CIGARETTE TESTING MACHINE

Harland Jesse Snow, Ocee Keaton Groppe, and David Latimer Porter, Richmond, Va., assignors to AMF Incorporated, a corporation of New Jersey

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ABSTRACT OF THE DISCLOSURE

A machine for pressure drop testing cigarettes wherein individual cigarettes are positioned in slots in the periphery of a rotating drum and automatically ejected from the slots onto a conveyor belt after they have been tested. During the initial portion of rotation of the cigarette with the drum, one end of each cigarette is sealingly engaged and connected to a source of reduced pressure to draw air through the cigarette. When the volume of air passing through the cigarette exceeds a predetermined level, this is detected and the defective cigarette is automatically ejected from the drum before it reaches the conveyor belt.

BACKGROUND OF THE INVENTION

The present invention relates to cigarette testing machines and more particularly to a cigarette testing machine which tests individual cigarettes by applying fluid pressure to one end only of each cigarette.

At the present time, automatic machines which produce cigarettes at speeds of two thousand cigarettes per minute are frequently employed, and the trend is toward higher speed machines. At such speeds a demand exists for automatic inspection and rejection of substandard cigarettes to prevent these cigarettes reaching the automatic packers. It seems to be accepted that the modern cigarette making machines produce plain cigarettes of such a quality that automatic inspection of features other than the ends of the cigarettes is not justified. However, in the case of filter cigarettes, the sealing of the filter to the tobacco rod by a uniting band is a constant source of trouble, largely because of variations in filter size and geometry which result in air channels between the uniting band which, in turn, permit air to enter the smoke screen as the cigarette is smoked.

The usual method of making filter tipped cigarettes is to make two all-tobacco cigarettes, place them axially in line with a double length filter between them, overlap the assembly with a suitable uniting band to form a single composite rod, and sever the center of a filter to form two filter tipped cigarettes. In accordance with the prior art, these double length composite rods were tested prior to severing by coupling apparatus to each end of the rod, applying air pressure or vacuum via one coupling, and measuring the air pressure of flow at the other coupling. Such measurements are affected by leaks in the composite rod, and therefore, indicate substandard or defective cigarettes.

This prior art testing technique cannot distinguish between good and bad cigarettes in any assembled pair. Therefore, for every faulty cigarette, two filter tip cigarettes (the entire composite rod) must be rejected. Another important disadvantage of the prior art testing technique is that the fluid coupling devices must make a tight seal with both tobacco ends of the composite cigarette rod having the double length filter in the middle. This is a very difficult thing to do because of the variable nature of the tobacco ends and their susceptibility to damage.

SUMMARY OF THE INVENTION

In accordance with the present invention, the disadvantages of the prior art testing technique are overcome by testing each individual cigarette after the final severing operation has been completed so that substandard cigarettes can be rejected individually. This is done by sealingly engaging one end only of each cigarette, applying a fluid pressure to this end and monitoring the fluid flow to detect any defect in the cigarette being tested. By sealingly engaging one end only of the cigarette, the stronger filter end of the cigarette can be selected as the end to be sealed to greatly facilitate an efficient airtight coupling without damaging the cigarette being tested.

The pressure applied to the end of the cigarette may be positive or negative, but in the preferred embodiment a vacuum technique (negative pressure) is employed to draw air through the cigarette. When the filter end of the cigarette is sealingly engaged automatically, leaks in the half of the cigarette nearest to the filter are easily determined, whereas leaks near the tobacco end of the cigarette are more difficult to determine. This is because the normal tobacco filling of the cigarette obstructs the inflow of air sufficiently to permit side leaks to modify the total flow by a significant amount. Since too much or too little tobacco in the cigarette will modify the air flow independently of leaks, this inherently produces the additional desirable result of enabling cigarettes to be rejected which depart too far from the desired normal density of tobacco filling.

More specifically, in a preferred embodiment of the invention, the individual cigarettes are automatically positioned in slots in the periphery of a rotating drum at a first angular position of the drum. Cigarettes are automatically ejected at a second angular position. During the initial portion of rotation of the drum from the first angular position, the filter end of each cigarette is sealingly engaged and connected to a vacuum chamber to draw air through the cigarette. If the cigarette is defective or substandard, a larger volume of air will flow into the vacuum chamber. This increase or change in pressure in the vacuum chamber is detected and a signal is produced to activate a defective cigarette ejecting device to eject the defective cigarette before it reaches the second angular position.

Other features and objects of novelty of the present invention will be specifically pointed out or will otherwise become apparent when referring, for a better understanding of the invention, to the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a machine illustrating one embodiment of the invention;
FIG. 2 is an enlarged sectional view of the inspection drum of the machine of FIG. 1 taken along the line 2—2 of FIG. 3;
FIG. 3 is a front view of the machine of FIG. 1 with parts thereof omitted to more clearly show the manner in which the inspection drum receives cigarettes from drums of a conventional cigarette making machine;
FIG. 4 is an enlarged sectional view of one of the ported valve blocks for making the necessary air connections to the inspection drum, and the aneroid bellows switch connected to each ported valve block;
FIG. 5 is an end view of the rotary control switch of the logic and memory unit of the machine of FIG. 1;
FIG. 6 is a sectional view taken along the line 6—6 of FIG. 5;
FIG. 7 is a schematic circuit diagram of the logic and control circuit of the machine; and FIG. 8 is a fragmentary view of a portion of the structure of FIG. 3 illustrating a modification of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a testing machine 10 is shown which illustrates one embodiment of the invention. The machine 10 comprises a main housing 12 having an inspection drum 14 supported on a drive shaft 16 rotatably mounted on and projecting from the front wall 13 of the housing 12. The drive for rotating the shaft 16 is mounted within the housing 12. The projecting end of the shaft 16 is supported by an end support bracket 18 supported on the ends of rods 20, 22 and 24. The inner ends of the rods 20 and 22 are connected to a casting 26 which, in turn, is mounted on the front wall 13 of the housing 12.

The inner end of the rod 24 is connected to a similar casting (not shown) mounted on the front wall 13 of the housing. With this construction the end support bracket 18 can be removed to facilitate servicing and removal of the inspection drum 14.

Referring to FIG. 2 as well as FIG. 1 the drum 14 comprises a first drum section 30 and a second drum section 32 both mounted on a sleeve 34 slidably keyed to the shaft 16 by tapered keys 35. The right end of the shaft 16, as viewed in FIG. 2, extends through the front wall 13 of the housing 12 and is rotatably journaled therein by bushings 36 and 38 mounted in the ends of a flanged bushing 40 fixed in the front wall 13. A gear 42 is fixed on the right end of the shaft 16 and is drivingly connected to a timing belt 44. A ring gear 46 is fixed to the gear 42 by screws 50 and 52 and is drivingly connected to a timing belt 48. The timing belt 48 is connected to a rotary switch of a logic and memory unit for controlling the operation of the inspection machine, as will be described in greater detail hereinafter.

The other timing belt 44 is drivingly connected to a rotary switch of a logic and memory unit for controlling the operation of the inspection machine, as will be described in greater detail hereinafter.

The sleeve 34 which supports the drum sections 30 and 32 is fixed against axial movement to the right by the tapered keys 35 which, in turn, are restrained against axial movement to the right by a flange 54 on the shaft 16. The sleeve 34 is fixed against axial movement to the left by a sleeve 56 threaded connection to an externally threaded portion 58 of the shaft 16. The sleeve 56 is rotatably journaled in the end support bracket 18 by ball bearings 60 and 62.

The drum section 30 comprises a cylindrical hub 64 having axially spaced washer shaped walls 66, 68 and 70 projecting radially from the hub. A plurality of equally spaced concave recesses 72 are formed in the periphery of the wall 66, and similar recesses 74, 76 and 78 are formed in the periphery of the walls 68 and 70 in alignment with each of the recesses 72. Each aligned set of recesses 72-78 define a slot in the periphery of the drum section 30 for receiving a cigarette, as will be described.

The drum section 32 is similar to the drum section 30 and has a cylindrical hub 80, washer shaped walls 82, 84 and 86 and aligned recesses 88, 90 and 92, sets of which define slots for receiving the cigarettes.

A sealing ring 94 is fixed to the washer shaped wall 70 of the drum section 30 in a suitable manner such as by a plurality of screws 96. A second ring 98 made of a suitable material, such as graphite, slides engages the right face of the sealing ring 94 and is fixed to a back-up ring 100. The back-up ring 100 is slidably pinned to a member 102 rotatably journaled on the projecting right end of the cylindrical wall of balls 104 are also positioned between the back-up ring 100 and the member 102 to facilitate relative axial movement between the two and a plurality of springs 106 are interposed between the back-up ring 100 and the member 102 to resiliently bias the ring 98 against the face of the sealing ring 94.

The ring 98, back-up ring 100 and member 102 are fixed against rotation by means (not shown) supported on the rod 24.

A tapered bore 108 is provided in the left face of the sealing ring 94 in alignment with each of the recesses 78, so that the axis of each of the tapered bores 108 will be coaxially aligned with the cigarette in each of the slots defined by the aligned sets of recesses in the drum section 30. With this arrangement the cigarettes positioned in the slots can be shifted to the right, as will be described, to securly engage one end of the cigarettes with the tapered wall of the tapered bore 108 aligned therewith.

Alternate ones of the tapered bores 108 communicate directly with an opening 110 on the face of the sealing ring 94 slidably engaging the ring 98, as in the case of the upper tapered bore illustrated in FIG. 2, and the remaining tapered bores communicate with a radially offset opening 112 positioned radially inwardly of the openings 110, as in the case of the lower tapered bore illustrated in FIG. 2.

The openings 110 are positioned to communicate with an arcuate recess 114 in the left face of the ring 98 and the openings 112 are positioned to communicate with a second arcuate recess 116 in the left face of the ring 98 concentric with the arcuate recess 114. Each of the arcuate recesses subdivide the same angle and the radial displacement between the arcuate recesses is identical to the radial displacement between the openings 110 and 112. Thus the openings 110 and 112 are normally sealed by the left face of the ring 98 except for the period when they sweep across one of the arcuate recesses, as will be described in greater detail hereinafter.

A sealing ring 94, as just described, is fixed to the right end of the shaft 16 in a similar manner, and a second ring 98, back-up ring 100, and member 102 are provided as previously described, along with the springs 106 and balls 104 between the back-up ring 100 and member 102. In this case however the washer shaped member 102 is fixed to a hub 108 journaled directly on the shaft 16 by ball bearings 114.

Before describing the manner in which the cigarettes are loaded, tested and ejected, the mechanism for shifting the cigarettes axially in their slots into sealing engagement with the tapered walls of the tapered bores 108 will be described. Still referring to FIG. 2, a member 120 is fixed on the left end of a rod 122 slidably extending through the cylindrical hub 64 of the drum section 30. A similar member 124 is fixed on the right end of the rod 122 between the drum sections. The member 120 is also slidably supported on a pin 126 fixed to and projecting from the left end face of the drum section 30 to prevent rotation of the road 122 relative to the drum section 30 without restricting relative axial movement therebetween. A link 128 is fastened to the member 120 and projects therefrom in position to support a cam follower roller 130. The cam follower roller 130 rides in a cam slot 132 in a cam ring 134 fixed on the hub of the end support bracket 18. A pin 136 is fixed on the end of each of the members 120 and 124 in position to engage the end of the cigarette in the slots with which the members are associated.

At this point it is noted that the members 120 and 124, and their related components, are provided for each of the slots in the drum sections 30 and 32. The drive of the cam slot is such as to shift the connected pair of members 120 and 124 to the right at a predetermined angular position to sealingly engage the other ends of the cigarettes with the walls of the tapered bores. The cigarettes are maintained in this position while the tapered bore arcuate across the recesses. The cigarettes are shifted to the left by an air jet, as will be
described, to disengage the sealed ends from the tapered bores 108. The diameter of each of the pins 136 is preferably smaller than the diameter of the cigarettes being tested, so that the pins engage the tobacco in the ends of a cigarette and not the paper. This minimizes damage to the tobacco ends of the cigarettes. The cigarettes are also oriented in the slots so that the filter ends are adjacent to the sealing rings 94 since the filter ends are less susceptible to damage.

Referring to FIG. 3, the cigarette testing machine 10 is illustrated in conjunction with a conventional cigarette making machine 140. The cigarettes manufactured by the machine 140 are transferred in a conventional manner from a drum 142 of the cigarette making machine to a transfer drum 144, and from the transfer drum to the inspection drum 14 of the cigarette testing machine 10. As illustrated in FIG. 3, the inspection drum 14 is rotating in a clockwise direction and there are eight cigarette ends positioned in eight of the fourteen slots in the periphery of the drum section 30 of the inspection drum. Eight additional cigarette ends are positioned in a similar manner in the drum section 32 behind the drum section 30. In describing the operation reference will be made to drum section 30, but it will be understood that the same sequence of events simultaneously occurs in connection with the drum section 32.

One of the cigarettes 146 is illustrated in a first angular position wherein it is being transferred from the transfer drum 144 to the drum section 30 in a conventional manner. The cigarette 146 is removed from this cigarette is illustrated in a second angular position wherein it is leaving its slot and being transferred to a powered conveyor belt 148. A stationary shroud 150 overlies an angular portion of the periphery of the inspection drum beginning at the aforementioned first angular position and mechanically retains the cigarettes in their slots in a conventional manner. A second shroud 152 overlies another angular portion of the inspection drum ending at the aforementioned second angular position, the shroud being designed with a reverse curve to facilitate rolling the cigarettes onto the conveyor belt 148. The adjacent ends 154 and 156 of the shrouds 150 and 152 are spaced apart to provide an ejection space through which defective cigarettes can be ejected.

Four tubes 158 project into the four spaces between the washer shaped walls of the drum sections 30 and 32 (see FIG. 2). The four tubes 158 are connected to a cylindrical manifold 162 (also illustrated in FIG. 1) bolted on the front wall 13 of the housing 12 by bolts 165 extending through lugs 163 on the left end of the manifold. A conduit 164 is connected to the manifold 162 for connecting the manifold to a vacuum source. The open lower ends of the tubes 158 overlie and bridge the ejection space between the ends 154 and 156 of the shrouds 152 and 150. During operation of the testing machine, a vacuum is normally applied to the tubes 158 to retain the cigarettes in their slots by suction as the cigarettes pass over the ejection space.

A smaller ejection tube 160 is positioned within each of the tubes 158 in position to eject a defective cigarette from its slot through the ejection space when a blast of pressurized air is directed through the end of the ejection tube 160. Hoses 166 are connected to the tubes 158 by fittings 161 for delivering pressurized air to the ejection tubes 160 in each of the tubes 158 in response to a control signal to eject a defective cigarette traversing the ejection space between the shrouds 150 and 152, as will be described.

Referring to FIGS. 3 and 4, four ported valve blocks 170 are mounted on the shroud 150 in position to overlie the inspection drum 14. The two blocks visible in FIG. 3 overlie the drum section 30 and the other two (not visible in FIG. 3) overlie the drum section 32. Each of the blocks 170 has a main passage 173 which communicates with a transverse passage 174. The transverse passage 174 of one of the blocks 170 communicates with the arcuate recess 114 and the transverse passage 174 of a second block communicates with the arcuate recess 116. The two remaining two valve blocks 170 communicate with the arcuate recesses 114 and 116 in the drum section 32 in the same manner. A filler 176 is mounted in each of the valve blocks in position to fill the arcuate recesses 114 and 116 during the main passage 172. A pair of connectors 178 and 180 are mounted on each block on opposite sides of the filler 176 to facilitate connection to a conventional manometer (not shown) for checking the filler 176 and for establishing the pressure drop of a good cigarette as a reference. A metering valve 182 is mounted on the valve block 170 having an adjustable needle 184 projecting therefrom in position to adjust air flow through the main passage 172. The metering valve is operated at sonic velocity to minimize the effect of compressibility on the air flow. A fitting 186 is mounted on each valve block to facilitate connection to a high vacuum source (over fifteen inches Hg) associated with the machine 10 to produce the sonic flow through the passage 172 and metering valve 182. The end of passage 172 is closed by a plug 188. An elbow fitting 190 on the other end of each valve block is connected to a monometer bellows switch 220 by a conduit 222 to place the aneroid bellows switch in communication with the passage 174.

The two ported valve blocks 170 illustrated in FIG. 3 are connected to the ring 98 associated with the drum section 30 and the two ported valve blocks 170 behind them are connected to the ring 98 associated with the drum section 32. With this arrangement a high vacuum is created in the arcuate recesses 114 and 116 of both drum sections 30 and 32 because the open faces of the arcuate recesses are sealed by the sealing ring 94 associated with each of the drum sections 30 and 32.

The aneroid bellows switch 220 comprises a body 224 fastened to a body 226 with a clamping and sealing ring 228 encircling the juncture between the bodies. A diaphragm 230 is clamped between the two bodies of a diaphragm chamber 232. A plug 234 is threadably engaged in an internally threaded bore 236 of the body 226 in position to seat one end of a spring 238, the other end of which acts on the diaphragm 230. A spring 240 is mounted in the body 224 in position to act on the other side of the diaphragm 230.

The conduit 222 is connected to a port 242 in the body 224 which, in turn, communicates with a chamber 244. A micro switch 246 is mounted in an opening in the body 224 with its plunger 248 exposed to the chamber 244. A plug 250 covers an access hole in the body 224.

A switch actuating arm 252 is connected to the diaphragm 230 by a member 254 so that the position of the diaphragm controls the position of the arm 252. The switch 246 is a normally open switch and in the position illustrated, the actuating arm 252 is located to the right of the plunger 248 so that the switch is in its normally open position. In this position the diaphragm 230 engages the wall of the diaphragm chamber 232 formed by the body 224. When the cigarette testing machine is in operation, and drawing a full vacuum, the diaphragm 230 is sucked to the left and maintains actuating arm 252 in position to actuate the plunger 248 to hold the switch 246 closed. The arrangement is such that the diaphragm 230 will remain in this position, and the switch 246 will remain closed as long as the cigarettes being tested are good. However, when a substandard or defective cigarette passes over the arcuate recess being monitored by the particular aneroid bellows switch, the diaphragm 230 will move back to the position illustrated in FIG. 4 and the switch 246 will open.

The switch 246 of each of the aneroid bellows switches 220 forms part of the memory unit for determining whether a cigarette is to be ejected as it passes over the ejection space between the shrouds 150 and 152. The
volume between the metering valve 182 and the cigarettes is held to approximately 20 cc. In going from an empty cigarette slot to a slot having a good cigarette therein sweeping over one of the arcuate recesses. This volume will be expanded seven percent or 1.4 cc. which will be retained in each cigarette being tested at the maximum rate of inspection. With this arrangement air flow through the cigarette is thus assured, rather than volume expansion.

The sequence of operation of the machine 10 will now be described with particular reference to FIG. 3 and with reference to cigarettes being loaded in the drum section 30. However, it is to be understood that cigarettes are simultaneously being loaded and tested in the drum section 32 in the same manner, as previously mentioned.

As soon as a cigarette 146 is loaded on the inspection drum section 30 and closes the shroud associated with the transfer drum 144, the cam ring 134 shifts members 120 and 122 to the right to press the pins 136 against the tobacco ends of the cigarettes in the slots of the drum sections 30 and 32 and shift the cigarettes to the right so as to engage their filter ends with the walls of the tapered bores 108, as previously described in connection with FIG. 2. This sealing action is completed before the cigarettes in the drum sections 30 and 32 reach the arcuate recesses 114 and 116. If the particular tapered bore securely engaged by the filter end of a cigarette communicates with the opening 110, the filter end will be placed in communication with the arcuate recess as it sweeps thereacross. If the tapered bore communicates with the opening 112, the filter end will be placed in communication with the arcuate recess 116 as it sweeps thereacross.

Therefore, as the tapered bores sweep across the arcuate recesses, the filter ends of the cigarettes are engaged thereby against the high vacuum to draw air through the cigarettes. In the event the cigarette is substandard and there is leakage around the filter end, an increased volume of air will flow into the ported valve block 170 as described with the particular arcuate recess involved, as compared to the air flow of a standard or non-defective cigarette. This increased volume of air flow through the valve block 170 shifts the aneroid bellows connected to the block to the right, as viewed in FIG. 4, to open the switch 246 of the aneroid bellows and produce an electrical signal to indicate that the cigarette being tested is defective or substandard. If the filter is satisfactorily united to the cigarette, but the density of the tobacco in the cigarette is substandard, an increased volume of air will also be drawn through the cigarette, as compared to a good cigarette, and the switch 246 of the aneroid bellows will open to produce a signal indicating that the cigarette is substandard or defective. The signals produced by the aneroid bellows switches 220 are stored in a memory unit, as will be described, and the memory unit thereafter produces a signal when the defective cigarette reaches the ejection space between the shrouds 150 and 152. At this point a blast of air is directed through the nozzles of the ejection tubes 160 to eject the defective cigarette.

When a pair of aligned cigarettes sealed against the tapered bores of the drum sections 30 and 32, respectively, egress their arcuate recesses, the cam ring 134 (FIG. 2) retracts the pins 136 engaging the tobacco ends of the cigarettes, and a light blast of pressurized air is delivered through the tapered bores to shift the cigarettes axially to disengage the filter ends from the tapered bores. This jet of air is delivered through an opening 200 in the face of each of the rings 99 sidewise engaging the sealing rings 94. A suitable fitting 202 is connected to the periphery of each of the rings 98 for connecting flexibile hoses 204 to the openings 200 of the rings, the hoses 204 being connected to a source of pressurized air. In this manner the filter ends of the cigarettes are disengaged from the tapered bores before they pass over the ejection space so that they are free to be ejected. As previously explained, if the cigarettes are not defective they are retained in their slots by the vacuum shoe or bridge 158 as they pass over the ejection space.

As illustrated in FIG. 3 one of the cigarettes in communication with the end of the arcuate recess 116 and a second cigarette, trailing the first cigarette, is in communication with the arcuate recess 114. A third cigarette, trailing the second cigarette, is not quite in position to communicate with the arcuate recess 116. The spacing between each of the cigarette retaining slots is such that the aforementioned first cigarette will leave the arcuate recess 116 before the third cigarette reaches the arcuate recess so that two cigarettes do not simultaneously communicate with the same arcuate recess.

However, in order to avoid extreme fluctuations acting on the aneroid bellows switch 220 monitoring the particular arcuate recess involved, a narrow throttling slot 260 is provided in extension of the leading edge of the arcuate recesses 114 of the drum sections 30 and 32, and a similar throttling slot 262 extends from the leading edge of the arcuate recess 116 of the drum section 32 and the end of the throttling slot 262 which is visible in FIG. 3 is such that the tapered bore securely engaging the afore-mentioned third cigarette will communicate with the throttling slot 262 before the tapered bore of the first cigarette leaves the arcuate recess 116. Thus when the first cigarette leaves the arcuate recess 116 communication between the throttling slot 262 and the third cigarette will allow a reduced volume of air to flow through the third cigarette to minimize the aforementioned fluctuations. The throttling slots 260 associated with the arcuate recesses 114 function in a similar manner.

By making the switch 246 of each of the four aneroid bellows switches 220 normally open and holding them closed by the vacuum produced by a good cigarette, as previously described, the closed position of the switches constitutes the non-eject condition. With this arrangement, good cigarette signals intentionally overlap so that the switch 246 remains closed and the non-eject condition prevails for a succession of good cigarettes. The change in vacuum produced by the increased air flow through a bad cigarette opens a switch 246 to place the memory unit in its eject condition to eject the defective cigarette as it passes over the arcuate recess between the shrouds 150 and 152. By using good cigarettes to maintain the normally open switch 246 closed, and thus maintain the non-eject condition, the ejection tube 160 is activated to eject defective cigarettes for a briefer period than would be the case if the occurrence of a bad cigarette were used to close the switch 246 of the aneroid bellows. This lessens the possibility of ejecting good cigarettes preceding or trailing a bad cigarette.

The condition of the switch 246 of each aneroid bellows switch 220 is read by the memory unit when the cigarette being tested nears the end of the arcuate recess being monitored by the aneroid bellows switch, as will be described. This indicates the condition of the cigarette (standard or substandard) after the system and diaphragm of the bellows switch has stabilized, and begins the start of the memory period. A memory unit is used in order to give the cigarette time to be unsealed by the tapered bores by the blast of pressurized air through the opening 200, as previously described, before the cigarettes reach the ejection space between the shrouds 150 and 152.

Referring to FIGS. 5 and 6 the construction of the rotary sequence control switch 270 of the logic and memory circuit will be described before describing the overall logic and memory circuit illustrated schematically in FIG. 7. The sequence control switch 270 is mounted in the main housing 12 and comprises a cup-shaped body member 272 having a hub 274 projecting through the front wall 13 of the main housing. The cup-shaped member 272 is
fixed to the front wall 13 in a suitable manner, such as by a plurality of bolts 278, and has a washer shaped flange 276 on the periphery thereof. A shaft 280 is rotatably journaled and axially fixed within the hub 274 by a pair of ball bearings 282. A gear 284 is fixed on the shaft 280 in position to be driven by the timing belt 44 extending upwardly from the gear 42 (see FIG. 2). This rotates the shaft 280 in timed relation to the shaft 16 which carries the inspection drum 14.

A small cup-shaped center support member 286 is fixed on the end of the shaft within the housing 12 in position to support three radially extending straps 288. A washer shaped member 290 is supported on the ends of the shafts 288 in parallel spaced apart relation to the washer shaped flange 276 on the periphery of the cup-shaped member 272. A hub member 292 is fixed on the shaft 280 between the gear 284 and the support member 286. Discs 294 and 298 of magnetic permeable material are fastened on the ends of the hub member 92 for rotation therewith.

As most clearly illustrated in FIG. 5, the periphery of each of the discs is stepped to provide radial shoulders 298, 300 and 302. The radial shoulder 298 defines an arcuate segment extending counterclockwise from the radial shoulder 298 to the radial shoulder 302. The radial shoulder 300 defines an arcuate segment extending counterclockwise from the radial shoulder 300 to the radial shoulder 302. A radial notch 304 is formed in the smallest diameter portion of each of the discs 294 and 298. The shoulders 298-302 and the notches 304 of the plates 294-298 are aligned, and therefore, only one set of shoulders and notches can be seen in FIG. 5.

Four reed switches S1-1, S1-2, S1-3, and S1-4 are supported by support members 306 in position to overlie the left face of the disc 294. These reed switches are positioned radially to overlie the arcuate segment 299 defined by the shoulders 300 and 302. The shoulder 298 is similarly supported by support member 308 in position to overlie the right face of the disc 296. In a similar manner four reed switches S2-1, S2-2, S2-3, and S2-4 are supported by support members 310 in position to overlie the left face of the disc 294, and four reed switches S3-1, S3-2, S3-3, and S3-4 are supported by support members 312 in position to overlie the right face of the disc 296. The reed switches S1-1 through S1-4 are positioned radially so as to overlie the arcuate segments 301 defined by the radials shoulders 300 of the discs 294 and 296. Four reed switches SS-1, SS-2, SS-3, and SS-4 are supported by support members (not shown) in position to overlie the left face of the disc 294 and four additional reed switches SS-1 through SS-4 are supported by support members 314 in position to overlie the right face of the disc 296. The switches SS-1 through SS-4 are positioned radially to overlie the notches 304 as the notch sweeps thereacross.

A permanent bar magnet 316 is fixed in parallel spaced apart relation to each of the reed switches so as to pass lines of flux through the reed switches to maintain them closed in a well known manner. However, when the arcuate segments of the discs 294 and 296 are disposed between the reed switches and their corresponding magnets, the lines of flux of the magnets are shunted through the magnetic permeable material of the discs and the reed switches are biased to their open condition in a well known manner.

Technical aspects 318 are associated with each of the reed switches for facilitating electrical connection thereto. The support members 306 and 308 are bolted to the washer shaped flanges 276 and 270, respectively, as are the support members 314. However, in the case of the support members 314, the bolts extend through slots 320 to enable the angular position of the reed switches supported thereby to be varied.

The shaft 280 is rotated in a counterclockwise direction as illustrated by the arrows in FIG. 5 and the ratio between the gears 42 and 284 drivenly connected by the timing belt 44 is such as to rotate the shaft 280 through 90° while the inspection drum is rotating through the angle between two adjacent cigarettes. The reed switches are maintained in their open condition while arcuate segments of the discs 294-296 sweep between the reed switches and their corresponding magnets, and the reed switches are maintained in their closed condition when the arcuate segments are not positioned between the reed switches and their corresponding magnets.

Referring to FIG. 7 the logic and memory unit, which includes all of the reed switches associated with the disc 294 of the sequence control switch 270 is illustrated schematically. This circuit controls the drum section 30 and an identical circuit (not shown) containing the reed switches associated with the disc 296 controls the drum section 32. The circuit includes four identical firing circuits 400, 402, 404, and 406 each containing an SCR 408.

The firing circuits 400 and 402 are controlled by the even bellows switch which is the switch 246 of the aneroid bellows switch 220 monitoring the arcuate recess 114, and the firing circuits 404 and 406 are connected to the odd bellows switch which is the switch 246 of the aneroid bellows switch 220 monitoring the arcuate recess 116.

Assuming the cigarette on the drum section 30 exposed to the arcuate recess 114 is defective, the even bellows switch will close when the defective cigarette reaches the end of the arcuate recess 114, the switch SS-2 closes and current passes through the resistor 410 and diode D1. This causes the SCR 408 of the firing circuit 402 to conduct. The SCR 408 of the firing circuit 402 will remain conductive until the presence of the second switch S1-1 is detected. With the defective cigarette near the ejection space, the switch S2-2 closes and the firing circuit 400 is disabled by the diode D2 and the diode D3 is reversed biased so that it cannot conduct.

As soon as switch S1-1 of the firing circuit 404 opens, reverse bias is removed from the diode D5 which can then conduct to allow current to flow through the resistor 410 to cut off the transistor 414. Cutting off the transistor 415 interrupts current flow through the gate of the triac 416 to cut off the triac which, as previously described, is fired by the solenoid S. Interruption of current flow through the solenoid S shifts a valve to connect the ejection tube 160 to a source of pressurized air to eject the defective cigarette as it traverses the ejection space between the shrouds 150 and 152.

Following the rejection phase, switch S2-2 opens and switch S1-2 is closed to restore the SCR 408 associated with the firing circuit 400 to its non-conducting state. When a good cigarette passes over the arcuate recess 114, the even bellows switch remains open and the SCR 408 of the firing circuit 400 will not fire when the switch SS-2 closes. Therefore, when the switch S1-2 closes conduction through the diode D3 will be restored so that reverse bias cannot be removed from the diode D5 when the switch S1-2 opens. Therefore the diode D5 will not conduct, the transistor 414 remains on, rather than being cut off, the triac 298 remains on, rather than being cut off, and the solenoid S remains energized. With the solenoid S energized, the aforementioned valve is not shifted and the source of pressurized air is not connected to the ejection tube 160. Therefore the good cigarette will be retained in its slot by the vacuum bridge 158 as it passes across the ejection space.

If the even bellows switch is closed when the switch SS-4 closes, the firing circuit 402 will be fired because the switch S1-4 will be open, and the firing circuit 400 will not be fired because the switch S1-2 will be closed. In this event the previously described sequence of events repeats itself. The SCR 408 of the firing circuit 402 is fired by the closing of the switch SS-4 and when the defective cigarette reaches the ejection space, the switch S1-2 closes to cause the diode D2 of the firing circuit 402 to disable the firing circuit.
the firing circuit. In addition the diode D3 of the firing circuit 400 is reversed biased and cannot conduct. As soon as the switch S1-3 opens, reverse bias is removed from the diode D5 which can then conduct to cut off the transistor 414 and the triac 416, and de-energize the solenoid S to connect the source of pressurized air to the ejection tube 312 to eject the defective cigarette traveling across the ejection space.

In the case of the odd bellows switch monitoring the arcuate recess 116 of the drum section 30, the firing circuit 404 will fire when the reed switch SS-3 closes, if the odd bellows switch is closed, and the firing circuit 404 will not fire because the switch S1-3 is closed, the switch S1-3 being open when SS-3 closes. If the firing circuit 404 fires in this manner, it will be disabled by the diode D2 when the switch S1-3 closes. Upon closing of the switch S1-3, the diode D3 is reverse biased and cannot conduct, and as soon as the switch S1-3 opens, reverse bias is removed from the diode D5 which can then conduct and de-energize the solenoid S to eject the defective cigarette which caused the odd bellows switch to be closed when the reed switch SS-3 closed just before the defective cigarette reached the end of the arcuate recess 116.

Similarly, if the odd bellows switch is closed when the reed switch SS-3 closes, the firing circuit 406 will fire because the switch S1-3 will be open, and the firing circuit 404 will not because the switch S1-3 will be closed. The steps described above repeat themselves and the diode D5 will conduct when the reed switch SS-3 opens.

When a good cigarette passes over the arcuate recess 116 the odd bellows switch will remain open and closing of the reed switch SS-3 or the reed switch SS-1 will not fire the SCR 408 of either of the firing circuits 404 and 406. Therefore, the solenoid S will remain energized and the air that passes over the oil bath that is mounted between the washer shaped walls of the drum section. An ejection finger 330 projects downwardly from the link 332 in position to eject a cigarette when the finger is moved downwardly into the path of the cigarette traversing the ejection space.

The solenoid S is the same solenoid illustrated schematically in FIG. 7 and during operation is normally energized to retain the link 322 in the retracted position illustrated. When the solenoid S is de-energized, as previously described in connection with the schematic diagram of FIG. 7, the operating arm 328 is advanced counterclockwise direction about the stationary pin 324 to advance the ejection finger into the path of the cigarette to be ejected. When the solenoid S is energized for the retracted finger 332 is retracted to enable the vacuum bridge to retain the good cigarettes in their slots as they traverse the ejection space. A similar ejection mechanism 320 is associated with the drum section 32.

While it will be apparent that the embodiments of the invention herein disclosed are well calculated to fulfill the objects of the invention, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims. For example, each of the pins 136 (FIG. 2) which engage the tobacco ends of the cigarettes could be enlarged and formed with blind (no hole) tapered bores to sealingly engage the tobacco ends in the same manner as the filter tips are sealingly engaged by the tapered bores 108.

Also, although the rings 98 (FIG. 2) have been shown as complete rings, it is apparent that most of each ring 98 could be removed and only the arcuate portion having the arcuate recesses 114 and 116 retained. This would provide a fixed arcuate shoe sealingly engaging each of the rings 54 containing the tapered bores 108. After the tapered bores leave the arcuate shoe, they could pass across a fixed nozzle or outlet for pressurized air to disengage the cigarettes from the tapered bores before the cigarettes reach the ejection space between the shrouds 150 and 152.

What is claimed is:
1. A cigarette testing machine comprising a cylindrical drum rotatably mounted on said machine having a plurality of circumferentially spaced axially extending slots on the cylindrical surface thereof, means for rotating said drum in timed relation to means for automatically loading a cigarette in each of said slots when each slot reaches a first angular position, means for automatically ejecting the cigarettes from said slots when each said slot reaches a second angular position spaced less than 360° from said first angular position, means automatically activated during a predetermined angular portion of rotation of said drum between said first and second angular positions for sealingly engaging one end of each cigarette and applying a fluid pressure to said end, said other end remaining free to atmosphere, means responsive to the fluid flow produced by said pressure applying means for producing a signal indicative of a defective cigarette, means responsive to said signal and activatable for automatically ejecting the defective cigarette from the slots when each slot reaches a third angular position located in advance of said second angular position, means for storing a plurality of said signals and activating said activatable ejecting means each time the slot carrying the defective cigarette which has reached the second position, means for maintaining said defective cigarette ejecting means activated each time it is activated until said signal producing means indicates that a subsequent cigarette is not defective and until the defective cigarette preceding said non-defective cigarette has been ejected at said third angular position, wherein said defective cigarettes are ejected before said second angular position and the non-defective cigarettes are ejected at said second angular position.
2. A cigarette testing machine comprising a cylindrical
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13 drum rotatably mounted on said machine having a plurality of circumferentially spaced axially extending slots on the exterior surface thereof, means for automatically loading a cigarette in each of said slots when each slot reaches a first angular position, means for automatically ejecting the cigarettes from said slots when each of said slots reaches a second angular position spaced less than 360° from said first angular position, means for maintaining the air pressure in said drum at a reduced level, means for automatically shifting each cigarette axially toward said ring means to seal one end of the cigarette against the tapered wall of said tapered bore and maintain said one end sealed substantially throughout said predetermined angular portion of rotation of the drum, means communicating with said arcuate recesses for rotating said drum in timed relation to means for automatically loading a cigarette in each of said slots when each slot reaches a first angular position, means for automatically ejecting the cigarettes from said slots when each of said slots reaches a second angular position spaced less than 360° from said first angular position, ring means mounted on one end of said drum for rotation therewith defining a tapered bore near the end of each of said slots for sealingly engaging the cigarette in the slot, a ported plate mounted on said frame having an annular surface slidably and sealingly engaging an annular surface of said ring means, an arcuate recess in the annular surface of said plate defining said predetermined angular portion of rotation of said drum, a plurality of passages in said ring means each communicating one of said tapered bores with the annular surface of said ring means in position to sweep across and communicate with said arcuate recesses, means for maintaining the air pressure in said arcuate recesses at a reduced level, means for automatically shifting each cigarette axially toward said ring means to seal one end of the cigarette against the tapered wall of said tapered bore and maintain said one end sealed substantially throughout said predetermined angular portion of rotation of the drum, means communicating with said arcuate recesses for rotating said drum in timed relation to means for automatically loading a cigarette in each of said slots when each slot reaches a first angular position, means for automatically ejecting the cigarettes from said slots when each of said slots reaches a second angular position spaced less than 360° from said first angular position, ring means mounted on one end of said drum for rotation therewith defining a tapered bore near the end of each of said slots for sealingly engaging the cigarette in the slot, a ported plate mounted on said frame having an annular surface slidably and sealingly engaging an annular surface of said ring means, a plurality of arcuate recesses where each arcuate recess subtends an angle greater than the angle between said slots are formed in the annular surface of said ported plate with different groups of said tapered bores communicating with different ones of said arcuate recesses, means for maintaining the air pressure in each of said arcuate recesses at a reduced level, and means for automatically shifting each cigarette axially toward said ring means to seal one end of the cigarette against the tapered wall of said tapered bore and maintain said one end sealed substantially throughout said predetermined angular portion of rotation of the drum, an aneroid bellows switch communicating with said arcuate recesses responsive to the fluid flow produced by said pressure applying means for producing a signal each time the fluid flow pressure in one of said arcuate recesses increases due to a defective cigarette, and means responsive to said signal for ejecting the defective cigarette from its slot at a third angular position located in advance of said predetermined angular portion whereby the defective cigarettes are ejected before said second angular position and the non-defective cigarettes are ejected at said second angular position.

4. A cigarette testing machine comprising a cylindrical drum rotatably mounted on said machine having a plurality of circumferentially spaced axially extending slots on the cylindrical surface thereof, means for rotating said drum in timed relation to means for automatically loading a cigarette in each of said slots when each slot reaches a first angular position, means for automatically ejecting the cigarettes from said slots when each of said slots reaches a second angular position spaced less than 360° from said first angular position, ring means mounted on one end of said drum for rotation therewith defining a tapered bore near the end of each of said slots for sealingly engaging the cigarette in the slot, a ported plate mounted on said frame having an annular surface slidably and sealingly engaging an annular surface of said ring means, a plurality of arcuate recesses where each arcuate recess subtends an angle greater than the angle between said slots are formed in the annular surface of said ported plate with different groups of said tapered bores communicating with different ones of said arcuate recesses, means for maintaining the air pressure in each of said arcuate recesses at a reduced level, and means for automatically shifting each cigarette axially toward said ring means to seal one end of the cigarette against the tapered wall of said tapered bore and maintain said one end sealed substantially throughout said predetermined angular portion of rotation of the drum, an aneroid bellows switch communicating with said arcuate recesses responsive to the fluid flow produced by said pressure applying means for producing a signal each time the fluid flow pressure in one of said arcuate recesses increases due to a defective cigarette, and means responsive to said signal for ejecting the defective cigarette from its slot at a third angular position located in advance of said second angular position whereby the defective cigarettes are ejected before said second angular position and the non-defective cigarettes are ejected at said second angular position.

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S. CLEMENT SWISHER, Primary Examiner