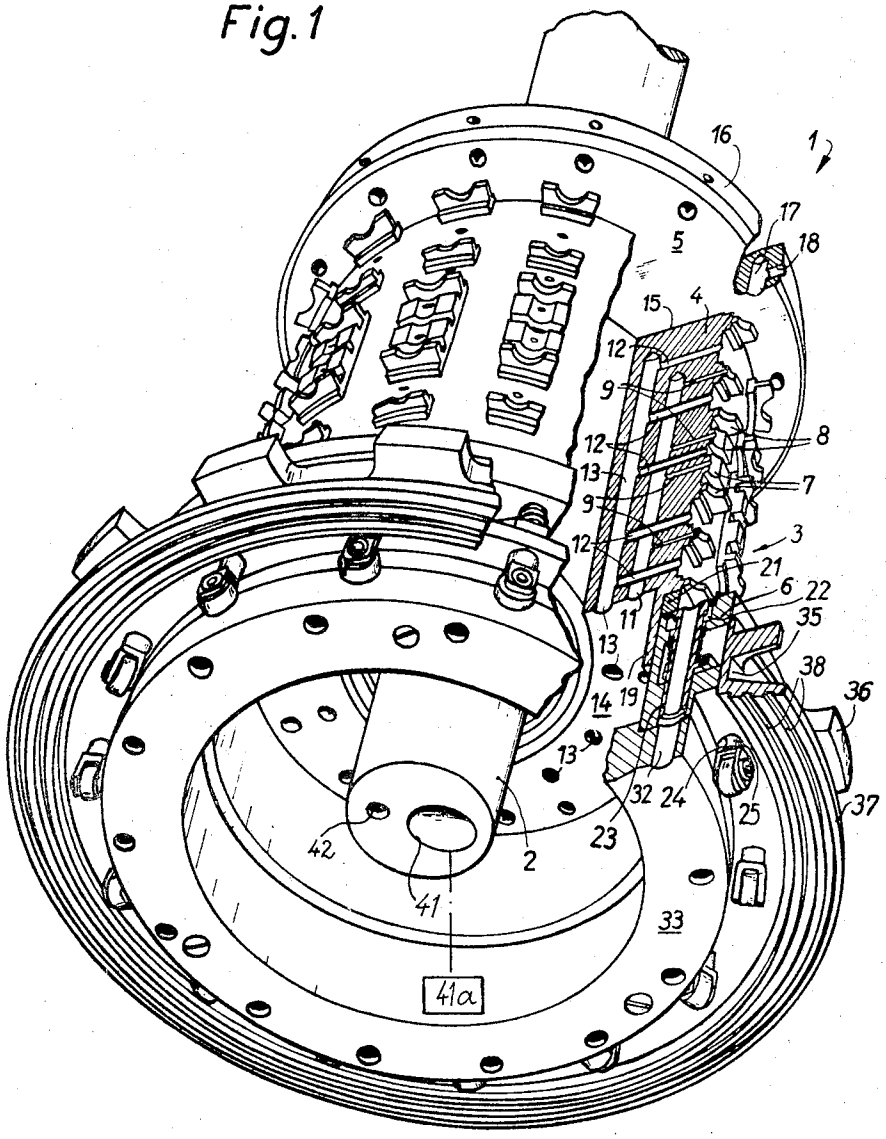
July 14, 1970 B. HEITMANN ET AL 3,520,177

APPARATUS FOR TESTING AND CLASSIFYING CIGARETTES OR THE LIKE

Filed Jan. 17, 1968 3 Sheets-Sheet 1

Fig. 1



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APPARATUS FOR TESTING AND CLASSIFYING CIGARETTES OR THE LIKE

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Fig. 2

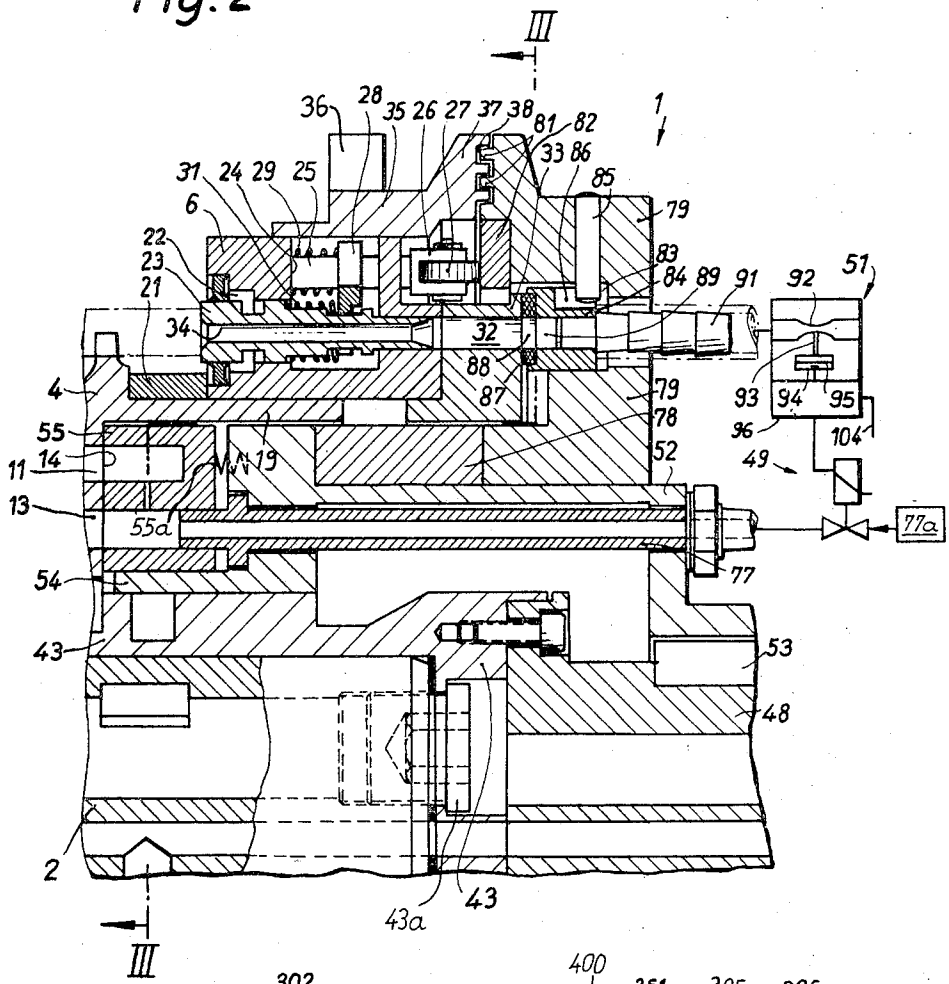
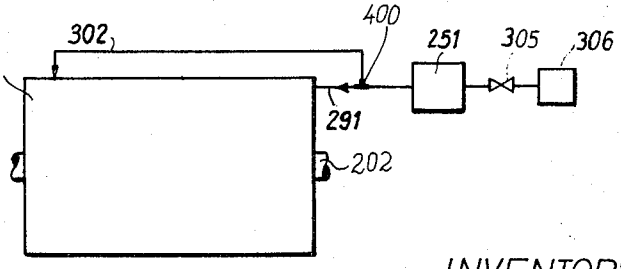


Fig. 4



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APPARATUS FOR TESTING AND CLASSIFYING CIGARETTES OR THE LIKE

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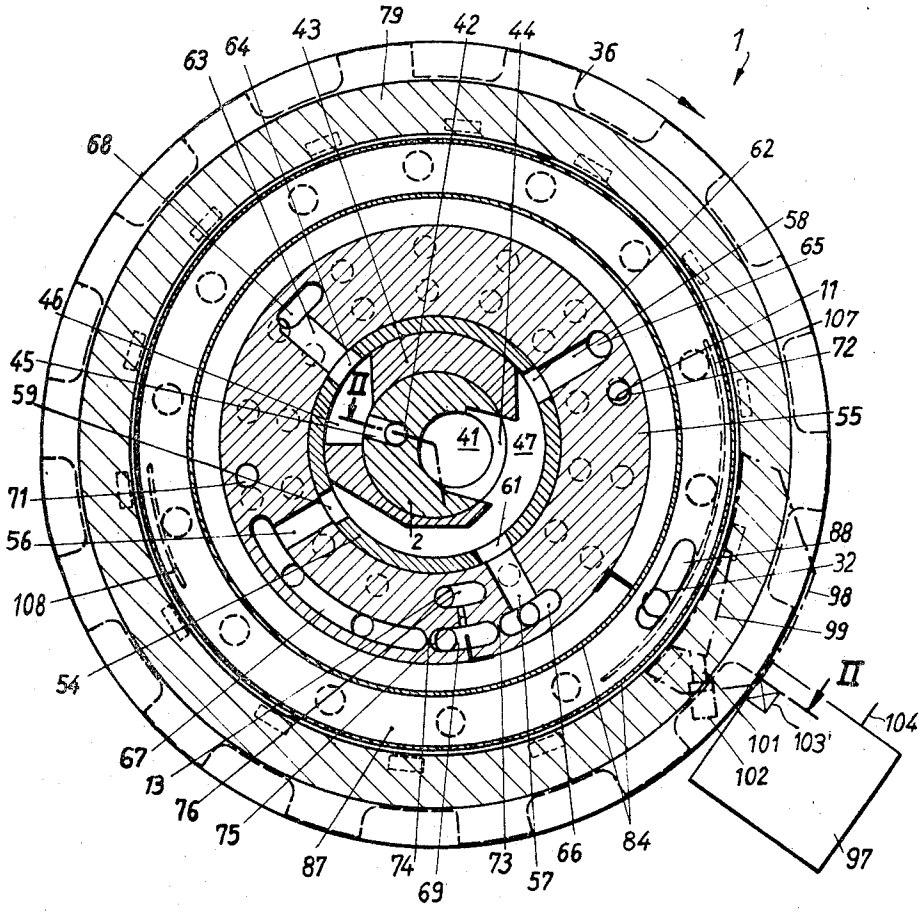
Fig. 3



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APPARATUS FOR TESTING AND CLASSIFYING CIGARETTES OR THE LIKE

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Int. Cl. G01m 3/04
U.S. Cl. 73—45.1 12 Claims

ABSTRACT OF THE DISCLOSURE

A rotary testing drum for cigarettes is provided with axially parallel flutes which receive cigarettes at a first station and advance them past a testing station where the cigarettes are tested for the presence of defects, thereupon past an ejection station where a defective cigarette is expelled from its flute by compressed air, and finally past a transfer station at which the satisfactory cigarettes leave their respective flutes. The drum is provided with suction ports communicating with the flutes and with orifices adjacent to each flute. Satisfactory cigarettes are held by suction during travel past the ejecting station. The testing unit which tests cigarettes during travel past the testing station sends signals to an ejecting device which includes a stationary conduit for compressed air and a regulating valve in the conduit. The valve opens in response to a signal and the conduit then admits compressed air into orifices adjacent to that flue which accommodates a defective cigarette or directly into the ports in such flute to effect expulsion of defective cigarettes at the ejecting station. In order to facilitate expulsion of defective cigarettes by compressed air, suction ports in a flute which accommodates a defective cigarette can be automatically connected with the aforementioned conduit during travel past the ejecting station so that, when the conduit admits compressed air to a set of orifices, it also admits air to the corresponding suction ports to raise the pressure therein and to reduce the force with which the defective cigarette is held in its flute. The orifices adjacent to a flute for a defective article can be connected with the corresponding suction ports by way of a flow restriction passage or orifice provided in a control ring which regulates the evaluation of air from suction ports and the admission of air from the conduit into the orifices in response to rotation of the drum.

CROSS-REFERENCE TO RELATED APPLICATION

The apparatus of our present invention constitutes an improvement over and a further development of testing apparatus disclosed in the copending application Ser. No. 431,355, now U.S. Pat. No. 3,412,856, filed by Albert Esenwein on Feb. 9, 1965 and assigned to the same assignee.

BACKGROUND OF THE INVENTION

The present invention relates to apparatus for testing and classifying cigarettes, cigarillos, or cigars with or without filters and of unit or multiple unit length, filter rod sections and analogous rod shaped articles wherein an open-ended tubular wrapper surrounds a filler of air-permeable material. More particularly, the invention relates to improvements in apparatus wherein the articles are tested by means of air or another fluid while traveling sideways in the flutes of a conveyor from a receiving station, past a testing station and thereupon past an ejecting station where the defective articles are removed from their flutes.

It is already known to hold cigarettes or like rod shaped articles by suction while the articles travel sideways past a testing station where the wrappers and/or fillers of such articles are tested by means of air. Ejection of defective articles is effected by jets of compressed air which expel defective articles from their holders on the conveyor in response to signals received from the testing unit. A serious drawback of many presently known testing apparatus is that it requires too much time to open the valve which admits compressed air, especially if such apparatus are employed for testing of cigarettes or filter cigarettes issuing from a high-speed cigarette or filter cigarette machine. The ejecting devices of high-speed testing apparatus must produce very strong jets of compressed air in order to insure that a defective article is invariably expelled in a predetermined zone of the path along which the articles travel past and beyond the testing station. The flow of such strong jets of compressed air must be regulated by relatively large valves whose inertia is high, i.e., a large and bulky valve requires more time for opening and/or closing than a smaller valve of lightweight design.

SUMMARY OF THE INVENTION

It is an object of our invention to provide a novel and improved testing apparatus wherein defective articles can be readily and rapidly segregated from satisfactory articles while such articles travel at a high speed beyond a testing station where the articles are tested for the integrity of their components.

Another object of the invention is to provide a testing apparatus wherein the defective articles can be segregated by relatively weak blasts or jets of air or another suitable gaseous fluid.

A further object of the invention is to provide a testing apparatus wherein the force which retains the articles on the conveyor which transports them past and beyond a testing station can be reduced automatically so that the defective articles offer little resistance to expulsion and resulting segregation from satisfactory articles.

The improved testing and classifying apparatus comprises a conveyor which preferably includes a drum rotatable about a fixed axis and having axially parallel holders provided with flutes for a succession of rod shaped articles. The articles travel past a testing station and thereupon past an ejecting station for defective articles. Those articles which are satisfactory are held by suction during travel past the ejecting station. A testing unit which tests articles during travel toward the ejecting station controls the operation of an ejecting means which includes a stationary conduit connectable with a source of compressed gas and a regulating valve which opens in response to signals from the testing unit to admit compressed gas into the conduit and into orifices provided in the conveyor adjacent to the flutes for a defective article. In order to facilitate expulsion of defective articles from their flutes, the conduit is automatically connected with suction ports which normally hold the articles in their flutes so that the pressure in the ports for a defective article rises and relatively weak jets of air issuing from the orifices can readily dislodge a defective article. The suction reducing means preferably resembles a flow restricting orifice provided in a control means which regulates the suction in the aforementioned ports and the admission of compressed gas from the conduit into the orifices in response to movement of holders.

It is also possible to admit compressed gas directly into the suction ports and to omit the orifices.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved testing 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 perspective view of a conveyor in a testing apparatus which embodies one form of our invention;

FIG. 2 is a fragmentary axial sectional view of the apparatus, substantially as seen in the direction of arrows from the line II—II of FIG. 3;

FIG. 3 is a transverse sectional view as seen in the direction of arrows from the line III—III of FIG. 2; and

FIG. 4 is a diagrammatic side elevational view of a second testing apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The apparatus of our invention is utilized for testing of cigarettes, filter cigarettes, filter rod sections, cigarillos or like rod-shaped articles wherein an open-ended tubular wrapper surrounds an air-permeable filler. The apparatus comprises a conveyor **1** which serves to advance a series of articles sideways from a receiving station, past a testing station, thereupon past an ejecting station for defective articles and finally past a transfer station where the satisfactory articles are taken off for transport to one or more additional processing stations.

In the illustrated embodiment, the conveyor **1** includes a hollow drum **3** which is rotatable about the axis of a fixed shaft **2**. The upper end of the shaft **2**, as viewed in FIG. 1, is mounted in a supporting frame (not shown). The drum **3** comprises a cylindrical portion **4** (hereinafter called cylinder for short) which is rigid with two axially spaced radial extensions or flanges **5** and **6**. The latter flange **6** is mounted on and is affixed to a tubular extension **19** of the cylinder **4** at that end of the cylinder which is remote from the aforementioned frame. The flange **6** is surrounded by an annular synchronizing cam **35** having equidistant radial metallic projections or lobes **36**, and that axial end of the extension **19** which is remotest from the flange **5** is adjacent to but spaced from a ring **33**.

The exterior of the cylinder **4** is provided with sets of axially parallel holders **8** having grooves or flutes **7** which accommodate the articles during travel with the drum **3**. The grooves **7** are equidistant from each other and are parallel to the axis of the shaft **2**. The cylinder **4** has an internal annular shoulder **14** which is surrounded by the extension **19** and this cylinder is provided with pairs of axially parallel blind bores or channels **11, 13** extending toward but short of the inner end face **15** of the flange **5**. Each pair of channels **11, 13** is located in a radial plane of the drum **3**, such plane also including one set of grooves **7**. The centers of channels **11, 13** are located on two circles whose centers are located on the axis of the shaft **2**. Each channel **11** communicates with radially outwardly extending suction ducts or ports **9** which terminate in the grooves **7** of the associated set of holders **8** and the channels **11** can be connected to a suction generating device **41***a* to hold by suction articles in the associated grooves **7** while such articles travel from the receiving station and beyond the testing station. Radially outwardly extending orifices **12** communicate with the channels **13** and terminate in the periphery of the cylinder **4** between the corresponding grooves **7**. The orifices **12** are preferably defined by small-diameter tubes which are inserted into the cylinder **4** and extend across the associated suction channels **11**. The channels **13** can be

connected to a source **77***a* of compressed gas, preferably air, to effect expulsion or ejection of articles from the corresponding grooves **7**. The external diameters of tubes which form the orifices **12** are smaller than the diameters of suction channels **11**.

The inner end face **15** of the flange **5** is formed with a set of axially parallel blind bores **17** each of which registers with the grooves **7** of one set of holders **8**, and each bore **17** communicates with a radially outwardly extending bore **18** which terminates in the smooth peripheral surface **16** of the flange **5**. The bores **17, 18** serve to convey a testing fluid.

A ring-shaped distancing element or spacer **21** is installed on the extension **19** between the flange **6** and an external annular shoulder of the cylinder **4**. The flange **6** is of U-shaped cross-sectional outline and comprises two radially outwardly extending portions or arms at the axial ends of a ring-shaped web which surrounds the extension **19** of the cylinder **4**. The arms of the flange **6** are formed with axially parallel bores or passages **22** each of which registers with one of the blind bores **17** in the flange **5**, and each bore **22** comprises three sections of different diameter (see particularly FIG. 2). The bores or passages **22** accommodate nozzles **23** one of which is shown in greater detail in FIG. 2 and which serve to clamp the articles against the flange **5** and to convey testing air. The aforementioner ring **33** has bores or passages **32** each of which registers with one of the passages **22**, and each passage **22** is inwardly adjacent to an outer passage or bore **24** in the arms of the flange **6**. Each bore **24** accommodates an axially reciprocable shifter pin **25**. The number of lobes **36** on the synchronizing cam **35** equals the number of sets of holders **8**, and all of these lobes are located in a common plane which is normal to the axis of the shaft **2**. The cam **35** is elongated in the axial direction of the shaft **2** and is provided with a radially outwardly extending flange **37** remote from the lobes **36** and located at that end of the cam which faces away from the cylinder **4**. That end face of the flange **37** which faces away from the lobes **36** is provided with a group of concentric ring-shaped grooves **38**.

FIG. 2 is a fragmentary axial sectional view of the drum **3** and shaft **2** and illustrates some of the heretofore described parts including the cylinder **4** with extension **19**, channels **11, 13** and shoulder **14**, flange **6**, cam **35**, ring **33**, spacer **21**, and a shifter pin **25**. The free end portion of the shaft **2** (i.e., that end portion which is remote from the aforementioned frame) is surrounded by a sleeve **43** which is axed thereto by a bolt, screw or like fastener **43***a*. The sleeve **43** is bolted to a carrier **48** for an electromagnetically operated regulating valve **49** and a testing unit **51**. The carrier **48** is further connected with a sleeve-like support **52** by way if a key **53**. The support **52** has a cylindrical extension **54** which projects toward the cylinder **4** and is accurately fitted onto the sleeve **43**. This support **52** is surrounded by a ring-shaped distancing element or spacer **78** and by a flange **79**. The spacer **78** is interposed between an external shoulder of the support **52** and the flange **79**.

The extension **54** of the support **52** is surrounded by a non-rotatable control ring **55** which regulates the flow of air. Springs **55***a* installed in blind bores of the support **52** bias the control ring **55** axially toward the shoulder **14** of the cylinder **4**. A compressed air conduit **77** is mounted in the support **52** and its discharge end (i.e., the left-hand end, as viewed in FIG. 2) can register with successive pressure channels **13** of the cylinder **4**. The discharge end of the conduit **77** extends into a bore of the control ring **55** and the latter is movable axially of this conduit. The right-hand end of the conduit **77** is connected with the source **77***a* of compressed air, e.g., a compressor. The valve **49** is mounted in the conduit **77** immediately or closely adjacent to the point where the conduit enters the support **52**. The exact configuration

and function of the control ring **55** will be described with reference to FIG. 3. The ejecting device for defective articles includes the valve **49** and the conduit **77** with source **77***a*.

The left-hand end face of the flange **79** on the support **52** has ring-shaped ribs **81** which extend into the grooves **38** of the flange **37** on the synchronizing cam **35**. The ribs **81** are of rectangular cross-sectional outline. An annular recess provided in the flange **79** inwardly of the ribs **81** accommodates a ring-shaped shifter cam **82** having an end face tracked by roller followers **27** mounted in bifurcated end portions **26** of shifter pins **25**. Each pin **25** further carries a shifter fork **28** located between the arms of the flange **6**. A helical spring **29** which is inserted between one arm of the flange **6** and shifter fork **28** biases the pin **25** in a direction to the right, as viewed in FIG. 2, to maintain the follower **27** in engagement with the face of the cam **82**. The prongs of the fork **28** straddle a reduced-diameter portion of the nozzle **23**, and this fork has some freedom of axial movement with reference to the nozzle. A helical spring **31** operates between the prongs of the fork **28** and a shoulder of the nozzle **23** to bias the latter in a direction to the left, as viewed in FIG. 2. The nozzle **23** has an axial passage **34**.

The flange **79** on the support **52** has an annular recess **83** which accommodates a second control ring **84**. This ring is movable axially but cannot turn with reference to the flange **79**. The latter carries a radially inwardly extending guide pin **85** projecting into an axially parallel notch **86** of the control ring **84**. A conduit **91** for testing air is connected with the control ring **84** to register at certain times with the bores **32** in the ring **33**. The conduit **91** extends through a bore in the flange **79** and is connected with the testing unit **51**. A slide ring **87** is affixed to that end face of the control ring **84** which faces the cylinder **4**, and this slide ring is biased by springs (not shown) against the ring **33**. The just mentioned springs operate between the control ring **84** and flange **79**; the latter has recesses which receive portions of such springs in a manner similar to that shown for the spring **55***a*.

The testing unit **51** comprises a venturi **92** which is installed in the conduit **91** and whose throat is provided with a radial duct **93** conveying testing air to a chamber **94** which accommodates a diaphragm **95** constituting the movable electrode of a capacitor. The capacitance of the capacitor changes as a function of changes in air pressure in the venturi **92** and this capacitor is connected in an oscillator circuit in a manner as disclosed in the aforementioned Esenwein application. The oscillator circuit is connected with a rectifier, a preamplifier, a signal storing device and finally with the regulating valve **49**. The just mentioned elements of the electric circuitry of the testing device **51** are denoted cumulatively by the numeral **96**.

Referring now to FIG. 3, the shaft **2** has an axially parallel suction bore **41** which is connected with a suction generating device **41***a* (FIG. 1), and an axially parallel pressure bore **42**. The bore **41** communicates with a radial cutout **44** of the shaft **2** and this cutout communicates with a cutout **47** of the sleeve **43**. The cutout **47** communicates with radial bores **59**, **61** and **62** provided in the cylindrical extension **54** of the support **52**. The bore **42** communicates with a radial port **45** of the shaft **2**, and this port **45** communicates with a radial bore **64** of the extension **54** by way of a cutout **46** in sleeve **43**. The control ring **55** is provided with an inner slit shaped opening **76** located at the same distance from the axis of shaft **2** as the channels **13**, and with a group of outer slit-shaped openings **65**, **66**, **69**, **67**, **68** located at the same distance from the axis of shaft **2** as the channels **11**. These openings are machined into that face of the control ring **55** which faces the cylinder **4**. The opening **76** serves to admit compressed air to pressure channels **13** and the openings **65**, **66**, **69**, **67** can evacuate air from the channels **11** and ports **9** of the cylinder **4**. The opening **65** is located at the two o'clock position, as viewed in FIG. 3, and is connected with a radial bore **58** which communicates with the aforementioned bore **62**. The bore **58** is provided in the ring **55**. The opening **65** is located in the region of the receiving station, i.e., where a feed admits articles into successive sets of aligned grooves **7**.

A fresh air admitting bore **72** machined into the control ring **55** is angularly spaced from the opening **65** by a distance exceeding slightly the diameter of a channel **11**. The second outer opening **66** begins at the five o'clock position and serves to convey suction air which holds the articles during travel past the testing station. This opening **66** communicates with a radial bore **57** of the control ring **55** and with the bore **61** in the extension **54** of the sleeve **52**. The opening **66** is immediately followed by the opening **69** and the latter is immediately followed by the opening **67** which terminates at the eight o'clock position. The opening **67** communicates with a radial bore **56** of the ring **55** and with the bore **59** in the extension **54**. A first flow restricting orifice **73** connects the openings **66**, **69**, and a second flow restricting orifice **74** connects the opening **69** with the elongated opening **67**. A third flow restricting orifice **75** connects the opening **69** with the inner opening **76** of the control ring **55**. Air conveyed through the opening **76** serves to eject articles from their respective sets of grooves **7**. The length of openings **69** and **76** (as considered in the circumferential direction of the control ring **55**) respectively equals the distance between two adjoining channels **11** or **13** minus the diameter of a channel **11** or **13**. A further fresh air conveying opening **71** which resembles a circular bore is provided in the control ring **55** in circumferential alignment with the openings **65**, **66**, **69**, **67** and **68**. The distance between the left-hand end of the opening **67** and opening **71** exceeds slightly the diameter of a channel **11**. The opening **68** is provided downstream of the delivery or transfer station to admit compressed air to channels **11** in order to expel impurities from the ports **9** and grooves **7**. The opening **68** communicates with a radial bore **63** of the ring **55** and the radial bore **63** communicates with the radial bore **64** in the extension **54**.

The opening **76** is in communication with the compressed air conduit **77** shown in FIG. 2. In the region between the openings **71** and **65**, the slide ring **87** is provided with a control slot **88** whose length equals the distance between two adjoining bores **32** and which communicates with one or two bores **32**.

The second control ring **84** has a control slot **89** (FIG. 2) at that side which is adjacent to the slide ring **87**. The dimensions of the control slots **88**, **89** are the same and there slots are in registry, as seen in the circumferential direction of the drum **3**. The control slot **89** is in communication with the conduit **91** for testing air.

A stationary contactless initiator or signal generator **97** is immediately adjacent to the path of lobes **36** on the synchronizing cam **35**; this initiator contains an induction coil **103** and is connected with the signal storing device in the electric circuit **96** of the testing unit **51** by way of a conductor **104**.

A stationary shoe **98** is in sliding contact with the smooth peripheral surface **16** of the flange **5** and serves to convey testing air. In the region adjacent to the control slot **88**, the shoe **98** is provided with a slot **99** which communicates with a channel **101** and by way of this channel with a supply conduit **102** for testing air. The latter is connected with a suitable source of testing air, not shown in FIGS. 1–3.

Arcuate retaining shields **107** extend along the periphery of the drum **3** from the opening **65** to the opening **66** to mechanically hold the articles in the respective grooves **7**. Additional retaining shields **108** are provided between the opening **67** and the point of removal of satisfactory articles from the drum **3**.

The drum 3 is rotated by a gear (not shown) which is affixed to the flange 5 and turns in a clockwise direction, as viewed in FIG. 1 or 3.

The suction openings 65, 66 and 67 are main suction openings because they are in direct communication with bore 41 by way of bores 58, 57, 56, bores 62, 61, 59 and cutouts 44, 47. The opening 69 is an auxiliary opening because it is connected with bore 41 indirectly, i.e., by way of orifices 73, 74 and main openings 66, 67.

The operation is as follows:

Articles are fed into successive groups or sets of grooves 7 in the region of the suction opening 65 shown in FIG. 3. Each such article is held by suction air drawn through the ducts 9, channel 11, opening 65, bore 58, bore 62, cutout 47, cutout 44 and bore 41. The article is thereupon engaged by the stationary retaining shields 107. Once a freshly transferred article reaches the region of the fresh air admitting bore 72, suction in the corresponding ducts 9 decreases because the associated channel 11 communicates with the bore 72 as the drum 3 continues to turn in a clockwise direction, as viewed in FIG. 3. However, the article cannot leave its groove 7 because it is held by the shields 107. The face of the cam 82 is configurated in such a way that it causes a roller follower 27 traveling past the bore 72 to move toward the cylinder 4 and to thus displace the pin 25 and fork 28 against the opposition of the corresponding spring 29 (see FIG. 2). The fork 28 displaces the nozzle 23 by way of the spring 31, i.e., the nozzle is shifted in a direction toward the flange 5. Such axial movement of the nozzle 23 is terminated when the left-hand end of an article received in the grooves 7 registering with the nozzle 23 shown in FIG. 2 reaches the inner end face 15 of the flange 5, namely, when one end of the article overlies the open end of the registering bore 17 in the flange 5. The fork 28 continues to move to the left, as viewed in FIG. 2, so that the spring 31 is compressed and biases the nozzle 23 against the adjoining end of the article. The spring 31 compensates for eventual differences in the length of articles which are admitted seriatim into successive sets of grooves 7 on the cylinder 4.

The drum 3 continues to rotate in a clockwise direction whereby the corresponding radial bore 18 of the flange 5 reaches the slot 99 in the stationary shoe 98 which bears against the peripheral surface 16 of the flange 5. The source of testing air then admits air by way of supply conduit 102, channel 101, slot 99, radial bore 18, blind bore 17, axially through the filler of the article, bore 34 of the corresponding nozzle 23, bore 32 of the ring 33, control slot 88 of the slide ring 87, control slot 89 in the second control ring 84, conduit 91 and venturi 92 of the testing unit 51. Some testing air escapes through the pores of the wrapper on the tested article. If the article is defective, for example, because its wrapper has developed a leak due to a faulty seal between the overlapping edges of the wrapper material or due to a tear in such wrapper material, the amount of air escaping through the wrapper exceeds a predetermined minimum amount which is indicative of satisfactory articles. The testing unit 51 then receives less air than when the tested article is satisfactory. The pressure of air flowing through the venturi 92 of the testing unit 51 is measured in the chamber 94 which receives air through the duct 93, and the nature, length and/or intensity of impulses produced by the circuit 96 of the unit 51 is a function of the pressure of air flowing through the venturi 92. The initiator 97 cooperates with the lobes 36 of the rotating synchronizing cam 35 to produce synchronizing signals of a length corresponding to the interval during which the next-following set of grooves 7 occupies the position previously occupied by the preceding set of grooves. The initiator 97 generates such signals in response to travel of lobes 36 past the coil 103, and the resulting signals are converted into steeply rising impulses.

When a bore 32 of the ring 33 moves beyond the control slot 88 of the slide ring 87, the corresponding article is held in the associated grooves 7 by suction air drawn through the opening 66. At the same time, the face of the cam 82 allows the corresponding spring 29 to expand and to push the fork 28 in a direction to the right, as viewed in FIG. 2. The fork 28 moves the nozzle 23 in the same direction and causes the nozzle to move away from the adjoining end of the tested article. This step is completed when the bore 34 of the nozzle 23 moves beyond the opening 66. Satisfactory articles are retained by suction which is effective through the orifice 73, auxiliary opening 69, orifice 74, channel 11 and ducts 9. If the article is defective, the testing unit 51 sends to the valve 49 a signal at the time when the defective article reaches the auxiliary opening 69. The valve 49 opens and permits compressed air to flow from compressor 77a, through conduit 77, opening 76, channel 13 and orifices 12 whereby the jets or blasts of air issuing from these orifices eject the defective article from its grooves 7. Such defective article can drop into a collecting receptacle (not shown) to be transported to an apparatus wherein the filler is recovered for renewed introduction of tobacco into a cigarette machine.

When the opening 76 admits compressed air to effect ejection of a defective article, some air flows through the flow restricting orifice 75 and into the auxiliary opening 69 so that the retaining force generated by suction in the ports 9 is reduced considerably or drops to zero. In fact, there can develop in the opening 69 a pressure which slightly exceeds atmospheric pressure to insure that the defective article is not held by suction and can be readily expelled from its grooves 7.

A satisfactory article is held by suction while moving along the elongated opening 67 of the control ring 55. When the corresponding channel 11 moves beyond the left-hand end of the opening 67, it reaches the fresh air admitting opening 71 so that the inflowing atmospheric air reduces the suction to zero. From there on, the satisfactory article is held by the shields 108 and is transferred from the grooves 7 onto a further conveyor as soon as it advances beyond the shields 108. The corresponding suction channel 11 advances toward and past the opening 68 which admits compressed air to expel from the ports 9 and grooves 7 solid particles which might have entered such ports and grooves during transport of an article from the region of the main opening 65 to the region downstream of the shields 108. The opening 68 receives compressed air by way of radial bore 63, bore 64, cutout 46, port 45 and bore 42.

If the apparatus of FIGS. 1 to 3 is to be employed for testing of articles of different lengths (for example, for testing articles which are longer than previously tested articles not because of inaccuracies developing during severing from a continuous rod but because the cutoff mechanism of the cigarette machine is intentionally adjusted to form longer cigarettes), the spacers 21 and 78 are replaced by shorter spacers. The position of flanges 6 and 79 is then changed accordingly but the position of other parts remains unchanged. If the next batch of articles contains articles which are shorter than the previously tested articles, the spacers 21 and 78 are replaced by spacers of greater axial length. The initiator 97 is preferably adjustable with reference to the drum 3.

FIG. 4 illustrates a portion of a modified testing apparatus. The testing drum 201 is rotatable about the axis of the shaft 202. The conduit which admits testing air to one end of an article is shown at 302 and the conduit which admits testing air to the other end of the same article is shown at 291. The conduits 291, 302 are connected with each other by a junction 400, and the testing unit 251 is located upstream of the junction 400, as considered in the direction of air flow into the conduits 291 and 302. The unit 251 is connected with a source 306 of testing air by way of a conduit which contains a flow restrictor or throttle 305.

The apparatus of FIG. 4 operates as follows:

The source **306** supplies testing air which flows through the throttle **305** and testing unit **251**, conduit **302** and conduit **291**. If the article which receives air from the conduits **291**, **302** is satisfactory, its wrapper permits escape of a relatively small amount of testing air. However, if the wrapper of the tested article has a leak or is torn at one or more points, the amount of escaping testing air exceeds a predetermined minimum amount so that a larger quantity of air must flow via testing unit **251** and toward the junction **400**. A portion of the testing cycle is cut off electronically to insure that faulty signals which can appear on entry into the testing zone for other reasons cannot produce a signal which would result in ejection of a satisfactory article. This is fully described in the aforementioned Esenwein application. For example, the configuration of lobes on the synchronizing cam of the drum **201** shown in FIG. 4 can be selected in a way to avoid generation of signals during blowing up of articles.

The operation of testing units **51** and **251** is analogous. These testing units produce impulses at a frequency corresponding to the rate at which the articles travel through the testing zone. The impulses are indicative of satisfactory or unsatisfactory articles, depending on the pressure of air flowing through the venturi of the respective testing unit. The timing or synchronizing impulses are transmitted by the initiator **97** at a rate corresponding to the speed of lobes **36** on the cam **35**. The signal storing unit in the circuit **96** produces impulses only when it receives an impulse from the initiator **97** simultaneously with an impulse from the capacitor in the chamber **94**, i.e., when the capacitor produces an impulse which is indicative of a defective article. The accuracy of the initiator **97** (i.e., the accuracy of synchronization of impulses produced by initiator **97** with the frequency at which the lobes **36** travel past the initiator) is important because it determines the length of the zone in which the defective articles are ejected from the respective grooves **7**.

An important advantage of our testing apparatus is that suction which holds articles in their grooves **7** can be reduced very rapidly and that a relatively low pressure of air currents which are admitted via orifices **12** suffices to dislodge defective articles from their holders. Also, the apparatus may utilize a relatively small and lightweight regulating valve **49** whose inertia is low so that it can close and open without any appreciable delay. As stated before, the apparatus of our invention can be used with equal advantage for testing of cigarettes with or without filters, cigarillos, cigars with or without filters, filter rod sections and analogous rod shaped articles. Also, the apparatus can be used for testing of cigarettes or filter cigarettes or filter rod sections of unit length or multiple unit length.

If the cylinder **4** of the drum **3** is not provided with channels **13** and orifices **12**, the opening **76** in the member **55** can be omitted and the conduit **77** then admits compressed air into ports **9** by way of the opening **69**. When the valve **49** opens, the conduit **77** admits compressed gas into the suction ports **9** of a holder **8** which contains a defective article, and the gas expels the article from the respective grooves **7**. In such apparatus, the grooves **7** of the holders **8** are preferably configurated in a way to prevent excessive buildup of suction between the wrapper of a defective article and the adjoining surfaces of the holders **8** because such suction would oppose the ejecting action of compressed gas issuing from the ports **9**. Grooves wherein such suction does not develop are known in the art.

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 our contribution to the art.

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

We claim:

1. In an apparatus for testing and classifying cigarettes or like rod shaped articles, a combination comprising conveyor means provided with holder means for transporting a series of articles sideways, said holder means being provided with suction port means to retain satisfactory articles during travel past an ejecting station for defective articles; ejecting means provided at said station for expelling defective articles from the respective holder means, said ejecting means including conduit means for admitting a compressed gas with attendant reduction of suction in said port means whereby such gas expels defective articles from the respective holder means, and regulating means for controlling the admission of gas to said conduit means; and synchronizing means for synchronizing the operation of said regulating means with the rate of article travel past said ejecting station, said synchronizing means comprising cam means provided on said conveyor means and a contactless initiator arranged to transmit to said regulating means signals at the frequency determined by said cam means.

2. In an apparatus for testing and classifying cigarettes or like rod shaped articles, a combination comprising conveyor means provided with holder means for transporting a series of articles sideways, said holder means being provided with suction port means to retain satisfactory articles during travel past an ejecting station for defective articles; and ejecting means for expelling defective articles from the respective holder means, said ejecting means including conduit means for admitting a compressed gas which expels defective articles from the respective holder means, suction reducing means operative to reduce suction in the port means of holder means for defective articles not later than during admission of gas to said conduit means, and regulating means for controlling the admission of gas to said conduit means.

3. A combination as defined in claim **2**, wherein said conduit means includes a single stationary supply conduit and orifice means adjacent to each suction port means and communicating with said supply conduit during travel past said ejecting station, said suction reducing means connecting said orifice means with the respective port means during travel past said ejecting station so that gas admitted via said conduit means can penetrate into the respective port means to reduce suction therein.

4. A combination as defined in claim **2**, wherein said conduit means is arranged to admit gas through said conveyor means.

5. A combination as defined in claim **2**, further comprising suction generating means and control means for connecting said suction generating means with said port means during travel of holder means past said ejecting station, said control means having main opening means connecting said port means with said suction generating means during travel toward said ejecting station and auxiliary opening means connected with said conduit means by way of said suction reducing means and with said suction generating means by way of said main opening means, said auxiliary opening means communicating with successive port means during travel of the respective holder means past said ejecting station.

6. A combination as defined in claim **2**, further comprising testing means arranged to test successive articles upstream of said ejecting station and to produce signals in response to detection of defective articles, said regulating means comprising valve means installed in said conduit means to open in response to said signals.

7. A combination as defined in claim **6**, wherein said conduit means comprises a single stationary supply conduit and at least one orifice provided in each of said holder means, the orifices of successive holder means being arranged to communicate with said supply conduit when the conveyor means is in motion and said valve means being installed in said supply conduit.

8. A combination as defined in claim 2, wherein said conveyor means comprises a member rotatable about a fixed axis and said holder means extend in parallelism with said axis, said member having means connecting at least one end of each successive article with a source of testing fluid upstream of said ejecting station, and further comprising testing means for determining the characteristics of testing fluid and for operating said regulating means to admit a gas to said conduit means when the thus determined characteristic is indicative of a defective article.

9. A combination as defined in claim 8, wherein said testing means comprises a venturi through which the testing fluid flows and means for determining the characteristics of testing fluid in said venturi while such fluid penetrates into an article upstream of said ejecting station.

10. A combination as defined in claim 2, further comprising means for synchronizing the operation of said regulating means with the rate of article travel past said ejecting station.

11. A combination as defined in claim 2, wherein said conveyor means comprises a rotary drum.

12. A combination as defined in claim 2, wherein said conveyor means comprises means for clamping the articles during travel toward said ejecting station.

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