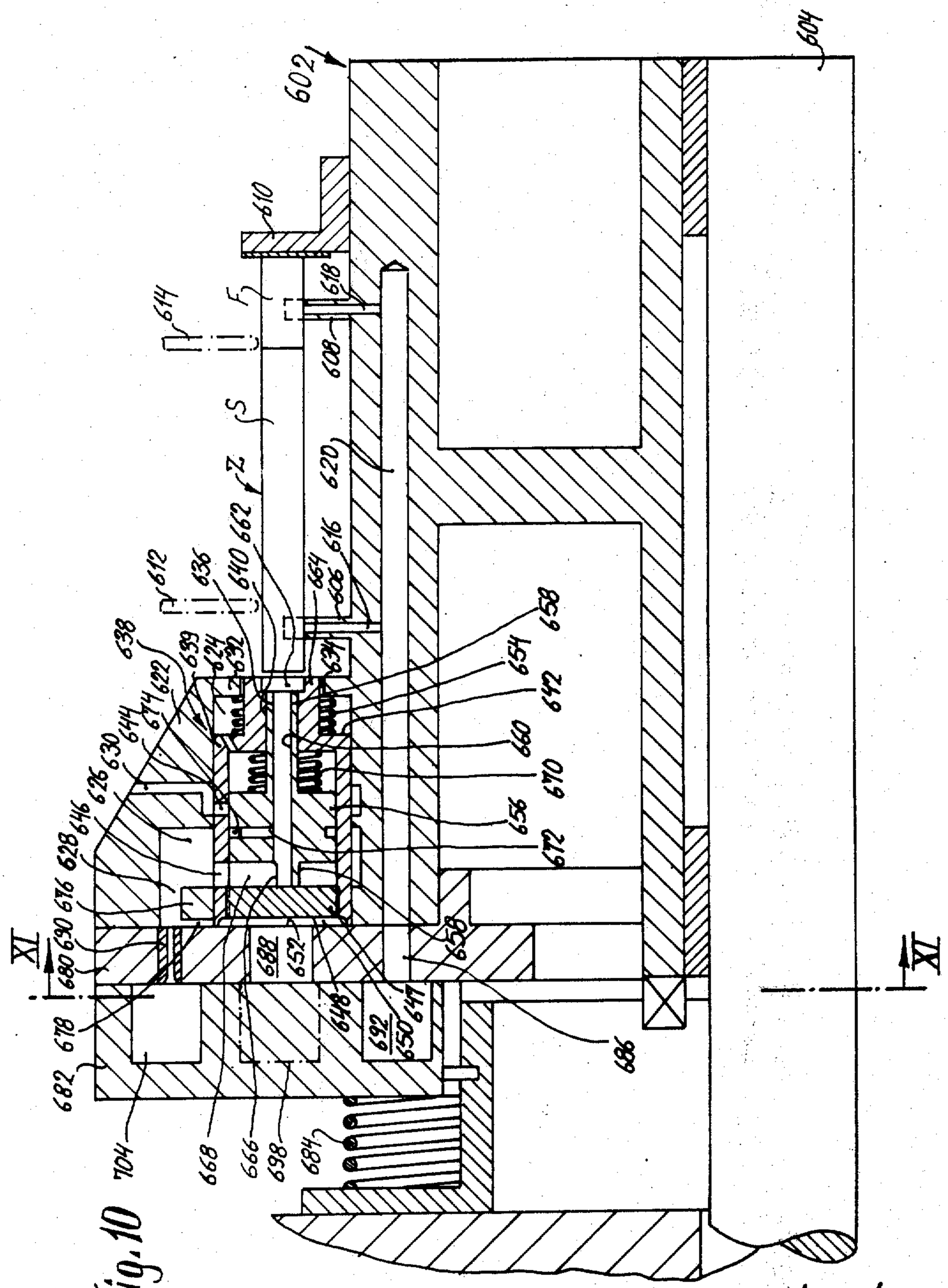

Fig. 10

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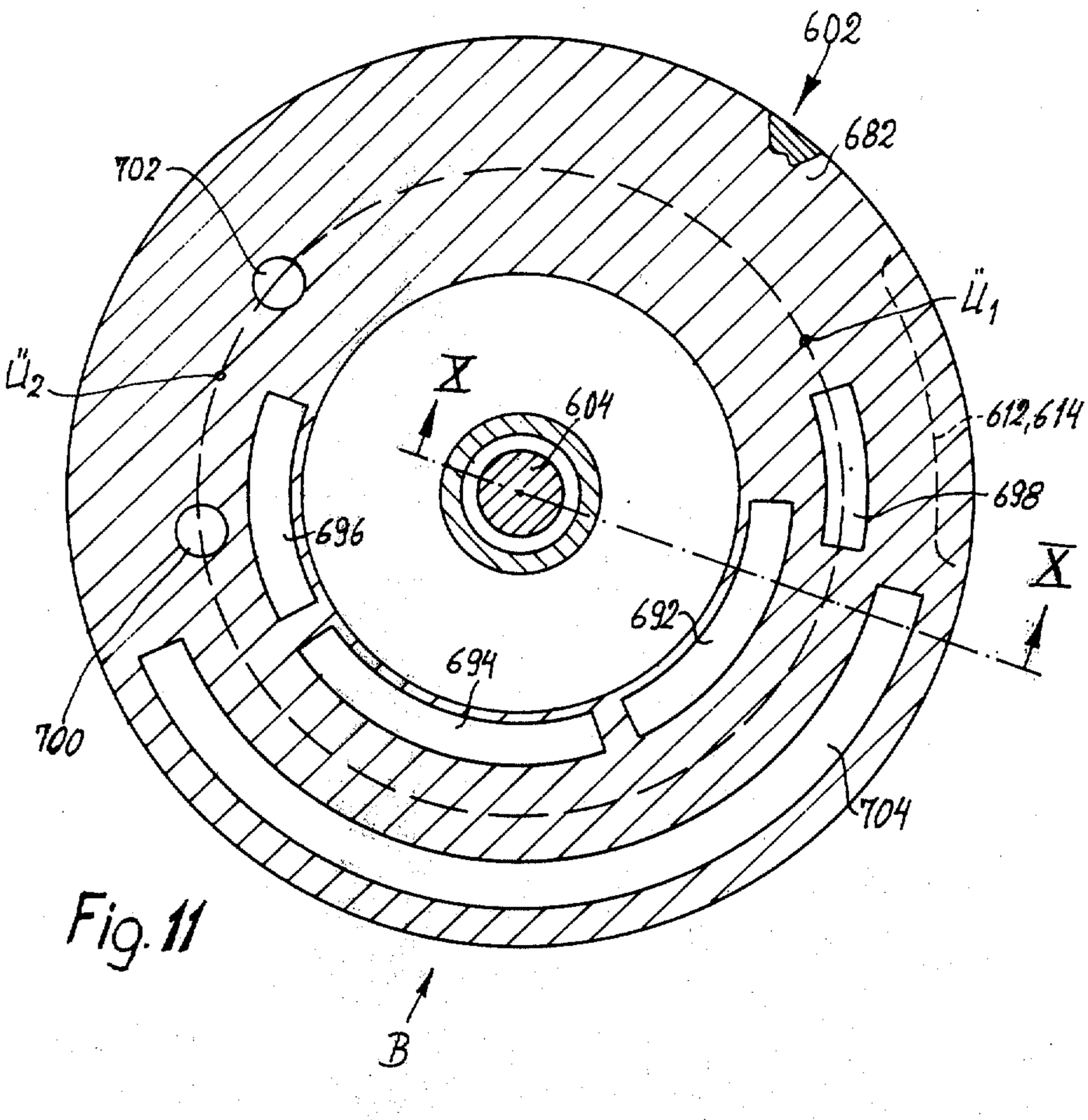

Fig. 11

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METHOD AND APPARATUS FOR SEPARATING SELECTED CIGARETTES OR ANALOGOUS ROD-SHAPED ARTICLES FROM A SERIES OF RAPIDLY MOVING EQUIDISTANT ARTICLES

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

BACKGROUND OF THE INVENTION

The present invention relates to a method and apparatus for segregating or separating selected rod-shaped articles from a series of rapidly moving articles, particularly for segregating tobacco-containing plain or filter-tipped rod-shaped articles or sections of filter rods while such articles or sections move sideways. For example, the method and apparatus of the present invention can be utilized to segregate defective rod-shaped tobacco-containing articles or defective sections of filter rods from a row of such articles or sections wherein the defective articles or sections are in random distribution with satisfactory articles or sections.

In the manufacture of cigarettes, cigars, cigarillos, filter rod sections and analogous rod-shaped articles which are used in the manufacture of or constitute smokers' products, the articles are tested at one or more stations to segregate from satisfactory articles those articles which exhibit one or more defects, for example, to segregate sections of a wrapped tobacco filler rod or filter rod if such sections exhibit a leak (such as a hole in the wrapper or an unsatisfactory seam between the overlapping marginal portions of the wrapper) or if the filler of a section is too dense or contains less than the desired quantity of tobacco and/or filter material. [If] *It* is also known to break up rows of closely adjacent rod-shaped articles by removing from the row each second, third, etc. article in order to convert a single row into two or more rows or to stack selected articles in trays or other types of containers. Furthermore, segregation of selected articles from a predetermined path wherein the articles move lengthwise or sideways is often necessary in order to convert a file of articles which move axially into one or more rows of articles which move sideways, or vice versa.

In the majority of presently known machines for the mass-production of cigarettes or like rod-shaped articles, the defective articles are segregated by pneumatic ejecting means. The ejecting means receives electrical or pneumatic signals which are produced by the detector or detectors of a testing unit and are employed to effect the segregation of articles at an ejecting or segregating station having a width which equals or approximates the distance between two neighboring articles. The detector or detectors scan the wrappers, the fillers and/or the heads of articles and produce signals in response to detection of one or more defects. Since a modern cigarette making machine produces up to 70 cigarettes per second, the testing of cigarettes must be carried out at the same speed and, therefore, the intervals for ejection of a defective article which is flanked by two satisfactory articles are extremely short. As a rule, the length of intervals which are allotted for ejection of defective articles in the range of one or more milliseconds. It is very difficult and highly expensive to

produce satisfactory pneumatic valves which are capable of responding to electrical or pneumatic signals without any delay or with a delay which permits for segregation of a rapidly advancing article within an interval of a few milliseconds. Delayed opening of valves can result in ejection of satisfactory articles (in addition to or instead of defective articles). If the valve or valves remain open longer than for the interval which is required to move a defective article through a distance corresponding to that between the centers of two neighboring articles, a satisfactory article which follows a defective article is likely to be segregated with such defective article. Furthermore, if the defective articles are ejected by streams of compressed air, it takes a certain amount of time before the air pressure in the conduits for compressed air builds up to a value which is satisfactory for reliable expulsion of the selected article.

Certain recent types of electromagnetic valves are capable of opening and closing with a minimum of delay; however, the useful life of such valves is so short that they must be replaced at very frequent intervals and the valves are so expensive that they contribute excessively to the cost of testing apparatus for cigarettes or the like. Furthermore, since the valves are prone to malfunction after short periods of use, they are likely to cause ejection of satisfactory articles or to permit passage of defective articles during the interval which elapses between the start of malfunction and the detection of faulty operation of a valve. The operating speed of modern cigarette making or like machines being very high, even short-lasting malfunctioning of valves which are supposed to effect segregation of defective articles is likely to result in substantial losses in output or in the production, packing and sale of large quantities of defective products.

It is also known to segregate defective articles by gravity, by centrifugal force or by a combination of such forces with each other and/or with a pneumatically produced force. For example, the articles are advanced along a circular path and are held against the action of gravity and/or centrifugal force by mechanical and/or pneumatic means. The retaining force which acts upon a defective article is terminated in response to detection of a defect. Such methods and apparatus exhibit the drawbacks of the aforediscussed proposals, i.e., it is difficult to terminate the retaining action within a very short interval of time in order to insure that the ejecting force (e.g., gravity or centrifugal force) will act only upon a defective article but will be unable to dislodge a satisfactory article which precedes or follows the defective article.

It can be said that the development of reliable ejecting or segregating devices lags behind the development of machines for the mass-production and testing of plain or filter cigarettes, cigars or cigarillos and filter rod sections.

SUMMARY OF THE INVENTION

An object of the invention is to provide a novel and improved method of reliably segregating selected rod-shaped articles from a file or row of rapidly moving equidistant articles in such a way that the segregation of selected articles can be carried out without affecting the speed and/or orientation of remaining articles.

Another object of the invention is to provide a novel method of segregating selected rod-shaped articles from a row or file of equidistant articles which travel

through a segregating or ejecting station at a speed of not less than 1,000 and up to and more than 4,000 articles per minute.

A further object of the invention is to provide a novel and improved method of reliably segregating defective plain or filter-tipped cigars, cigarillos, cigarettes of unit length or multiple unit length and/or filter rod sections of unit length or multiple unit length from a row or file of such articles wherein the defective articles are in random distribution with satisfactory articles and travel therewith at a speed normally exceeding the speed which is required to transport at least 1,000 articles per minute through an ejecting or segregating station.

An additional object of the invention is to provide a novel and improved apparatus for segregation of selected rod-shaped articles from a series of rapidly moving equidistant articles wherein the selected articles are randomly distributed among the remaining articles of the series or are separated from each other by predetermined numbers of remaining articles.

Still another object of the invention is to provide an apparatus for segregation of selected rod-shaped articles from a series of rapidly moving equidistant articles wherein the segregation of selected articles can be carried out by resorting to rugged, reliable and long-lasting components which cooperate to insure reliable segregation or ejection of defective or other selected articles even though they cannot respond to signals with the dispatch which is needed to segregate an article within an interval which is available to transport an article through a distance which at most equals the distance between two neighboring articles.

An additional object of the invention is to provide an apparatus which can segregate defective or other selected cigarettes or filter cigarettes from a row or file of such articles while the row or file advances at the speed at which the articles leave a modern mass-producing cigarettes making or filter cigarette making machine.

The method of the present invention is utilized for individually removing selected cigarettes or analogous rod-shaped articles from a predetermined path for a series of equidistant discrete articles moving at an elevated speed (preferably at a speed of at least 1,000 articles per minute). The removal of articles is effected by a separating force to which a selected article is subjected in response to a pneumatic or electric signal coming from a device which tests the articles for the presence of defects or from a device which produces signals at regular intervals so as to bring about a segregation of each n-th article wherein n is a whole number exceeding 1.

The method comprises the steps of starting the application of the separating force in response to a signal and in a direction which crosses the path at a point coinciding with the locus of a selected article, and moving the point of application of the separating force along the path at the speed of articles and through a predetermined distance which substantially exceeds the distance between a pair of neighboring articles of the series.

The method may comprise the additional steps of subjecting all articles of the series to the action of a mechanical or pneumatic retaining force which is stronger than the separating force and acts on the articles in a direction to retain the articles in the path, and terminating the action of the retaining force upon a selected article when such article occupies the aforementioned locus. In accordance with the just described

embodiment of the method, the separating force can be a mechanical force, such as the force of gravity and/or the centrifugal force, especially if the aforementioned path is an arcuate path which is defined, for example, by a drum-shaped conveyor having axially parallel flutes or analogous receiving means for the articles of the series.

The separating force can be furnished by a gaseous fluid, e.g., by one or more streams of compressed air which are caused to move with the receiving means for the selected articles while such receiving means cover the aforementioned predetermined distance. Such distance can be between n–1 and n times the distance between a pair of neighboring articles.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved separating apparatus itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a fragmentary schematic elevational view of a separating apparatus which embodies one form of the invention and wherein the selected articles are separated by streams of a compressed gaseous fluid in response to electric signals from a testing device;

FIG. **2** is a similar fragmentary schematic elevational view of a second separating apparatus wherein the selected articles are separated by streams of a gaseous fluid in response to pneumatic signals from a testing device;

FIG. **3** is a similar fragmentary elevational view of a third apparatus wherein the selected articles are separated under the action of gravity and/or centrifugal force in response to termination of retention of such articles by suction;

FIG. **4** is a similar schematic fragmentary elevational view of a fourth apparatus which constitutes a modification of the apparatus shown in FIG. **1**;

FIG. **5** is an elevational view of a portion of a fifth apparatus wherein the ejecting means comprises a pair of stationary ejectors mounted in the interior of the conveyor;

FIG. **6** is a sectional view as seen in the direction of arrows from the line VI—VI of FIG. **5**;

FIG. **7** is an elevational view of a portion of a sixth apparatus which comprises a discrete ejector for each article receiving means of the conveyor;

FIG. **8** is a sectional view as seen in the direction of arrows from the line VIII—VIII of FIG. **7**;

FIG. **9a** illustrates a portion of a first signal transmitting system for use in the apparatus of FIGS. **7** and **8**;

FIG. **9b** illustrates a portion of a second signal transmitting system for use in the apparatus of FIGS. **7** and **8**;

FIG. **10** is a fragmentary axial sectional view of a conveyor forming part of a seventh separating apparatus wherein the articles are normally retained by mechanical means, the sections being taken in the direction of arrows as seen from the line X—X of FIG. **11**; and

FIG. **11** is a smaller-scale transverse vertical sectional view as seen in the direction of arrows from the line XI—XI of FIG. **10**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. **1**, there is shown a drum-shaped conveyor **1** of the type known as HC X and produced by Hauni-Werke, Korber & Co. K.G., of Hamburg-Bergedorf, Western Germany. Reference may be had to U.S. Pat. No. 3,408,858 to Kaeding et al. The conveyor **1** (hereinafter called drum for short) is formed with axially parallel equidistant peripheral article receiving means or flutes **2** which are disposed at a predetermined distance from each other as considered in the circumferential direction of the drum. The flutes **2** are designed to receive portions of rod-like articles **3** such as plain cigars, cigarillos or cigarettes of unit length or multiple unit length, filter cigarillos, cigarettes or cigars of unit length or multiple unit length, or filter rod sections of unit length or multiple unit length. While moving sideways with the respective flutes **2**, the rod-shaped articles **3** are tested for the presence or absence of defects by streams of a compressed testing fluid (normally air) which is admitted into one axial end of the filter of each article through a coupling device (not shown) which is in sealing engagement with the respective end of the wrapper on the adjacent article. Thus, the separating apparatus of FIG. **1** is *a* testing apparatus wherein defective articles are to be segregated from satisfactory articles.

Alternate flutes **2** respectively communicate with radially inwardly extending channels or ports **5a, 5b** which respectively communicate with axially parallel channels or bores **10a, 10b** machined into the body of the drum **1.** The ports **5a** are longer than the ports **5b.**

A testing unit or detector **4** is mounted at a testing station A which is adjacent to the path of the flutes **2.** The detector **4** is designed to detect deviations of the pressure of testing fluid from a reference pressure which is indicative of satisfactory rod-shaped articles. For example, if the detector **4** detects that the pressure of fluid issuing from the adjacent end of an article in a flute **2** which reaches the testing station A is well below the reference pressure, this normally indicates that the wrapper of the article at the testing station A has a leak which permits uncontrolled escape of testing fluid. The detector **4** then generates an electric signal and its output **6** transmits such electric signal to the first stage **7a** of a shift register **7.** The latter comprises seven stages **7a, 7b, 7c, 7d, 7e, 7f, 7g,** and the last stage **7g** is connected with the input of an electronic switching circuit **28.** The stages **7a–7g** of the shift register **7** are further connected with a pulse generator or timer **8** which transmits shifting pulses serving to transport electric signals which are transmitted to the stage **7a** by the output **6** of the detector **4.** A detector which can be used in the apparatus of FIG. **1** is disclosed, for example, in U.S. Pat. No. 3,412,856 to Esenwein.

The purpose of the testing and separating apparatus of FIG. **1** is to segregate selected (defective) articles **3** from satisfactory articles at an ejecting or segregating station B in response to signals which are transmitted to an ejector unit by way of the shift register **7.** In presently known testing apparatus, the width of the ejecting station at most equals or only slightly exceeds the distance between the centers of two neighboring flutes or analogous receiving means for tested articles. The maximum width of ejecting stations in conventional testing apparatus is much closer to the distance between the centers of two neighboring flutes than to twice the

distance between the centers of two neighboring flutes. As a rule, the selected (defective) articles are ejected by pneumatic means, namely, by resorting to a complex electromagnetically operated valve which is installed in a conduit for compressed gaseous fluid and opens in response to reception of a signal at the exact moment when the defective article which has caused the generation of such signal reaches the ejecting station. Such testing apparatus are sufficiently reliable for the testing of rod-like articles which are not transported at a very high speed, for example, for the testing of plain or filter cigarettes of multiple unit length. However, they are much less reliable for the testing of relatively short articles, such as plain cigarettes of unit length or filter cigarettes of unit length which are often transported at extremely high speeds of up to and in excess of 4,000 articles per minute. In can be readily calculated that the length of the interval during which an article is transported through a relatively narrow ejecting station is in the range of a few milliseconds. Valves which are sufficiently sophisticated to open at extremely rapid intervals and for extremely short periods of time are very expensive and the wear on their parts is so pronounced that the useful life of such valves is very short. Therefore, such complicated valves are not suited for the testing of plain or filter cigarettes which are transported as a series of closely or immediately adjacent articles and at a speed of several thousand articles per minute.

In accordance with one feature of the invention, the width of the ejecting station B in the testing apparatus of FIG. **1** can be increased well beyond the width of ejecting stations in conventional testing apparatus (for example, to nearly twice the distance between the centers of two neighboring flutes **2**) by the provision of channels or ports **5a, 5b** of different length and by the provision of an ejector unit which includes two discrete ejector valves **9** and **11,** one for defective articles (**3a**) travelling with flutes which communicate with the ports **5a,** and the other for defective articles (**3b**) travelling with flutes which communicate with the ports **5b.** The valves **9** and **11** respectively control the admission of a compressed fluid (preferably air) into conduits **18, 19** which respectively communicate with arcuate grooves **12, 13** provided in a stationary control member here shown as a valve plate **14** which is adjacent to one end face of the rotary drum **1.** The grooves **12, 13** are machined into that surface of the valve plate **14** which is in sealing engagement with the adjacent end face of the drum **1,** and these grooves are located at the ejecting station B. The valve members **16, 17** of the valves **9, 11** are operated by electromagnets **21, 22** which are connected with amplifiers **23, 24.** The amplifiers **23, 24** are respectively connected with bistable logical circuits **26, 27** of the type known as flip-flops. When the valve member **16** or **17** of the valve **9** or **11** is moved to an open position in response to energization of the respective electromagnet **21, 22,** it respectively admits compressed gas from a source **20** to the conduit **18** or **19** whence the gas flows into the groove **12** or **13** to cause expulsion of the defective article **3a** or **3b** at the ejecting station B.

The amplifiers **23, 24** respectively receive signals from the outputs c of the flip-flops **26, 27.** The inputs b of these flip-flops receive signals from a signal generator or timer **29** and the inputs a of the flip-flops receive signals from the electronic switching circuit **28.** The signals from the timer **29** to the inputs b of the flip-flops

erase the signals which are being transmitted to the amplifiers **23** and **24.** The frequency at which the timer **29** transmits signals to the inputs b of the flip-flops **26, 27** is half the frequency of pulse transmission by the timer **8** for the shift register **7.** The frequency of pulse transmission by the timer **8** is synchronized with the speed of the drum **1.**

The switching circuit **28** has an element **28a** which acts not unlike the moving contact of a two-way electric switch and can transmit signals to the input a of the flip-flop **26** (in one of its positions) and to the input a of the flip-flop **27** (in its other position). The circuit **28** can be said to constitute a component part of a signal transmitting means between the detector **4** and the ejector valve **9** or **11** to transmit to the electromagnet **21** or **22** signals which are indicative of defective articles **3a** or **3b.** The position of the element **28a** changes at the frequency of pulse transmission by the generator **8.** The entire signal transmitting means between the output **6** of the detector **4** and the electromagnets of the ejector valves **9, 11** includes the shift register **7,** the pulse generator **8,** the switching circuit **28,** the flip-flops **26, 27,** the timer **29** and the amplifiers **23, 24.**

The operation:

When a defective article (e.g., one of the articles **3b** which alternate with identical articles numbered **3a**) reaches the detector **4,** the latter produces an electric signal and its output **6** transmits such signal to the first stage **7a** of the shift register **7.** The signal is transported through successive stages **7b–7g** by pulses transmitted by the generator **8.** The transport of the signal through the shift register **7** takes place in synchronism with the transport of defective article **3b** toward the ejecting station B. Thus, the defective article **3b** reaches the station B when the signal reaches the last stage **7g.** The element **28a** of the switching circuit **28** is then located in the right-hand end position of FIG. **1** (indicated by broken lines) so that the signal is transmitted to the inpt a of the flip-flop **26** while the latter's input b does not receive a signal from the timer **29.** The output c of the flip-flop **26** then transmits a signal which is amplified at **23** and energizes the electromagnet **21** of the ejector valve **9** which moves its valve member **16** to the open position so that the conduit **18** conveys a stream of compressed gaseous fluid from the source **20** into the groove **12** of the control means or valve plate **14.** The electromagnet **21** is energized and moves the valve member **16** to open position with such a delay following the generation of signal by the detector **4** that the defective article **3b** reaches the ejecting station B when the stream of compressed fluid issuing from the source **20** and passing through the conduit **18,** groove **12,** the corresponding channel or bore **10b** and the corresponding channel or port **5b** impinges against the defective article in its flute **2** and expels the defective article into a chute, into a collecting receptacle or into another suitable intercepting device, not shown. It is to be noted that, though FIG. **1** does not show any retaining means which produces a retaining force serving to prevent ejection of articles **3a, 3b** during transport with the flutes **2** past the testing station A and toward, past and beyond the ejecting station B, it is clear that the testing apparatus is provided with suitable mechanical and/or pneumatic (suction operated) retaining means which holds the articles against movement under the action of gravity and/or centrifugal force. Since the flip-flops **26, 27** are bistable logical circuits, the signal at the output c of the flip-flop **26** remains after the

transmission of signal from the switching circuit **28** is terminated. The signal at the output c of the flip-flop **26** is erased in response to transmission of a signal to its input b from the timer **29** which operates at half the frequency of the generator **8.** Thus, the valve member **16** of the valve **9** remains in open position after the element **28a** of the switching circuit **28** moves to its left-hand end position and for an interval which is long enough to insure the flow of a stream of compressed gaseous fluid into the groove **12** of the valve plate **14** while the flute **2** for the defective article **3b** travels through the ejecting station B. The valve member **16** thereupon returns to its closed position to seal the groove **12** from the source **20.** As shown in FIG. **1,** the width b of the ejecting station B almost equals twice the distance between the centers of two neighboring flutes **2.**

If the defective article **3b** is immediately followed by a defective article **3a,** the output **6** of the detector **4** again transmits an electric signal to the first stage **7a** of the shift register **7,** and such signal is transported to the last stage **7g** by pulses furnished by the generator **8.** The stage **7g** emits a signal when the element **28a** of the switching circuit **28** is in the solid-line left-hand end position of FIG. **1** so that the signal reaches the input a of the flip-flop **27** which energizes the electromagnet **22** of the ejector valve **11** by way of the amplifier **24** so that the valve member **17** moves to its open position and admits a stream of compressed gaseous fluid from the source **20,** through the conduit **19,** groove **13** of the valve member **14,** the corresponding channel or bore **10a,** the corresponding channel or port **5a,** and into the flute **2** which contains the defective article **3a.** The groove **13** remains in communication with the source **20** while the flute **2** for the defective article **3a** travels through the ejecting station B so that the defective article **3a** can be ejected during a portion of or during the entire interval which elapses while the corresponding flute **2** covers the distance b. Thus, the interval which is available for ejection of a defective article **3a** or **3b** almost equals the combined length of two intervals which are required to move an article through a distance corresponding to twice the distance between the centers of two neighboring flutes.

It will be seen that a stream of compressed gaseous fluid which starts to issue from the port **5a** or **5b** when the defective article **3a, 3b** reaches the ejecting station B produces a separating force which crosses the path of the articles **3a, 3b** at a point which coincides with the right-hand end of the station B and with the locus of the respective defective article **3a** or **3b.** The groove **5a** or **5b** of the control means or valve plate **14** then insures that the point of application of the force furnished by the stream of compressed gaseous fluid moves along the path for the articles **3a, 3b** at the exact speed of such articles and through a predetermined distance (b) which substantially exceeds the distance between the centers of a pair of neighboring flutes. In the apparatus of FIG. **1,** the separating force is furnished by a gaseous fluid.

An advantage of the apparatus of FIG. **1** is that it can employ readily available, rugged and reliable components which can insure segregation or ejection of selected articles even though the article which is to be segregated is flanked by two articles which should not be removed from the drum **1** during travel through the ejecting station B. The parts which respond to signals from the output **6** of the detector **4** need not be as

sensitive as the aforediscussed components of certain presently known ejecting apparatus because they can effect ejection of selected articles within intervals which are substantially longer than the interval needed to move an article through a distance corresponding to that between the centers of two adjoining flutes **2.** Thus, the ejector valves **9, 11** can be of the type which, though not as sensitive as certain recently developed electromagnetically operated valves, is capable of standing long periods of use. This is achieved by constructing the apparatus in such a way that the width b of the ejecting station B substantially exceeds the distance between the centers of two neighboring flutes **2** in the drum **1.** The apparatus of the present invention is especially suited for segregation of selected articles from a series (file or row) of articles which are transported through the testing station A at the rate of at least 15 and up to 70 articles per second, i.e., at about 1,000–4,500 articles per minute. The distance between the neighboring flutes **2** is of lesser importance; such distance is selected in dependency on the dimensions of the drum **1** and certain other factors, such as the nature of devices which feed articles to the flutes at a first transfer station located upstream of the testing station and which receive satisfactory articles from the drum **1** at a second transfer station located downstream of the ejecting station. The two transfer stations (U1 and U2) are shown in FIG. **11.**

The apparatus of FIG. **2** constitutes a first modification of the apparatus of FIG. **1.** All such components of the second apparatus which are clearly analogous to or identical with the corresponding components of the first apparatus are denoted by similar reference characters plus 100. In contrast to the detector **4** of FIG. **1** which generates electric signals, the output **106** of the detector **104** shown in FIG. **2** is designed to emit pneumatic signals which are transmitted to the first stage a of a pneumatic shift register **107.** The pneumatic elements of the system which transmits signals from the detector **104** to the ejector valves **109, 111** of the ejector unit in the apparatus of FIG. **2** are available on the market and are produced by the Corning Glass Works, Corning, N.Y. The pulse generator **108** comprises a disk which is rotated in synchronism with the drum **101** and has apertures which transmit pneumatic pulses from a conduit **108a** (which contains an adjustable flow restrictor **108b** and is connected with the source **120** of compressed gas) to a conduit **108c** which transmits pulses to the stages a, b, c, d, e, f, g of the shift register **107.** The timer **129** also comprises a disk which is provided with apertures and rotates at half the speed of the disk of the pulse generator **108.** A first conduit (not shown) which is connected with the source **120** transmits pneumatic signals to a second conduit **129c** which is connected with the inputs b of two pneumatic flip-flops **126, 127.** The inputs a of the flip-flops **126, 127** are connected with the corresponding outputs of the pneumatic switching device **128** which receives a signal from the last stage g of the shift register **107** when the detector **104** at the station A detects a defective article **103a** or **103b.** The outputs c of the flip-flops **126, 127** are respectively connected with the actuating elements **123, 124** of the ejector valves **109, 111** which comprise valve members **116, 117** movable to open positions to thereby connect the source **120** with the conduit **118** or **119,** i.e., with the groove **112** or **113** of the control means or valve plate **114.**

The operation of the apparatus of FIG. **2** is analogous to the operation of the apparatus of FIG. **1.** Thus, the valve members **116, 117** can establish a connection between the source **120** and the grooves **112, 113** for intervals of time whose length corresponds to the length of the interval during which a flute **102** containing a defective article **103a** or **103b** moves through the ejecting station B having a width b which equals or approximates twice the distance between the centers of two neighboring flutes **102.** The grooves **112, 113** enable the channels **105a, 110a** or **105b, 110b** to move the point where the stream of compressed gaseous fluid crosses the path for the articles **103a, 103b** along such path, through the distance b, and at the exact speed of the flutes **102** so that a defective article **103a** or **103b** is subjected to the action of the separating force produced by the stream of compressed fluid as soon as it reaches the station B and until it leaves the respective flute **102,** not later than at the left-hand end of the station B.

The apparatus of FIG. **3** differs from the first two separating apparatus in that the ejection of defective articles **203a** or **203b** at the station B takes place under the action of a mechanical separating force, such as the force of gravity and/or centrifugal force. The articles **203a, 203b** are normally held in their flutes **202** by a retaining force which is produced by suction and is stronger than the mechanical separating force. The retaining force is terminated when a defective article reaches the ejecting station B. All such parts of the apparatus of FIG. **3** which are clearly analogous to or identical with the corresponding parts of the first apparatus are denoted by similar reference characters plus 200. The centrifugal force will act on the defective articles **203a** or **203b** irrespective of the location of the ejecting station B. It is preferred to place this station adjacent to the lower half of the drum **201** so that the ejection of defective articles can be assisted by gravity. As a rule, the centrifugal force is strong enough to insure ejection of defective articles at the station B because the drum **201** is assumed to be driven at a high speed, for example, at the speed which is required to transport 4,000 plain cigarettes of unit length or filter cigarettes of unit length per minute through the ejecting station B.

The source **20** of FIG. **1** is replaced with a suction generating device **220** and the valve members **216, 217** are arranged to close in response to reception of signals from the amplifier **223** or **224.** Thus, the ejector valves **209, 211** are normally open so that the suction generating device **220** is normally connected with the grooves **212, 213** of the valve plate **214.** When the valve members **216, 217** respectively seal the suction generating device **220** from the grooves **212, 213,** they automatically connect the conduits **218, 219** with the atmosphere (or with a source of compressed air) to insure a rapid rise of gas pressure in that flute **202** which travels through the ejecting station B.

Otherwise, the operation of the apparatus of FIG. **3** is identical with the operation of the first and second apparatus. The detector **204** at the testing station A is assumed to be identical with the detector **4** of FIG. **1,** i.e., its output **206** transmits electrical signals which are transported through the stages a to g of the shift register **207** and are transmitted to the input a of the flip-flop circuit **226** or **227** depending on the position of the element **228a** of the switching circuit **228.** The electromagnets **221, 222** are energizable or deenergizable to

thereby move the respective valve members **216, 217** to such positions that the suction generating device **220** is sealed from the grooves **212, 213** of the control means or valve plate **214** and that the conduit **218** or **219** is connected with the atmosphere or with a source of compressed gas to insure rapid expulsion of a defective article **203a** or **203b** from that flute **202** which is transported along the ejecting station B.

In this embodiment of the invention, the point of application of the mechanical separating force (gravity and/or centrifugal force) also travels along the path for the articles **203a, 203b** at the exact speed of such articles and through a distance (b) which substantially exceeds the distance between the centers of two neighboring flutes **202.** The main difference between the embodiment of FIG. **3** and the embodiments of FIGS. **1** and **2** is that defective articles **203a** or **203b** are separated from the remaining articles by a force which can act on all of the articles and as long as the articles travel along the path defined by the drum **201.** However, the mechanical separating force is normally opposed and overcome by the retaining force which is produced by suction and which is automatically terminated when a defective article **203a** or **203b** reaches the station B so that the mechanical separating force can take over and acts on the defective article during travel along that portion of the path which extends through the ejecting station B.

The apparatus of FIG. **4** differs from the apparatus of FIG. **1** in that the length b of the grooves **312, 313** in the stationary control means or valve plate **314** is less than the width b′ of the ejecting station B. The electromagnets **321, 322** of the ejector valves **309, 311** are designed to maintain the respective valve members **316, 317** in open positions for intervals whose length corresponds to the length of the interval which is required to transport a flute **302** of the drum **301** through the entire ejecting station B. The width b′ of the station B nearly equals twice the distance between the centers of two neighboring flutes **302** whereas the length b of the groove **312** or **313** equals or approaches such distance. Thus the width b′ is slightly less than or equals **2b.**

All such parts of the apparatus shown in FIG. **4** which are clearly analogous to or identical with the corresponding parts of the apparatus of FIG. **1** are denoted by similar reference characters plus 300.

An advantage of the apparatus of FIG. **4** is that the valve member **316** or **317** moves to open position before the channel **310b** or **310a** which communicates with the flute **302** carrying a defective article **303b** or **303a** begins to communicate with groove **312** or **313.** This enables the gas stream which issues from the source **320** to build up in the groove **312** or **313** a substantial pressure and to effect an abrupt ejection of a defective article **303a** or **303b** while the respective flute **[202]** *302* communicates with the groove **313** or **312.**

It will be seen that the apparatus of FIG. **4** is clearly analogous to the apparatus of FIGS. **1–3.** Even though the ejection of defective or selected articles **303a** or **303b** takes place during an interval which is shorter than the interval required for transport of articles through a distance corresponding to several times the distance b between the centers of two neighboring flutes, at time which is available for ejection or segregation of defective or selected articles is that time during which a flute covers the distance b′, namely, a distance

which considerably exceeds the distance b between the centers of two neighboring flutes **302.**

The apparatus of FIGS. **5** and **6** does not have a discrete control means or valve plate. Such valve plate is replaced by an integral part of the drum **401,** i.e., the control means moves with the conveyor for the articles. Alternate flutes **402** of the drum **401** communicate with recesses or grooves **412, 413** which are angularly offset with reference to each other (as considered in the circumferential direction of the drum) by a distance corresponding to that between the centers of two neighboring flutes. The recesses **412** form a first circle, the recesses **413** form a second circle (see FIG. **6**), and the two circles are partly separated from each other by a radially inwardly extending partition or baffle **431** of the drum **401.** Each of the recesses **412, 413** tapers radially outwardly toward the respective flute **402** and communicates with such flute by a relatively short radial port **405a, 405b.** The partition **431** prevents excessive flow of compressed air from the space which communicates with the recesses **412** into the space which communicates with the recesses **413** or vice versa. Thus, the partition **431** forms part of a moving control means which insures that the point of application of a separating force travels with the flute **402** for the selected article while such flute travels along the ejecting station B. The supply conduits **418, 419** for compressed air are stationary and are secured to a shaft **433** on which the drum **401** rotates. The shaft **433** has an axial bore **432** which connects the supply conduits **418, 419** with a source of compressed air. The valve members **416, 417** of the ejector valves **409, 411** in the conduits **418, 419** are normally closed. They open in response to pneumatic or electric signals from the detector (not shown) to admit compressed air into the adjacent recess **412** or **413,** depending upon whether the defective article which has caused the generation of a signal is one of the articles **403b** or **403a.** These articles are assumed to be filter cigarettes of unit length each having a wrapped tobacco filler rod section S and a filter plug F (see FIG. **6**). The remaining parts of the testing apparatus are assumed to be constructed and assembled in a manner as shown in FIG. **1.** Thus, the apparatus employs a detector **4,** a shift register **7,** and a source **20** of compressed gas. The numeral **421** denotes the electromagnet of the ejector valve **409.**

When the valve member **416** of the ejector valve **409** is caused by the electromagnet **421** to assume its open position in response to a signal from the detector at the testing station, the supply conduit **418** directs a stream of compressed gas into the adjacent recess **412** communicating with that flute **402** which contains the defective article **403b** (i.e., that article which has caused the generation of the signal for opening of the valve **409**). Since the inner end of the recess **412** at the ejecting station B is much wider than its outer end (the maximum width b of the recesses **412, 413** approximates twice the distance between the centers of neighboring flutes **402** and equals the width of the station B), the admission of compressed gas into the recess **412** at the station B is maintained for an interval of time which is long enough to effect ejection of the defective article **403b.** As shown in FIG. **6,** the channel or port **405b** between the recess **412** and the flute **402** at the ejecting station B directs the stream of compressed gas against the filter plug F of the defective article **403b,** and the separating force furnished by such stream is strong enough to effect expulsion or separation of the defec-

tive article while the corresponding recess **412** travels through the station B. The baffle **431** prevents the flow of compressed gas into the adjoining recesses **413** and the special configuration of the recesses **412, 413** insures that the stream of gas which is directed into the recess **412** at the station B cannot dislodge the neighboring (satisfactory) articles **403b** (in the flutes **402A, 402B** of FIG. **5**).

If the article **403a** which follows the freshly ejected article **403b** is also defective, the valve member **417** of the ejector valve **411** opens when such article **403a** reaches the ejecting station B so that the supply conduit **419** directs a stream of compressed gas into the respective recess **413.** The respective channel or port **405a** then directs the stream of compressed gas against the tobacco filler rod section S of the defective article **403a** and insures the expulsion of such article while the corresponding recess **413** travels through the ejecting station B. Such stream of gas cannot dislodge the satisfactory articles **403a** in the neighboring flutes **402D, 402E.**

Each of the apparatus shown in FIGS. **1–6** comprises an ejector unit or segregating unit with two discrete ejectors, such as the valves **9, 11** of FIG. **1,** whereby one ejector serves to segregate defective articles in the evenly numbered flutes of the drum and the other ejector serves to segregate defective articles in the oddly numbered flutes of the drum. It is clear, however, that the improved apparatus can be modified to have three, four or more ejectors for segregation of defective or selected articles in each third, fourth, etc. flute and that the thus modified apparatus then includes an ejecting or segregating station whose width approaches three, four, etc. times the distance between the centers of two neighboring flutes. Such apparatus must employ more complicated drums and more complicated systems for transmission of signals from the detector to the respective ejector valves. Referring specifically to FIG. **1,** the apparatus therein shown could be provided with three ejector valves, three flip-flops and a more complicated switching circuit which would insure energization of the proper electromagnet when a defective article reaches the ejecting or segregating station whose width is then approximately three times the distance between two neighboring flutes. Such apparatus must employ a different control means, e.g., a valve plate with three grooves located at different distances from the axis of the drum, and the drum must be provided with three sets of radial channels or ports and with three sets of axially extending bores or channels.

It is further clear that the apparatus of the present invention need not be used exclusively for the segregation or ejection of defective articles. Thus, it is often desirable to segregate from a row of cigarettes, cigars, cigarillos, cheroots or filter rod sections each second, third, etc. article not because the articles to be segregated are defective but because the single row is to be converted into two, three or more rows. Furthermore, the apparatus can be used for segregation of each n-th article for the purpose of testing in a separate apparatus, i.e., the apparatus of the present invention then merely constitutes a means for segregating from a series of closely adjacent rapidly moving equidistant articles each n-th article for the purpose of inspection or testing at a station which is not located upstream of the ejecting or segregating station. Also, the apparatus can be used to transfer each n-th article between a conveyor (e.g., the drum **1** of FIG. **1**) wherein the articles travel sideways and a conveyor whereon the articles travel lengthwise. Each n-th article can be removed from the drum **1** for immediate transfer onto a testing conveyor where the thus removed articles are tested in the same way as *at* the station A of FIG. **1** or by resorting to other types of testing devices.

The apparatus of FIGS. **7** and **8** differs from the apparatus of FIGS. **1–6** in that the drum **501** carries a large number of ejector valves **509,** one for each flute **502,** and that the ejector valves **509** orbit about the axis of the drum **501** at the speed of the articles **503** so that each valve **509** remains in permanent registry with the respective flute **502.** The valve member **516** of each ejector valve **509** can be moved to open position in response to energization of the corresponding electromagnet **521.** The ejector valves **509** are installed in supply conduits **518** which can discharge streams of compressed gas into the respective flutes **502** of the drum **501.** Each supply conduit **518** communicates with an axially parallel channel **518a** of the drum **501.** Each channel **518a** has an open end at the right-hand end face of the drum **501,** as viewed in FIG. **8,** and communicates with an arcuate groove **534** of a stationary valve plate **536** which is in sealing engagement with the adjacent end face of the drum **501** and is connected with a source **520** of compressed gas. The groove **534** is always filled with compressed gas and such gas can flow through a channel **518a** and the corresponding supply conduit **518** when the respective electromagnet **521** receives a signal to move the corresponding valve member **516** to the open position. It will be noted that the supply conduits **518** replace the ports or channels of the drums shown in FIGS. **1** to **6.**

The electromagnets **521** are energizable and deenergizable by discrete signal transmitting circuits **535** which rotate with the drum **501** and are connected with a source of electrical energy by means of conductors **544,** slip rings **541** on the drum **501,** and stationary brushes **543.** The drum **501** rotates about the axis of a stationary shaft **542** which supports the valve plate **536.** A first signal transmitting device **537** is adjacent to the path of the signal transmitting circuits **535** and can cause a selected signal transmitting circuit to energize the respective electromagnet **521** in response to a signal from the detector, not shown. A second signal transmitting device **538** causes the selected circuit **535** to deenergize the respective electromagnet **521** with a predetermined delay following the energization of the corresponding ejector valve.

As shown in FIG. **7,** the length of the groove **534** in the valve plate **536** corresponds to three times the distance between the centers of two neighboring flutes **502** and determines the width of the ejecting or segregating station B. The signal transmitting devices **537, 538** are respectively located upstream and downstream of the station B, as considered in the direction of rotation of the drum **501** (clockwise, as the parts appear in FIG. **7**). Energy storing devices **546** (e.g., batteries or capacitors) are connected in parallel with the signal transmitting circuits **535.**

The construction of the signal transmitting devices **537** and **538** is shown in FIG. **9a.** The device **537** comprises a light source **553** (e.g., a flashtube or a light-emitting diode) which produces a beam of light in response to a signal from the detector (such as the detector **4** of FIG. **1**) and thereby causes a light sensitive element or receiver **556** (e.g., a photothyristor) of the adjacent control circuit **535** to generate a signal which

causes energization of the corresponding electromagnet **521.** The signal transmitting device **538** comprises a light source **554** which is preferably identical with the light source **553** and can produce a light beam with a predetermined delay following the emission of a beam of light by the source **553** to thereby cause a second light sensitive element or receiver **557** of the adjacent circuit **535** to effect deenergization of the respective electromagnet **521.** The light sources **553, 554** can be said to constitute two contactless initiators or switches which can respectively cause completion and opening of the circuit of a selected electromagnet **521** in response to signals from the detector. The transmission of signals from the detector to the light source **553** is delayed in such a way that the flute **502** containing that defective article which has caused the generation of a signal during travel through the testing station moves into registry with the light source **553** when the latter energizes the respective electromagnet **521.** The corresponding valve member **516** then moves to its open position and the supply conduit **518** begins to receive a stream of compressed gas as soon as the corresponding channel **518a** reaches the groove **534** of the valve plate **536.**

As mentioned before, the light source **554** can be caused to produce a beam of light with a predetermined delay following the emission of light by the light source **553.** However, it is equally within the purview of the invention to provide for the light source **554** a circuit which causes the light source **554** to direct a beam of light against each successive receiver **557** irrespective of whether or not the circuit of the light source **553** was completed by a signal from the detector.

The operation of the apparatus of FIGS. **7, 8** and **9a** is as follows:

If a defective article **503** reaches the testing station (not shown), the detector at such station transmits a signal which causes completion of the circuit of the light source **553** (signal transmitting device **537**) with a delay which is required to transport the defective article **503** to the ejecting station B. The light source **553** transmits a signal to the adjacent receiver **556** which causes energization of the electromagnet **521** for that valve member **516** which controls the admission of compressed gas into the flute **502** for the defective article **503.** The valve member **516** moves to its open position and allows a stream of compressed gas to flow from the source **520,** through the groove **534** of the valve plate **536** and through the respective supply conduit **518** as soon as the respective channel **518a** moves into registry with the front end of the groove **534.** The ejection of the defective article **503** from its flute **502** can take place at any moment during the period of travel of the respective channel **518a** past the stationary groove **534.** The means for delaying the transmission of signals from the detector to the light source **553** may comprise a shift register or any other suitable time delay means. In the embodiment of FIGS. **7** and **8,** the length of the groove **534** is such that the ejection of a defective article **503** can take place during an interval which is required to transport a flute **502** through a distance corresponding to, approximating or even exceeding three times the distance between the centers of two neighboring flutes. When the respective receiver **557** reaches the light source **554** (signal transmitting device **538**), the source **554** transmits a photosignal which causes the receiver **557** to deenergize the electromagnet **521** shortly after the respective channel **518a** moves beyond the groove **534** of the valve plate **536.** The deenergization of the electromagnet **521** takes place in response to discharge of a capacitor **558** which discharges in response to illumination of the receiver **557** by light issuing from the source **554.**

It will be seen that the apparatus of FIGS. **7, 8, 9a** can effect segregation of selected articles **503** during travel of such articles through a distance which is more than twice the distance between two neighboring flutes **502** and in such a way that the ejection of a selected article **503** in no way influences the retention of the adjoining articles in their flutes.

FIG. **9b** illustrates two inductive signal transmitting devices **537′, 538′** which can be used in the apparatus of FIGS. **7, 8** as substitutes for the devices **537, 538** of FIG. **9a.** The devices **537′, 538′** respectively comprise stationary coils **561, 562** which respectively serve to transmit signals for energization and deenergization of selected electromagnets **521.**

Each signal transmitting circuit **535′** on the drum comprises two coils **563, 564** which are respectively connected by way of amplifiers **566, 567** with the inputs a and b of a signal storing device or circuit **560** of known construction. The output c of the signal storing device **560** is connected with the respective electromagnet **521** by way of a further amplifier **569.** The output c transmits a signal to the amplifier **569** to energize the electromagnet **521** and to move the corresponding valve member **516** to its open position in response to transmission of a signal to the input a of the signal storing device **560.** The signal at the output c disappears in response to transmission of a signal to the erasing input b of the signal storing device **560.**

When the detector at the testing station of the apparatus shown in FIGS. **7** and **8** detects the presence of a defective article **503,** the signal from the output of such detector is transmitted to the circuit of the coil **561** with a requisite delay whereby the current flowing through the coil **561** induces a voltage signal in the approaching winding **563** of that signal transmitting circuit **535′** which is associated with the ejector valve **509** for the flute **502** containing the defective articles **503** (namely, that article which has caused the generation of a signal at the testing station). The signal from the winding **563** is amplified at **566** and is transmitted to the input a of the signal storing device **560.** The output c of the signal storing device **560** transmits a signal to the amplifier **569** which energizes the electromagnet **521** to move the valve member **516** to the open position whereby the respective supply conduit **518** begins to receive a stream of compressed gas as soon as the corresponding channel **518a** reaches the front end of the groove **534** in the stationary valve plate **536.** The defective article **503** is segregated while the respective flute **502** travels through the ejecting or segregating station B, i.e., while the flute covers a distance which is several times the distance between the centers of two neighboring flutes.

The winding **564** of the signal transmitting circuit **535′** then reaches the winding **562** of the signal transmitting device **538′** which induces in the winding **564** a voltage signal. Such signal is amplified at **567** and is transmitted to the input b of the signal storing device **560** which terminates the transmission of signal to the amplifier **569.** Thus, the electromagnet **521** is deenergized and the valve member **516** reassumes its closed position.

The apparatus of FIGS. **10** and **11** differs from the apparatus of FIGS. **1** to **8** in that the rod-shaped articles Z are normally held by a mechanical retaining force and that the application of such mechanical retaining force is terminated in response to signals from a detector to thereby permit segregation of the article (which has caused the generation of a signal) by pneumatic means, by the action of gravity and/or by the action of centrifugal force.

The apparatus of FIGS. **10** and **11** comprises a conveyor or drum **602** which is rotatable on a stationary shaft **604** and carries on its periphery a set of equidistant receiving means for the articles Z and a set of testing units for such articles. It is assumed that the articles Z are filter cigarettes of unit length each of which has a wrapped tobacco filler rod section S and a filter tip F. Each receiving means comprises two aligned fluted receiving members **606, 608** which can receive an article Z so that the latter's axis is parallel to the axis of the drum **602.** The filter tips F of the articles Z are adjacent to a ring-shaped flange or abutment **610** of the drum **602.** The articles Z are temporarily held in the flutes of the receiving members **606, 608** by two arcuate shrouds or retaining members **612, 614** which are indicated in FIG. **10** by phantom lines. The centers of curvature of the shrouds **612, 614** are located on the axis of the shaft **604** (see FIG. **11**). The purpose of the shrouds **612, 614** is to hold the articles against ejection from the respective receiving members **606, 608** under the action of gravity and/or centrifugal force while the articles travel along predetermined portions of their path.

Each receiving member **606** of the drum **602** is provided with a radially extending suction channel or port **616** and each receiving member **608** is provided with a radially extending suction channel or port **618.** The ports **616, 618** for each pair of aligned receiving members **606, 608** communicate with discrete axially parallel channels or bores **620** of the drum **602.** The receiving members **606** are adjacent to a housing **622** which is provided on the drum **602** and accommodates a plurality of testing units, one for each pair of receiving members **606, 608.** The housing **622** has a set of cylindrical bores **624,** one for each receiving member **606** and adjacent to the right-hand end of the housing, as viewed in FIG. **10.** Each bore **624** communicates with a larger diameter bore **626** which in turn communicates with a channel **628** for admission of a testing fluid. Each bore **624** further communicates with a discrete channel **630** which can discharge testing fluid into the atmosphere.

The front end wall **632** of the housing **622** has a set of openings **634** for the heads **636** of working pistons **638** which are reciprocable in the respective bores **624.** The head **636** of each piston **638** has a bore **640** and extends forwardly from a ring-shaped shoulder **642** of the respective piston. Each piston **638** further comprises a shank **639** which extends rearwardly from the respective shoulder **642,** as viewed in FIG. **10.** Each shank **639** is formed with two channels **644, 646** the first of which constitutes an extension of the respective channel **630.** The left-hand or rear channel **646** of the shank **639** is located in the region of the respective larger-diameter bore **626.** The rear end of each piston **638** is sealed by a closure or plug **647** which is in mesh with the internally threaded left-hand end portion of the respective shank **639.** The outer surface **648** of each plug **647** is provided with a shallow depression or recess **650** and defines with an adjacent disk-shaped wall **680** of the housing **622** a compartment **652.** The shoulder **642** of each working piston **638** abuts against one end convolution of a helical spring **654** which reacts against the inner side of the front end wall **632** of the housing **622.**

Each working piston **638** accommodates a testing piston **656** which has a tubular plunger **658** provided with an axially extending bore **660.** The front end of each bore **660** communicates with the recess **662** of a mouthpiece **664** in the head **636** of the respective working piston **638.** Each testing piston **656** forms part of a retaining device for the adjacent article Z. The other or rear end of each bore **660** communicates with a port **666** in the wall of the respective piston **656** and the port **666** communicates with a compartment **668.** The channels **646** connect the compartments **668** with the respective bores **626.** It can be said that each testing unit in the housing **622** comprises a first testing chamber which constitutes the compartment **668** and a second testing chamber including the bore **626** and the compartment **652.** The bores **626** are in temporary communication with the respective compartments **652** during each revolution of the drum **602.** The front end face of each testing piston **656** is biased by a discrete helical spring **670** which reacts against the inner end of the head **636** of the respective working piston **638.** The purpose of the springs **670** is to bias the pistons **656** against the respective plugs **647** so that the front end faces of the plungers **658** are flush with the bottom surfaces in the respective recesses **662.**

A venting or aerating orifice **672** extends radially outwardly from the bore **660** of each testing piston **656** so that it can communicate with an annular channel **674** of the respective piston **683.**

The rear portion of each working piston **638** is guided in a portion **676** of the housing **622.** The housing portion **676** is located in front of connecting channels **678** which establish communication between the bores **626** and the respective compartments **652** when the corresponding working pistons **638** move forwardly whereby the thus connected bore **626** and compartment **652** constitute the second testing chamber of the respective testing unit. The outer side of the rear wall **680** of the housing **622** on the drum **602** abuts against a stationary control means or valve plate **682** which is biased against the drum by a strong helical spring **684.** The right-hand surface of the valve plate **682** (as viewed in FIG. **10**) is provided with several arcuate grooves which are best shown in FIG. **11.** The centers of curvature of such grooves in the valve plate **682** are located on the axis of the shaft **604.** The wall **680** has an annulus of axially parallel bores **686** each of which communicates with a channel **620** and travels along arcuate grooves **692, 694, 696** (FIG. **11**) of the valve plate **682** when the drum **602** rotates. A second annulus of bores **688** in the wall **680** can communicate with an arcuate groove **698** of the valve plate **682;** the bores **688** communicate with the respective compartments **652.** The channels **628** can communicate with an arcuate groove **704** of the valve plate **682** by way of exchangeable flow restrictors **690** in the wall **680,** one for each testing unit.

The groove **698** of the valve plate **682** is located radially outwardly of the grooves **692, 694, 696** but radially inwardly of the groove **704.** The grooves **692, 696** are connected with a suction generating device and the median groove **[692]** *694* is connected with a

source of compressed air. The length of the median groove **694** corresponds to at least twice the distance between a pair of neighboring receiving members **606** or **608** on the periphery of the drum **602.** The groove **698** of the valve plate **682** is located at the same distance from the axis of the shaft **604** as two bores **700, 702** of the valve [member] *plate*. The bore **700** can connect the compartments **652** with the atmosphere. The bore **702** is connected with a source of compressed air which can be admitted into the axial bores **660** to expel therefrom dust, particles of tobacco or other foreign matter. The groove **704** can communicate with the passages of the flow restrictors **690** and is connected with a source of testing fluid.

The operation of the apparatus of FIGS. **10** and **11** is as follows:

Successive pairs of axially aligned receiving members **606, 608** receive articles Z at a transfer station U1 shown in FIG. **11.** Such articles are immediately moved along the inner sides of the retaining shrouds **612, 614** so that they cannot leave the flutes of their receiving members under the action of centrifugal force and/or gravity. The means for feeding articles Z at the transfer station U1 may comprise a conventional transfer drum of the type well known from the art of filter cigarette making machines or filter plug making machines.

The bore **688** for the corresponding testing unit in the housing **622** on the drum **602** thereupon moves into registry with the arcuate groove **698** of the valve plate **682.** The groove **698** is connected with a source of compressed gaseous fluid (e.g., air) which penetrates through the respective bore **688** and enters the compartment **652** to move the corresponding working piston **638** in a direction to the right, as viewed in FIG. **10.** The piston **638** stresses the corresponding spring **654** whereby an internal shoulder of the respective mouthpiece **664** shifts the freshly transferred article Z axially so that the filter plug F of such article abuts against the flange **610** of the drum **602.** The free end of the wrapped tobacco filler rod section S of the article Z enters the respective mouthpiece **664** and is sealed from the atmosphere.

The drum **602** continues to rotate in a clockwise direction, as viewed in FIG. **11,** and moves the flow restrictor **690** of the respective testing unit into registry with the long arcuate groove **704** of the valve plate **682.** The groove **704** communicates with a source of compressed testing fluid (e.g., air) which passes through the flow restrictor **690,** through the corresponding channel **628** and bore **626,** through the channel **646** and compartment **668** and port **666** of the respective pistons **638** and **656,** and into the axial bore **660** to enter the filler of the respective wrapped tobacco rod section S. The pressure of gas in the compartment **668** causes the testing piston **656** to move forwardly (in a direction to the right, as viewed in FIG. **10**), and to cause its tubular plunger **658** to penetrate into the adjacent end of the filler if the filler is too soft, i.e., if the exposed end of the wrapped tobacco filler rod section [X] *S* contains less than a desirable quantity of tobacco shreds. When the plunger **658** is free to penetrate into the section S to such an extent that the orifice **672** and the channel **674** of the respective testing piston **656** move into registry with the channel **644** of the associated working piston **638,** the article Z is defective and should be segregated from other articles on the drum **602.** Such segregation takes place in the following way: When the channel **674** of the testing piston **656** moves into registry with the channel **644** of the working piston **638** (and hence with the corresponding channel **630** of the housing **622**), the testing fluid is free to escape from the compartment **668** into the atmosphere. The bias of the spring **654** for the working piston **638** is stronger than the bias of the spring **670** for the corresponding testing piston **656.** The spring **670** yields and permits the piston **638** to reassume its original (left-hand end) position so that the recess **662** of the mouthpiece **664** moves away from the left-hand end of the wrapped tobacco filler rod section S. The testing fluid is then free to escape into the atmosphere by way of the bore **660** in the plunger **658** of the testing piston **656.** The defective article Z is segregated by gravity and/or centrifugal force because it is then located beyond the arcuate groove **698** of the valve plate **682,** i.e., the ports **616, 618** of the respective receiving members **606, 608** are not connected with the suction generating device.

If the density of the free end of the filler of the section S is satisfactory, the plunger **658** cannot penetrate into the filler so that the channel **674** remains sealed from the channel **644** of the working piston **638.** The satisfactory article Z is then held against ejection because the end of its section S extends into the respective recess **662** and the filter plug F is biased against the flange **610.** The satisfactory article is also held by suction because the ports **616, 618** of the corresponding receiving members **606, 608** are connected with the suction generating device by way of the corresponding channel **620,** the corresponding bore **686** in the wall **680,** and the groove **692** of the valve plate **682.** The corresponding flow restrictor **690** reaches the groove **704** of the valve plate **682** and admits testing fluid into the bore **626** of the respective testing unit in the housing **622.** The quantity of such testing fluid corresponds to the quantity of fluid which can escape into the atmosphere through the pores of an article Z provided that the article is satisfactory, i.e., that the wrapper of its section S or filter plug F is without leaks. The testing fluid flows from the bore **626** into the channel **646** of the respective working piston **638** and compartment **668** to enter the bore **660** of the respective plunger **658** and to penetrate into the filler of the section S which extends into the adjacent recess **662.** If the wrapper of the article Z is defective, e.g., if the wrapper has a pronounced leak, the testing fluid and the control fluid escape through the leak at the rate which exceeds the rate of admission of fresh testing fluid. This results in a drop of pressure in the compartment **652** so that the spring **654** is free to expand and returns the pistons **638** and **656** to their starting positions. The recess **662** of the mouthpiece **664** moves away from the adjacent end of the article Z so that the latter is not held in the receiving members by a mechanical retaining force. The corresponding channel **620** then moves into registry with the arcuate groove **694** of the valve plate **682.** The groove **694** admits into the channel **620** compressed gas by way of the respective bore **686** in the wall **680** and the compressed gas stream expels the article whose wrapper has a leak from the flutes of the corresponding receiving members **606, 608.** Such compressed gas stream is divided into two discrete streams which reach the flutes of the members **606, 608** by way of the respective ports **616, 618.**

If the article Z has a filler of satisfactory density and a wrapper which is free of leaks, the rate at which the gaseous fluid escapes through the pores of the satisfac-

tory wrapper equals the rate of admission of testing fluid by way of the channel **628** of the respective testing unit in the housing **622.** Therefore, the piston **638** remains in its right-hand end position and the free end of the section S of the satisfactory article Z is received in the adjacent recess **662** while the filter plug F bears against the flange **610.** The mechanical retaining force acting on the satisfactory article Z is then such that the streams of compressed gas which are admitted into the corresponding ports **616, 618** while the corresponding channel **620** moves past the groove **694** of the valve plate **682** are too weak to expel the article from its receiving members **606, 608.** The channel **620** then reaches the groove **696** which is connected with the suction generating device so that the satisfactory article Z is held by suction.

The working piston **638** is retracted to its starting position to release the satisfactory article Z when the corresponding bore **688** of the wall **680** reaches the bore **700** which communicates with the atmosphere. The pressure in the compartment **652** decreases and the springs **654** and **670** expand. The satisfactory article Z is then ready to be transferred onto a further conveyor (not shown) at a second transfer station U2 shown in FIG. **11.**

The corresponding bore **688** of the wall **680** then moves into registry with the bore **702** of the valve plate **682.** The bore **702** admits a stream of compressed air which enters the respective bore **660** and expels fragments of tobacco or dust from the testing piston **656.** This takes place before the respective receiving members **606, 608** reach the first transfer station U1. The stream which is admitted by way of the bore **702** also cleans the recess **662** of the corresponding mouthpiece **664.**

It will be seen that the [mouthpiece] *mouthpieces* **664** remain in extended or retaining positions when such mouthpieces engage satisfactory articles Z, and that the mouthpieces are moved from retaining positions to retracted positions when they travel with defective articles. This insures that the action of the mechanical retaining force is terminated when a defective article reaches the ejecting station so that the defective article can be segregated by gravity and/or centrifugal force (assisted, if necessary, by the force which is furnished by a stream of compressed gas) as soon as the defective article reaches the ejecting station. The control means or valve plate **682** insures that the point of application of the separating force travels with the receiving means **606, 608** for a defective article while such receiving means travels along the ejecting station. This insures reliable segregation of the defective article while the respective receiving means **606, 608** covers a distance which is a multiple of the distance between a pair of neighboring receiving means. The width of the ejecting station corresponds to the length of the groove **694** of the valve plate **682.**

An important advantage of the improved method and apparatus is that the width of the ejecting or segregating station substantially exceeds (and is preferably a multiple of) the distance between a pair of neighboring articles. This renders it possible to insure that the selected (e.g., defective) articles are reliably segregated from the remaining articles even though the components which respond to signals from a testing or other signal generating device are unable to react as rapidly as is needed to insure the segregation of selected articles within an interval which is needed to transport an article through a distance which equals that between two neighboring articles.

The apparatus of FIGS. **1–6** exhibit the advantage that the pneumatic ejector units employ parts which can stand long periods of use because they need not be designed to insure instantaneous reaction in response to reception of signals. The apparatus of FIGS. **7** and **8** is slightly more complicated; however, the length of intervals which are available for segregation of selected articles can be many times the length of that interval which is needed to transport an article through a distance equaling that between two neighboring articles. The apparatus of FIGS. **10–11** need not be provided with means for rapid transmission of signals because the testing elements themselves detect the articles which must be segregated by terminating the mechanical retaining action upon such articles. Here, too, the length of intervals which are available for separation or ejection of defective or selected articles can be many times the length of that interval which is required to transport an article through a distance corresponding to the distance between two neighboring articles.

The signals for segregation of selected (defective or satisfactory) articles can be produced at regular or irregular intervals by the machine which produces or processes the articles, for example, by a filter cigarette making machine. The separated articles can be subjected to a testing operation.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of my contribution to the art and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. In a method of individually removing selected cigarettes or analogous rod-shaped articles from a predetermined path for a series of equidistant discrete articles moving at an elevated speed and forming at least two groups, the articles of one of said groups alternating with the articles of another of said groups and the removal of selected articles being effected by a separating force to the action of which a selected article is subjected in response to a signal, the steps of transmitting signals for removal of selected articles of said one group along a first route; transmitting signals for removal of selected articles of said other group along a second route; starting the action of said separating force in response to the thus transmitted signals and in a direction which crosses said path at a point coinciding with the locus of the respective selected article; and moving said point of application of said separating force along said path at said elevated speed and through a predetermined distance substantially exceeding the distance between a pair of neighboring articles of said series.

2. In a method as defined in claim **1,** the additional steps of subjecting the articles of said series to the action of a retaining force which is stronger than said separating force and acts on the articles in a direction to retain the articles in said path, and terminating the action of said retaining force upon a selected article when such article occupies said locus.

3. In a method as defined in claim 1, wherein said separating force is a mechanical force.

4. In a method as defined in claim 3, wherein said mechanical force is the force of gravity.

5. In a method as defined in claim 3, wherein said path is an arcuate path and said mechanical force is the centrifugal force.

6. In a method as defined in claim 1, wherein said separating force is furnished at least in part by a gaseous fluid.

7. In a method as defined in claim 1, wherein said selected articles include each n-th article of said series and wherein n is a whole number exceeding 1.

8. In a method as defined in claim 7, wherein said separating force is furnished at least in part by a gaseous fluid.

9. In a method as defined in claim 7, wherein said predetermined distance is between n–1 and n times the distance between a pair of neighboring articles of said series, and wherein n is a whole number exceeding 1.

10. In a method as defined in claim 1, wherein said separating force is furnished at least in part by a compressed gaseous fluid.

11. In a method as defined in claim 10, wherein said gaseous fluid forms at least one stream which is directed against the respective selected article when such article occupies said locus, and said step of moving said point of application comprises moving the stream at said speed so that the stream continues to cross said path through said predetermined distance.

12. In a method as defined in claim 1, wherein the application of said separating force is triggered by electric signals.

13. In a method as defined in claim 1, wherein the application of said separating force is triggered by pneumatic signals.

14. In a method as defined in claim 1, the additional steps of testing the condition of successive articles upstream of said point and producing said signals in response to detection of defective articles.

15. In a method as defined in claim 1, wherein said series of articles is moved at a speed of at least 1,000 articles per minute.

16. Apparatus for individually removing cigarettes or analogous rod-shaped articles from a series of equidistant discrete articles which form at least two groups and wherein the articles of one of said groups alternate with the articles of another of said groups, comprising conveyor means arranged to move said series of articles along a predetermined path at an elevated speed, said conveyor means having equidistant receiving means for the articles of said series; ejector means actuatable to subject selected articles of said series to the action of a separating force acting transversely of said path to thereby remove said selected articles from the respective receiving means, said force being effective along a predetermined portion of said path whose length substantially exceeds the distance between a pair of neighboring receiving means; control means for moving the point of application of said separating force at said elevated speed along said predetermined portion of said path; and means for actuating said ejector means when a selected article of said series reaches said predetermined portion of said path, including means for generating signals representing selected articles of said one group and said other group, means for transmitting to said ejector means along a first route signals representing said selected articles of said one group, and

means for transmitting to said ejector means along a second route signals representing said selected articles of said other group.

17. Apparatus as defined in claim 16, wherein said ejector means comprises retaining means movable to and from an operative position in which said retaining means retains the articles of said series in the respective receiving means with a second force which exceeds said separating force.

18. Apparatus as defined in claim 17, wherein said separating force is the force of gravity.

19. Apparatus as defined in claim 17, wherein said path is an arcuate path and said separating force is the centrifugal force.

20. Apparatus as defined in claim 16, wherein said ejector means comprises at least one pneumatic ejector.

21. Apparatus as defined in claim 20, wherein said ejector means comprises at least one valve.

22. Apparatus as defined in claim 16, wherein said signal generating means is arranged to furnish electric signals.

23. Apparatus as defined in claim 16, wherein said signal generating means is arranged to furnish pneumatic signals.

24. Apparatus as defined in claim 16, wherein said signal generating means comprises means for testing the articles of said series and for producing said signals in response to detection of defective articles.

25. Apparatus as defined in claim 16, wherein said actuating means is arranged to actuate said ejector means for separation of each n-th article of said series and wherein n is a whole number exceeding 1.

26. Apparatus as defined in claim 16, wherein said control means comprises a valve member having a plurality of grooves each extending along said predetermined portion of said path, said conveyor means comprising a plurality of channel means each permanently communicating with a different receiving means and communicating with one of said grooves during travel of the respective receiving means along said predetermined portion of said path, said ejector means comprising means for conveying a stream of gaseous fluid through said grooves and discrete valve means for each of said grooves, each of said valve means being movable between open and closed positions to thereby respectively permit and terminate the flow of gaseous fluid through the respective groove, said actuating means being arranged to effect movements of said valve means from one to the other position thereof when a channel means communicating with the receiving means for a selected article communicates with the respective groove.

27. Apparatus as defined in claim 26, wherein said means for conveying comprises a source of compressed gaseous fluid and said actuating means is arranged to effect movements of said valve means to open positions.

28. Apparatus as defined in claim 26, wherein said means for conveying comprises suction generating means and said actuating means is arranged to effect movements of said valve means to closed positions.

29. Apparatus as defined in claim 26, wherein the length of said grooves is between n-1 and n times the distance between a pair of neighboring receiving means and wherein n is a whole number exceeding 1.

30. Apparatus as defined in claim 26, wherein said valve member is a stationary valve plate and said con-

veyor means is arranged to rotate about a predetermined axis and has an end face in sealing engagement with said valve plate.

31. Apparatus as defined in claim **26,** wherein said valve member is rigid with said conveyor means.

32. Apparatus as defined in claim **16,** wherein said ejector means comprises a discrete ejector for each of said receiving means, said discrete ejectors being arranged to move with said conveyor means at said elevated speed so as to remain in unchanged positions with reference to the respective receiving means.

33. Apparatus as defined in claim **16,** wherein said conveyor means is arranged to transport said series of articles at a speed of at least 1,000 articles per minute.

34. Apparatus for individually removing cigarettes or analogous rod-shaped articles from a series of equidistant discrete articles, comprising conveyor means arranged to move said series of equidistant articles along a predetermined path at an elevated speed, said conveyor means having equidistant receiving means for the articles of said series; ejector means actuatable to subject selected articles of said series to the action of a separating force acting transversely of said path to thereby remove said selected articles from the respective receiving means, said force being effective along a predetermined portion of said path whose length substantially exceeds the distance between a pair of neighboring receiving means; control means for moving the point of application of said separating force at said elevated speed along said predetermined portion of said path; signal generating means for actuating said ejector means when a selected article of said series reaches said predetermined portion of said path; and means for transmitting signals from said signal generating means to said ejector means, including a shift register arranged to transport signals in synchronism with movements of the respective selected articles and means for transmitting signals from said shift register to said ejector means when the selected articles reach said predetermined portion of said path.

35. Apparatus as defined in claim **34,** wherein said means for transmitting signals from said shift register to said ejector means comprises cooperating first and second signal transmitting portions respectively provided on said conveyor means and adjacent to said conveyor means and being out of contact [from] *with* each other.

36. Apparatus as defined in claim **35,** wherein said signal transmitting portions include photosensitive means.

37. Apparatus as defined in claim **35,** wherein said signal transmitting portions include electromagnetic means.

38. In a method of individually removing selected cigarettes or analogous rod-shaped articles from a predetermined path for a series of equidistant discrete articles moving at an elevated speed and forming a plurality of groups, the articles of one of said groups alternating with the articles of another of said groups and the removal of selected articles being effected by a separating force to the action of which a selected article is subjected in response to a signal, the steps of transmitting signals for removal of selected articles of said one group along a first route; transmitting signals for removal of selected articles of said other group along a second route; starting the action of said separating force in response to the thus transmitted signals and in a direction which crosses said path at a point coinciding with the locus of the respective selected article; and moving said point of application of said separating force along said path at said elevated speed and through a predetermined distance not appreciably less than the distance between two neighboring articles of said series.

39. In a method as defined in claim 38, wherein said step of starting the action of said separating force is initiated prior to arrival of the respective selected article at said locus so that said separating force is built up and is fully effective as soon as the respective selected article reaches said locus.

40. In a method as defined in claim 38, wherein said separating force is furnished at least in part by a gaseous fluid.

41. Apparatus for individually removing cigarettes or analogous rod-shaped articles from a series of equidistant discrete articles which form a plurality of groups and wherein the articles of one of said groups alternate with the articles of another of said groups, comprising conveyor means arranged to move said series of articles along a predetermined path at an elevated speed, said conveyor means having equidistant receiving means for the articles of said series; ejector means actuatable to subject selected articles of said series to the action of separating forces acting transversely of said path to thereby remove said selected articles from the respective receiving means, each of said forces being effective along a predetermined portion of said path whose length is not appreciably less than the distance between a pair of neighboring receiving means; control means for moving the points of application of said separating forces at said elevated speed along said path; and means for actuating said ejector means not later than when a selected article of said series reaches said predetermined portion of said path, including means for generating signals representing selected articles of said one group and said other group, means for transmitting to said ejector means along a first route signals representing said selected articles of said one group, and means for transmitting to said ejector means along a second route signals representing said selected articles of said other group.

42. Apparatus as defined in claim 41, wherein said ejector means comprises a discrete pneumatic ejector for each of said plurality of groups.

43. Apparatus as defined in claim 41, wherein said signal generating means comprises means for testing the articles of said series and for producing said signals in response to detection of defective articles.

44. Apparatus as defined in claim 41, wherein each of said signal transmitting means comprises means for actuating said ejector means before a selected article of said series reaches said predetermined portion of said path so that the removal of such selected article begins as soon as the article to be removed reaches said predetermined portion of said path.

45. Apparatus for selectively removing discrete cigarettes or analogous rod-shaped smokers' products from equally spaced product-receiving means of a conveyor, comprising at least one control means which is operative to release products to the action of separating forces acting in a direction to remove the products from the respective receiving means; means for supplying signals for operation of said control means so as to maintain said control means in operative condition for an interval of time which is longer than that necessary to move a selected receiving means through a distance equal to that between two neighboring receiving means on said conveyor; and ejector means for applying said separating forces to a product in said selected receiving means while said control means is in operative condition and for an interval of time which at most equals the interval necessary to move said selected receiving means through said distance.

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