

Nov. 26, 1968

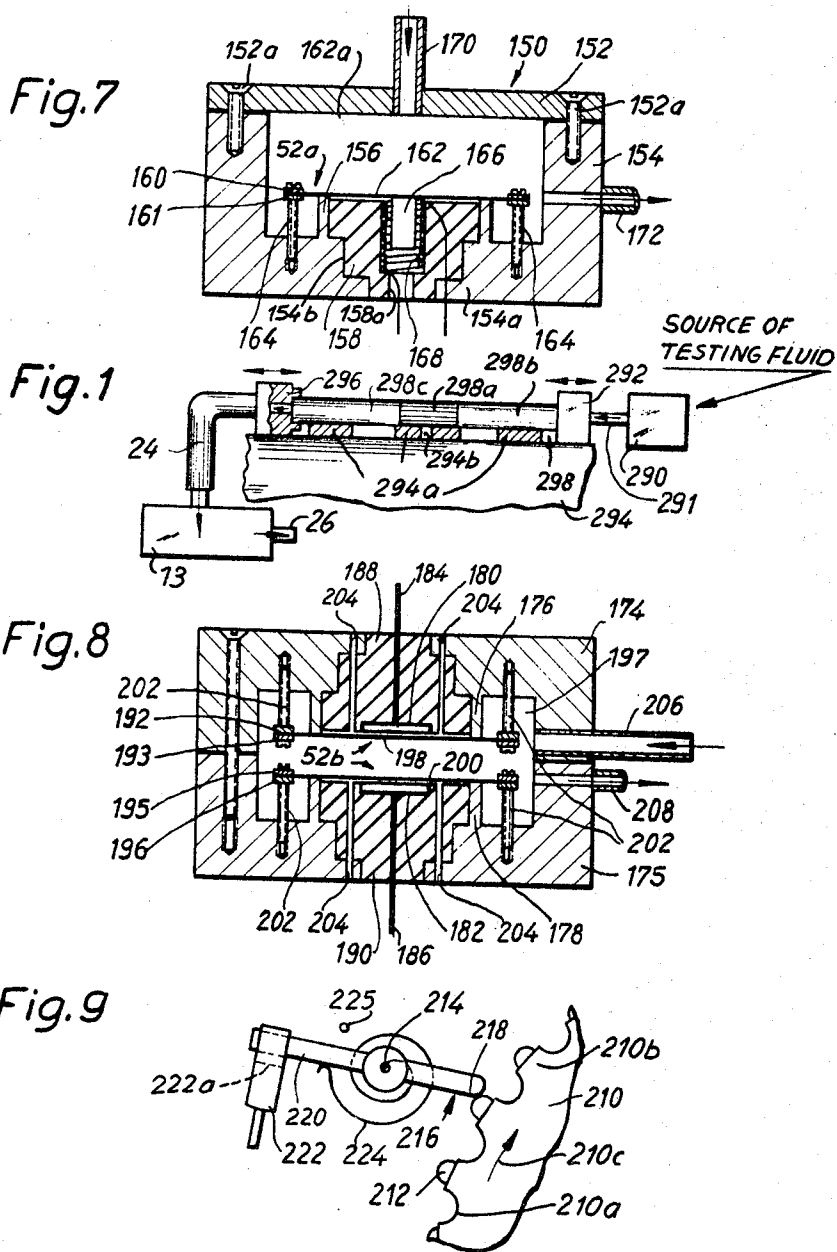
A. ESENWEIN

3,412,856

METHOD AND APPARATUS FOR TESTING CIGARETTES AND THE LIKE

Filed Feb. 9, 1965

4 Sheets-Sheet 1



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METHOD AND APPARATUS FOR TESTING CIGARETTES AND THE LIKE

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4 Sheets-Sheet 2

Fig. 1a

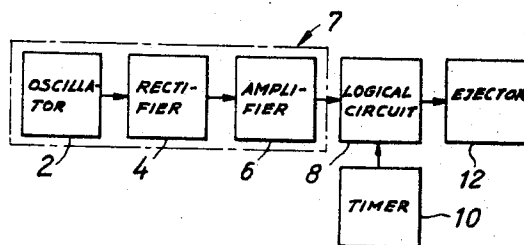


Fig. 2

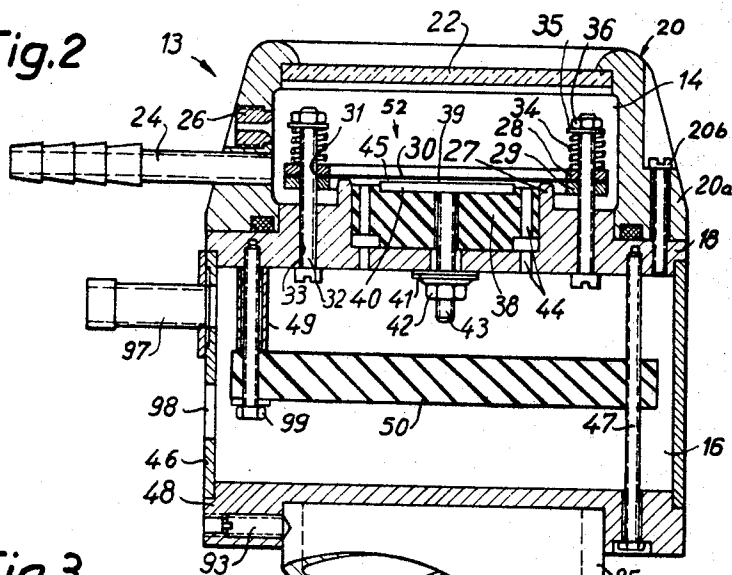
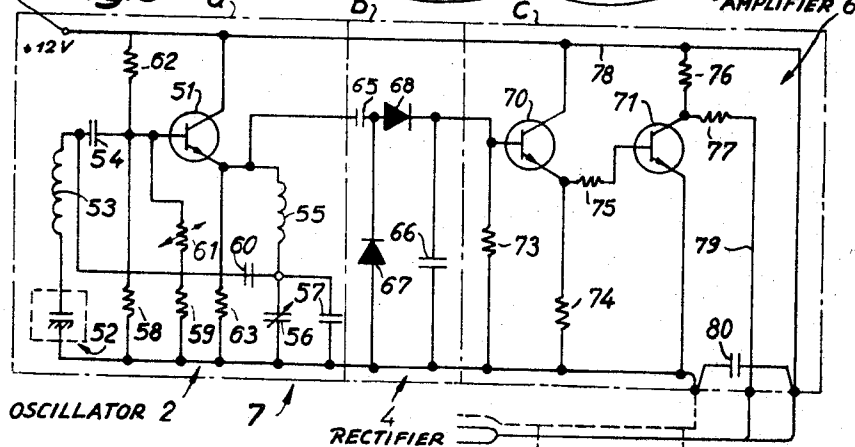


Fig. 3



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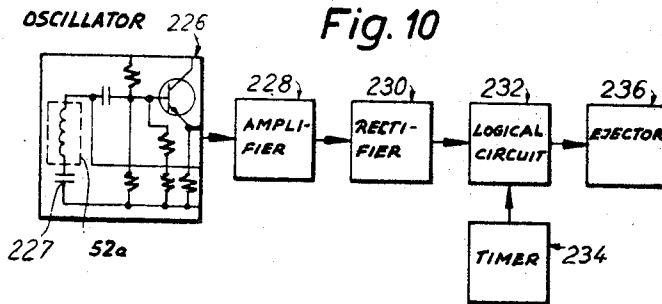
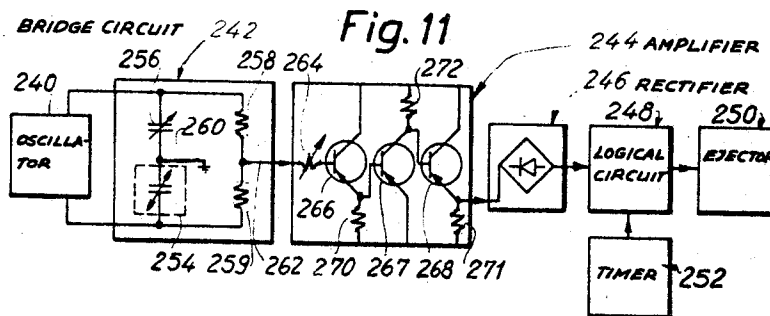
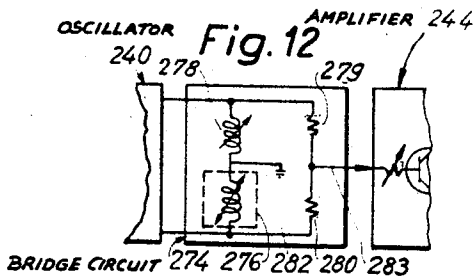
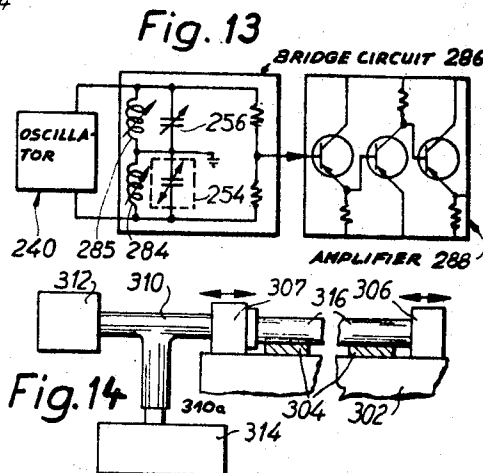
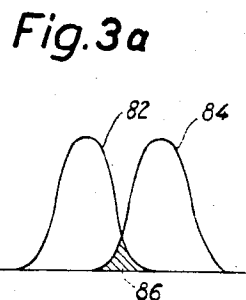
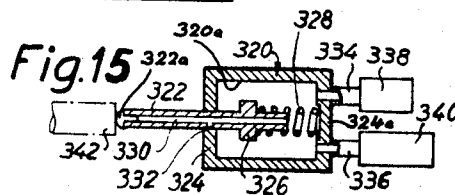
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METHOD AND APPARATUS FOR TESTING CIGARETTES AND THE LIKE

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4 Sheets-Sheet 3



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METHOD AND APPARATUS FOR TESTING CIGARETTES AND THE LIKE

Filed Feb. 9, 1965

4 Sheets-Sheet 4.

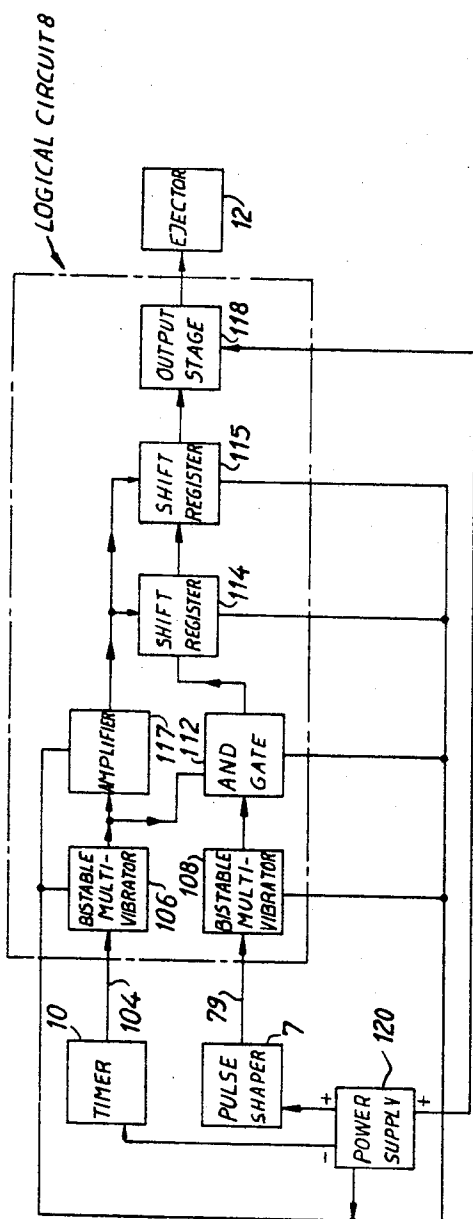


Fig. 4

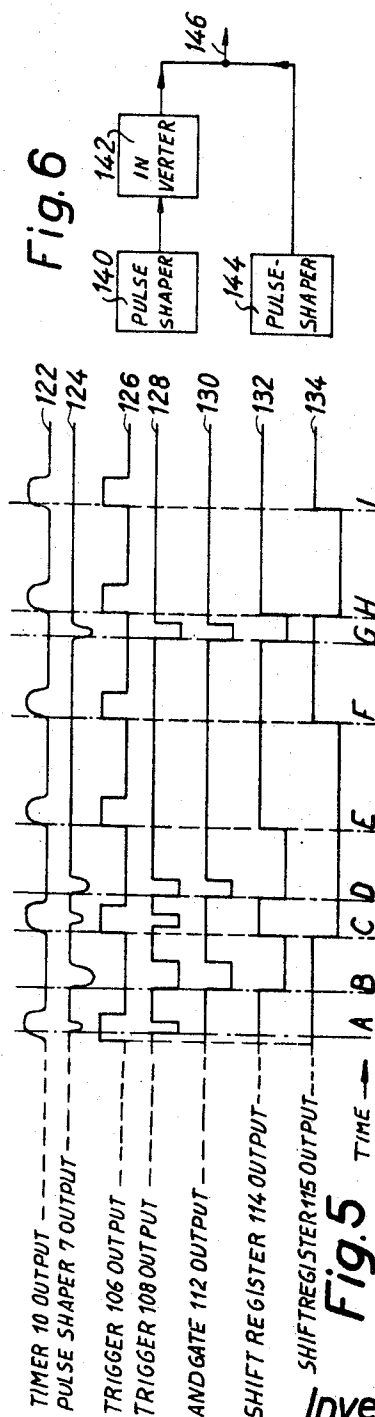


Fig. 6

Fig. 5

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3,412,856

METHOD AND APPARATUS FOR TESTING CIGARETTES AND THE LIKE

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Filed Feb. 9, 1965, Ser. No. 431,355

Claims priority, application Great Britain, Feb. 11, 1964,
5,640/64

41 Claims. (Cl. 209—74)

The present invention relates to a method and apparatus for testing cigarettes, cigars, cheroots, cigarillos, filter rods, filter mouthpieces, filter cigarettes of unit length or multiple unit length, and similar rod-shaped articles wherein a filler consisting of tobacco particles and/or filter material is surrounded by a tubular wrapper having one or two at least partially open ends. More particularly, the invention relates to a method and apparatus for controlled ejection of defective articles from their normal path after such defective articles were detected in a testing operation. Still more particularly, the invention relates to a method and apparatus for testing cigarettes or like articles and for ejecting defective articles in response to impulses initiated by changes in pressure or another characteristic of a testing fluid.

It is known to test cigarettes in an apparatus wherein a sensing pin is biased against one end of the cigarette. The sensing pin constitutes the valve member of a valve which controls the flow of a testing fluid. If the density of the cigarette is unsatisfactory or if the tested end of the cigarette is empty, the sensing pin will assume a position in which it either allows or prevents the flow of a testing fluid. The testing fluid is used to flex a diaphragm and the diaphragm produces signals which are used to eject defective cigarettes from their normal path. A serious drawback of such testing apparatus is that the generation of a signal requires some time, particularly if the defect of a cigarette is a borderline defect, i.e., if such a cigarette is not totally defective but is sufficiently defective to warrant its removal from the normal path which leads to storage, to a packing machine or to another processing station. The delayed generation of a signal may result in the ejection of a satisfactory article which precedes or which follows the defective article.

For example, the wrapper of a cigarette might have developed a slight leak. If such a cigarette is tested with a fluid, the pressure of fluid sinks only gradually and might reach a minimum value, which results in the generation of a signal, only at the time when the defective cigarette is about to leave the testing station. If the signal is utilized to immediately eject the defective cigarette, the ejecting station must be so wide that the defective cigarette can be ejected independently of that stage of testing operation during which the signal was actually produced. Since the cigarettes are tested while travelling at a high speed, and since the parts which effect the ejection of defective cigarettes must perform a movement whenever the testing operation results in the generation of a signal, the inertia of such moving parts often prevents the ejector from removing a defective cigarette, i.e., the ejector might remove a satisfactory cigarette which precedes or follows that defective cigarette whose examination resulted in the generation of a signal.

Accordingly, it is an important object of the present invention to provide a method of testing the integrity of

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cigarettes or similar rod-shaped articles in such a way that all signals which are generated in response to detection of defective articles are delayed sufficiently to render the ejecting operation independent of the exact moment when the testing operation upon a defective article results in the generation of a signal.

Another object of the invention is to provide a method of the just outlined characteristics according to which the ejecting operation is synchronized with the operation of the conveyor system which advances the articles through the testing and ejecting stations so that fluctuations in the speed of articles cannot affect the accuracy of the ejecting operation.

A further object of my invention is to provide a method according to which cigarettes and similar articles may be tested with a view to detect not one but two or more different types of defects including leaks in the wrapper, improper sealing of the seam on the wrapper, partial destruction of the wrapper, excessive density of the filler, insufficient density of the filler, and /or total absence of filler material.

Another object of the invention is to provide a method of testing cigarettes and the like for integrity according to which all defective cigarettes are ejected automatically a desired interval following the detection so that the testing and ejecting stations may be located at any desired distance from each other.

An additional object of the invention is to provide a method of testing cigarettes and the like according to which the degree of defectiveness which makes it necessary to eject an article may be selected at the discretion of the operators and according to which the standards controlling the quality of satisfactory and defective articles may be changed in the course of actual testing operation and with a minimum of delay.

A further object of the invention is to provide a method of testing the integrity of cigarettes or similar rod-shaped articles according to which two or more consecutive defective articles may be removed from their normal path in response to a continuous impulse so that the apparatus and instruments which effect such detection and ejection of defective articles are subjected to a minimum of wear.

A concomitant object of the invention is to provide an apparatus for practicing the above outlined method and to construct and assemble the apparatus in such a way that its ejecting mechanism has sufficient time for removal of a defective article even though the signal which initiates such removal might be generated immediately following the start or shortly prior to completion of the testing operation upon a defective article.

Another object of the present invention is to provide a testing apparatus which may be installed in or combined with modern high-speed cigarette machines and which can test cigarettes at the same rate at which the cigarettes issue from the machine.

A further object of the invention is to provide a novel signal transmitting system between the testing and ejecting units of the apparatus.

Another object of the invention is to provide a novel signal generating device which may be utilized in the testing unit of the improved apparatus.

Briefly stated, one feature of my invention resides in the provision of a method of testing the integrity of cigarettes and similar rod-shaped articles having only two

spaced openings therein connected by a restricted flow path. The method comprises conveying the articles in a predetermined path, first through a testing station and thereupon through an ejecting station, testing the articles at the testing station with a testing fluid whose characteristics (preferably pressure) are indicative of the quality of tested articles, generating a signal in response to each such change in the characteristics of testing fluid which is outside of a predetermined range indicative of satisfactory articles, delaying the signal until an article trailing the tested defective article enters the testing station or at least until the testing operation upon the defective article is completed, and utilizing the thus delayed signal to eject the respective defective article at the ejecting station.

It can happen that the testing operation upon a defective article results in the generation of a signal immediately at the start or shortly prior to completion of the testing operation. In accordance with my invention, such signal is delayed at least slightly and is transmitted to the ejector during a complete interval between entries of two consecutive articles into the testing station. Such consecutive articles may but need not immediately follow the defective article whose examination resulted in the generation of a signal. The signal is preferably an electric signal which is amplified, rectified, stored and otherwise treated prior to causing the operation of the ejector.

If two or more defective articles follow each other in their predetermined path, the apparatus produces a single signal of multiple unit length.

It will be seen that the timing of ejection of defective articles is independent of the exact moment when the testing operation upon the defective article results in the generation of a signal, i.e., the defective article will be ejected at a given time regardless of whether the signal was produced at the start, in a median stage or shortly prior to completion of the testing operation. This is due to the fact that the ejection of a defective article is delayed so as to take place during an interval following the entry of a trailing article into the testing station. The timing of each ejecting operation is dependent on the speed at which the articles travel through the testing station so that the ejection of defective articles can be carried out with the same degree of precision when the articles travel at a higher, lower or changing speed.

In a modern cigarette machine, the intervals between movements of consecutive cigarettes through a testing station are very short. Therefore, I prefer to utilize a full interval between advances of two consecutive articles through the testing station to effect removal of a defective article from its path. Since the ejecting operation normally begins at the time a trailing article enters the testing station and terminates when the next-following article enters the testing station, the interval of time during which a defective article is ejected is of the same length regardless of the exact stage of a testing operation which has resulted in the generation of a signal.

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 drawings, in which:

FIG. 1 is a fragmentary side elevational view of a testing apparatus which is constructed and assembled in accordance with a first embodiment of my invention;

FIG. 1a is a block diagram of an embodiment of a circuit which is utilized in the testing apparatus of FIG. 1;

FIG. 2 is an axial section through the housing for a signal generator which is utilized in the testing apparatus of FIG. 1;

FIG. 3 illustrates the details of a pulse shaper which forms part of the circuit shown in FIG. 1a;

FIG. 3a shows the curves which represent the oscillation of resonant circuits in the pulse shaper of FIG. 3;

FIG. 4 is a block diagram of an embodiment of a logical circuit which may be utilized in the circuit shown in FIG. 1a;

FIG. 5 illustrates the manner in which the circuit of FIG. 1a receives and transmits signals;

FIG. 6 is a block diagram of a modification of the circuit of FIG. 4;

FIG. 7 is an axial section through the housing of a modified signal generator which comprises an induction coil;

FIG. 8 is an axial section through a third signal generator which comprises two variable capacitors;

FIG. 9 is a side elevational view of a timer which is utilized in the apparatus of FIG. 1;

FIG. 10 is a block diagram of a modification of the circuit of FIG. 1a wherein the oscillator includes a signal generator of the type shown in FIG. 7;

FIG. 11 is a block diagram of another modification of the circuit of FIG. 1a wherein the pulse shapers of FIGS. 3 and 10 are modified;

FIG. 12 is a circuit diagram of a modified portion of the circuit of FIG. 11;

FIG. 13 is a circuit diagram of another modified portion of the circuit of FIG. 11;

FIG. 14 is a fragmentary side elevational view of a different testing apparatus wherein some testing fluid escapes through the pores in the wrapper of a tested article; and

FIG. 15 is a fragmentary axial sectional view of a further testing apparatus which tests cigarettes and similar articles for the compactness of their fillers.

Referring first to FIG. 1, there is shown a portion of an apparatus for testing the integrity of cigarettes, cigars, cigarillos, cheroots, filter rods, filter mouthpieces, filter cigarettes of unit length or multiple unit length and similar rod-shaped articles wherein a filler consisting of tobacco particles and/or filter material is surrounded by a tubular wrapper which is at least partially open at both ends. This apparatus comprises a source 290 of compressed testing fluid, preferably air, which discharges such fluid at a constant pressure, and a supply conduit 291 which delivers a fluid stream to one end of an article 298 to be tested. In the illustrated embodiment, the article 298 is a filter cigarette of double unit length including a filter mouthpiece 298a of double unit length and two cigarette rods 298b, 298c of unit length. The article 298 is held by suction (see the suction duct 294b) in an axially parallel multi-section pocket 294a of a rotary drum-shaped conveyor 294, and its end portions are sealed by sleeves 292, 296. These sleeves are reciprocable in the axial direction of the conveyor 294 (see the double-headed arrows) and respectively engage the ends of the cigarette rods 298b, 298c during the actual testing operation, i.e., while the article 298 advances through the testing station. The stream of testing fluid passes through the article 298 and is discharged through the sleeve 296 to enter a feed conduit 24. The numeral 13 denotes the housing for a signal generator which may include a variable diaphragm capacitor 52 to be described in connection with FIG. 2, and the housing 13 is provided with an outlet containing a fluid-discharging nozzle 26. The capacitor 52 in the housing 13 provides a current of varying strength in a manner to be described in connection with FIGS. 2-5.

The sleeves 292, 296 constitute the coupling elements of the testing device shown in FIG. 1 and move toward and away from each other at speeds which are synchronized with the rotational speed of the conveyor 294. The manner in which the sleeves 292, 296 can move with reference to and together with the conveyor 294 is disclosed, for example, in the copending applications Ser. Nos. 208,189 and 214,460 of Hans Kaeding et al., both

assigned to the same assignee. A further construction of the sleeves 292, 296 and their motion is shown in copending application 343,718 of Willy Rudszinat assigned to the same assignee. Reference may also be had to copending application Ser. No. 290,523 of Julius Hellmann assigned to the same assignee. When the sleeves 292, 296 are properly coupled to the cigarette rods 298b, 298c, the ends of the article 298 are sealed from the atmosphere and the stream of testing fluid admitted through the supply conduit 291 and sleeve 292 can pass solely through the restricted flow path defined by the wrapper of the article 298. The filler in the wrapper offers a predetermined resistance to the flow of testing fluid and, therefore, the pressure of fluid entering the sleeve 296 is lower than the pressure of fluid entering the sleeve 292. However, if the seam of the wrapper is defective, if the wrapper is torn, or if the filler of the wrapper offers a resistance which is less than the resistance of a satisfactory filler, the pressure of fluid entering the diaphragm chamber in the housing 13 is not within the desired range and the capacitor 52 will provide a current which is then amplified, rectified, stored and delayed in a manner to be described in connection with FIGS. 2 to 5 in order to insure that the ejector of the testing apparatus will remove the defective article from the pocket 294a of the conveyor 294 or from the pocket of a subsequent conveyor which receives articles from the pockets of the conveyor 294. This is the basic operation of the testing apparatus shown in FIG. 1, i.e., the apparatus comprises an arrangement for sending a stream of testing fluid through consecutive articles on a travelling conveyor and changes in the pressure of testing fluid are utilized to generate signals. Such signals are indicative of satisfactory or defective articles. The signals which are indicative of defective articles are utilized to operate an ejector which removes defective articles from their holders or pockets in a zone located past the testing station.

The length of the signal for ejection of a defective article preferably equals or at least approximates the length of the interval between entries of two consecutive articles into the testing or ejecting station. However, the timing of the signal which is transmitted to the ejector is preferably selected in such a way that the ejector may be actuated before the defective article enters that zone of its path from which it is ejected, and that the ejector is rendered ineffective before the next-following article enters the same zone provided, of course, that the article following the defective article is a satisfactory article. In other words, the ejector is ready at the time a defective article or a series of defective articles enters that zone of the path from which such article or articles are removed by jets of compressed air or in another suitable way. Invariably, the ejector returns to its inoperative condition or position before a satisfactory article enters the ejecting station or before a satisfactory article enters that zone of the ejecting station which is in the range of the ejector.

The signal which is generated in response to detection of a defective article may be delayed in such a way that the ejector is ready prior to entry of the defective article by a length of time corresponding to one-half the length of the interval between entry of two consecutive articles into the testing or ejecting station and remains operative during the full interval. By way of example, and assuming that the length of an interval between entry of consecutive articles into the testing station is one-thirtieth of a second, the ejector will be ready one-sixtieth of a second prior to entry of a defective article into its range and will remain operative for one-sixtieth of a second (or a little less) while the defective article is actually within its range. This suffices to eject the defective article from its pocket or holder.

Referring now to FIG. 1a, there is shown an electric circuit which is utilized to produce signals in response to detection of defective articles. The circuit comprises an oscillator 2 which produces AC voltage signals in response

to detection of a defective article, a rectifier 4 which receives signals from the oscillator 2, and an amplifier 6 which receives rectified signals from the rectifier 4. The units 2, 4 and 6 together form a signal or pulse shaper 7 which responds to variations in the capacity of the capacitor 52 in the housing 13 of FIG. 1 and produces a substantially square wave output signal in accordance with such variations. Such output signal is conveyed to a logical circuit 8 which functions as a signal storage arrangement and which is connected to a timer 10. The timer 10 may comprise any suitable means adapted to generate signals at a rate corresponding to the speed of the articles to be tested. The logical circuit 8 sends signals to an ejector 12 which serves to remove defective articles from their normal path.

Without disclosing the full details of the pulse shaper 7, the logical circuit 8, or the units 10 and 12, the operation of the circuit shown in FIG. 1a is briefly described as follows: Articles 298 are tested one after the other while travelling sideways in an elongated path defined by the conveyor 294. Each such article is tested by causing a stream of testing fluid to enter at one end and to be discharged at the other end of the respective article. If the testing fluid is compressed air, a certain change in air pressure at the other end of the tested article will indicate that the wrapper of the article has developed a leak, that the wrapper is torn, that the tobacco and/or filler particles in the wrapper are subjected to excessive or insufficient compression, and/or that the article exhibits two or more such defects which are sufficiently pronounced to warrant ejection of the article prior to packing, storing or other treatment. Whenever the pressure of testing fluid deviates from a predetermined pressure range, e.g., from a pressure range between 20-50 mm. water column, the oscillator 2 produces an AC signal which is fed to the rectifier 4, which rectifies the AC signal and sends the rectified signal to the amplifier 6. The timer 10 supplies to the logical circuit 8 a different type of signals at the exact rate at which the articles travel through the testing station and are tested by streams of testing fluid. The timer 10 may transmit signals when the articles enter or when the articles leave the testing station. If the logical circuit 8 receives from the pulse shaper 7 an amplified signal during an interval between two consecutive signals transmitted by the timer 10, said logical circuit supplies a signal to the ejector 12 which actuates a mechanism capable of removing the defective article from its normal path. The signal sent by the logical circuit 8 is transmitted during the full interval between two consecutive signals from the timer 10 following the reception of an amplified signal from the pulse shaper 7 so that the ejector 12 has ample time to remove the defective article. In other words, the logical circuit 8 will send signals with some delay, but will maintain such signals for the full length of an interval between consecutive signals received from the timer 10 to insure that the ejector 12 can utilize a full interval for removal of a defective article even at such times when the logical circuit 8 receives from the pulse shaper 7 a signal which might have been transmitted immediately prior to the second of two consecutive signals received from the timer 10. Depending on the distance between the testing station and the ejector 12, the operative connection between the logical circuit 8 and the ejector 12 may include one or more additional electrical or mechanical delay devices so that a defective article may be ejected a predetermined interval of time subsequent to its passage through the testing station.

For example, the additional signal delaying device or devices between the logical circuit 8 and ejector 12 may operate in such a way that a series of nine articles will pass through the testing station before a defective article (preceding such series of nine articles) is actually removed from its path at the ejecting station. In other words, if the distance between the testing and ejecting stations

is such that this distance corresponds to the length of a series of ten consecutive articles, and if the first article of such series is defective, the defective article will be ejected while the eleventh article undergoes a testing operation. In such apparatus, the additional signal delaying device or devices must effect a delay corresponding in length to the combined length of nine intervals between entries of two consecutive articles into the testing or ejecting station. The remaining delay (one interval between entry of consecutive articles into one of the stations) is effected by the logical circuit 8 of FIG. 1a.

By properly delaying the signal which is transmitted to the ejector, I insure that only defective articles actually leave their path even when a defective article is located between two satisfactory articles. Thus, it is not necessary to eject satisfactory articles just to make sure that a defective article which happens to be located between a pair of satisfactory articles is definitely removed from its path. This means that waste and the number of rejects are reduced to a minimum.

FIG. 2 illustrates the parts which are mounted in the diaphragm housing 13 of the testing apparatus shown in FIG. 1. The housing 13 defines a diaphragm chamber or test chamber 14 and an oscillator chamber 16. The two chambers are separated by a partition 18, and the housing comprises a cupped portion here shown as a cover or dome 20 which surrounds the chamber 14. The bottom wall 22 of the cover 20 consists of vitreous or other transparent material and forms a window located opposite and serving to allow for visual observation of a diaphragm 30. The annular wall 20a of the cover 20 has an inlet to receive the discharge end of the feed conduit 24 which conveys testing fluid into the diaphragm chamber 14. The annular wall 20a is further provided with a restricted outlet which is adjacent to the feed conduit 24 and accommodates the nozzle 26 defining a flow restricting orifice for escape of testing fluid. The nozzle 26 is threaded into the wall 20a and may be readily replaced by a nozzle having an orifice of different diameter. The diameter of the orifice in the nozzle 26 is smaller than the internal diameter of the feed conduit 24.

The central portion of the partition 18 is formed with an annular projection 27 which extends into the diaphragm chamber 14 and bears against one side of the diaphragm 30, i.e., the diaphragm overlies the end face of the projection 27. The diameter of the diaphragm exceeds the diameter of the projection 27, and its marginal portions are clamped between two rings 28, 29 which are formed with registering apertures 31 for guide bolts 32. The bolts 32 extend through tapped bores 33 provided in the partition 18 and the upper ends of their threaded stems carry nuts 36 for washers 35. Helical expansion springs 34 are placed between the ring 28 and washers 35 to bias the diaphragm 30 against the end face of the annular projection 27 and to thereby subject the diaphragm to initial tension. By rotating the nuts 36, the operator may adjust the bias of springs 34 and the initial tension of diaphragm 30. The projection 27 surrounds an insulator 38 whose top face is recessed and is located at a small distance from the underside of the diaphragm 30. The recess in the top face of the insulator 38 receives a plate-like electrode 40 which is separated from the diaphragm by a small air gap 39. The diaphragm 30 and the electrode 40 constitute the plates of the variable capacitor 52 and are separated from each other by a layer of dielectric material, i.e., by air filling the gap 39.

The electrode 40 is connected with a conductor here shown as a threaded bolt 43 which extends through the insulator 38 and, with at least some clearance, through a bore provided in the central portion of the partition 18. A nut 42 meshes with the lower end portion of the conductor 43 and is insulated from the partition 18 by one or more washers 41. Aerating holes 44 drilled into the partition 18 and insulator 38 allow atmospheric air

to reach the underside of the diaphragm 30 in a zone surrounded by the annular projection 27 of the partition 18. In other words, the air gap 39 contains air at atmospheric pressure.

The housing 13 further comprises a cylindrical wall 46 which bears against the underside of the partition 18 and whose lower end is closed by a wall 48. The wall 48 and partition 18 are connected to each other by one or more bolts 47 which simultaneously serve to hold the cylindrical wall 46 in the illustrated position. The bolt or bolts 47 also carry an insulator plate 50 which is held by one or more additional bolts 99 and is separated from the partition 18 by one or more spacer sleeves 49 surrounding the bolt or bolts 99. By changing the length of the spacer sleeve 49 shown in FIG. 2, the operator can adjust the distance between the insulator plate 50 and partition 18. The plate 50 supports the units of the pulse shaper 7, namely, the oscillator 2, the rectifier 4 and the amplifier 6.

The cylinder 46 is formed with an opening 98 which enables the oscillator chamber 16 to communicate with the atmosphere. The numeral 97 denotes a nipple which accommodates a portion of the cable (not shown) leading to the pulse shaper 7. The wall 48 is supported by a tubular carrier 95 and is detachably secured to this carrier by one or more screws 93. The carrier is secured to a rigid support, not shown.

The variable capacitor 52 of FIG. 2 operates as follows:

The feed conduit 24 admits a stream of testing fluid whose pressure will deviate from a predetermined pressure range if the stream was caused to pass through the wrapper of a defective cigarette, cigar, cigarillo, cheroot, filter cigarette, filter mouthpiece or a similar rod-shaped article. At the same time, testing fluid escapes through the orifice of the nozzle 26. Since the orifice of the nozzle 26 is smaller than the bore of the feed conduit 24, the pressure in the diaphragm chamber 14 first rises and then decreases whenever the pressure of testing fluid rises. Such changes in fluid pressure prevailing in the chamber 14 cause a flexing of the diaphragm in the zone surrounded by the annular projection 27 of the partition 18 because the underside of the diaphragm (as the parts appear in FIG. 2) is subjected to atmospheric pressure, the air being free to flow through the opening 98, oscillator chamber 16, holes 44 and into or from the air gap 39. Any flexing of the diaphragm 30 immediately causes a change in the width of the air gap 39 to thereby alter the dielectric constant and the capacity of the capacitor 52. The manner in which such change in the capacity of the capacitor 52 results in the generation of a signal will be described in connection with FIG. 3.

The window 22 allows for observation of the diaphragm 30 in order to detect any traces of contaminating matter such as may result from deposition of tobacco particles, dust or other foreign substances entrained by the testing fluid entering through the feed conduit 24. The cover 20 may be detached upon removal of bolts 20b which secure it to the partition 18 so that the operator may gain access to the diaphragm and may remove all traces of contaminating matter. As mentioned hereinabove, the nozzle 26 may be replaced by a nozzle having an orifice of different diameter if the testing apparatus is to be converted for operation with a testing fluid at different pressure or for testing of different articles.

If the stream of testing fluid which enters through the feed conduit 24 has passed through a satisfactory cigarette, its pressure is constant so that the diaphragm 30 need not change its position. The orifice of the nozzle 26 is dimensioned in such a way that the fluid which has passed through a satisfactory cigarette and enters the chamber 14 is maintained at a pressure which is within the range of pressures capable of effecting a flexure of the diaphragm 30. The pressure prevailing in the cham-

ber 14 is then substantially constant and the capacitor does not provide a signal. However, the diaphragm is flexed whenever the pressure of testing fluid rises above or drops below such pressure (or range of pressures) which is indicative of a satisfactory cigarette. As a rule, this range does not include pressures which are indicative of partly or slightly defective cigarettes because such cigarettes should be ejected from their path.

FIG. 3 illustrates an embodiment of a circuit which may be utilized as the pulse shaper 7 shown in FIG. 1a and is mounted on the insulator plate 50 in the housing 13 of FIG. 2. The oscillator 2 is a high-frequency oscillator including a transistor 51 and two tuned or resonant circuits. The first tuned or resonant circuit includes the capacitor 52 composed of the plates 30, 40 shown in FIG. 2. One lead of the capacitor 52 is grounded and its other lead is connected in series with an induction coil 53 and with one plate of a capacitor 54. The other plate of the capacitor 54 is connected to the base of the transistor 51. The emitter of the transistor 51 is connected to one end of an induction coil 55. The other end of the coil 55 is connected to a variable capacitor 56 and to a capacitor 57 which is connected in parallel with the capacitor 56. The other plates of the capacitors 56 and 57 are grounded. The coil 55 and the capacitors 56 and 57 constitute a second tuned or resonant circuit. The two resonant circuits are coupled inductively and capacitively through a capacitor 60 which is connected at one plate between the coil 53 and the capacitor 54 of the first resonant circuit. The other plate of the capacitor 60 is connected between the coil 55 and the non-grounded plates of the capacitors 56 and 57 forming part of the second resonant circuit. The base of the transistor 51 is connected with a variable (NTC) resistor 61 which is connected with one end of a resistor 59. The other end of the resistor 59 is grounded. The resistors 59 and 61 are connected in parallel with a resistor 58 one end of which is grounded and the other end of which is connected to the base of the transistor 51. The resistors 58 and 59 are connected in parallel with the first resonant circuit. Another resistor 62 is connected between the base and the collector of the transistor 51, and said collector is further connected to a lead 78 connected to a source 81 of DC electrical energy (+12 volts).

The second resonant circuit is connected in parallel with a resistor 63 one end of which is grounded and the other end of which is connected to the emitter of the transistor 51. The heretofore described parts of the pulse shaper 7 shown in FIG. 3 constitute the oscillator 2.

The rectifier 4 comprises two capacitors 65 and 66 and two diodes 67 and 68. The capacitor 65 is connected between the emitter of the transistor 51 and the diode 68. The diode 67 is connected between ground and the lead connecting the capacitor 65 and the diode 68. The other electrode of the diode 68 is connected to one electrode of the capacitor 66. The other electrode of the capacitor 66 is grounded.

The amplifier 6 comprises two transistors 70 and 71 and five resistors 73, 74, 75, 76 and 77. The base of the transistor 70 is connected, on the one hand, between the common connecting lead of the diode 68 and the capacitor 66 and, on the other hand, to one end of the resistor 73. The other end of the resistor 73 is grounded. The emitter of the transistor 70 is connected to the lead between the resistors 74 and 75, the resistor 75 being connected to the base of the transistor 71 and the resistor 74 being grounded. The collector of the transistor 70 is connected to the lead 78, and said lead is connected to one end of the resistor 76. The other end of the resistor 76 is connected to the collector of the transistor 71. A signal transmitting lead 79 connects one end of the resistor 77 to the logical circuit 8, and the other end of the resistor 77 is connected to the collector of the transistor 71. The emitter of the transistor 71 is grounded. The leads 78

and 79 are shield and the lead 78 is grounded through a capacitor 80.

The operation of the pulse Shaper 7 shown in FIG. 3 is as follows:

The capacity of the variable capacitor 52 in the first resonant circuit assumes a predetermined value whenever the pressure of testing fluid in the diaphragm chamber 14 of the housing 13 corresponds to a pressure which is indicative of a satisfactory article. The variable capacitor 56 is adjusted in such a way that the two tuned circuits oscillate in resonance in response to the lowermost satisfactory fluid pressure in the diaphragm chamber 14, e.g., in response to a pressure of at least 20 mm. water column. If the diaphragm 30 is then subjected to a higher pressure, the capacity of the variable capacitor 52 increases and causes more pronounced oscillation of the first resonant circuit. The diaphragm 30 is maintained under such initial tension (the tension being determined by the bias of the springs 34) that the resonance curve 84 of the first resonant circuit (see FIG. 3a) cannot fully coincide with the resonance curve 82 of the second resonant circuit. Therefore, the oscillator 2 will oscillate in response to all such pressures of testing fluid which exceed a predetermined minimum pressure. During oscillation of the oscillator 2, the output voltage is transmitted to the capacitor 65 which cooperates with the diodes 67 and 68 to shape said output signal by rectifying and filtering the same. The amplifier 6 amplifies the rectified signal and supplies the rectified signal to the logical circuit 8 via the lead 79. The variable resistor 61 serves as a temperature stabilizer and the capacitor 80 serves as a short-circuiting means for high frequency signals. When the pulse shaper 7 fails to produce a signal, the stream of testing fluid has passed through a satisfactory cigarette.

Since the pulse shaper 7 and the variable capacitor or signal generator 52 are in close proximity, each signal is amplified prior to being transmitted through elongated leads to the logical circuit 8. In other words, each signal which is provided by the capacitor or signal generator 52 is immediately amplified, and the thus amplified signal is then supplied to the input of the logical circuit 8 via the lead 79.

FIG. 3a illustrates the resonance curves of the two resonant circuits 52, 53, 54 and 55, 56, 57 in the oscillator 2 of FIG. 3. The resonant curve 82 is that of the second resonant circuit 55, 56 and 57 and may be varied by adjustment of the variable capacitor 56. When the oscillator 2 is in operation, the curve 82 remains unchanged. The resonant curve 84 is that of the first resonant circuit 52, 53, 54. The first resonant curve 84 varies in accordance with the instantaneous capacity of the capacitor 52 and may overlap a portion of the second resonant curve 82 as indicated at 86. The variable capacitor 52 is adjusted in such a way, i.e., the initial tension of the diaphragm 30 is so selected that the first resonant curve 84 cannot completely coincide with the second resonant curve 82. The oscillator 2 will oscillate if the curve 82 overlaps a portion of the curve 84. Thus, the hatched area 86 indicates the extent to which the oscillator 2 oscillates.

FIG. 4 illustrates the details of the logical circuit 8 which is assembled of replaceable circuit modules, also called Valvo blocks. The timer 10 may comprise a signal generator 222 (shown in FIG. 9) and is connected via lead 104 to a first bistable multivibrator 106 which may comprise, for example, a Schmitt trigger. The lead 79 connects the hereinbefore described pulse shaper 7 to a second bistable multivibrator 108 which may comprise, for example, a Schmitt trigger. The outputs of the bistable multivibrators or triggers 106 and 108 are connected to an AND gate 112. The AND gate 112 is connected to a first shift register or ring counter 114 which in turn is connected to a second shift register or ring counter 115. The trigger 106 is connected to each shift register 114

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and 115 via an amplifier 117. The second shift register 115 is connected to an output stage 118 which is in turn connected to the actuating member (not shown) of the ejector 12. For example, the actuating member of the ejector 12 may comprise a magnet or the like serving to open or close a valve which may allow a blast of compressed air to eject the defective article in the axial direction of a pocket 294a on the conveyor 294 of FIG. 1.

The logical circuit 8 is supplied with DC electrical energy by any suitable source of power supply such as, for example, a transformer and one or more rectifiers. The power supply source 120 applies a DC voltage of minus 12 volts to the signal generator 222 of the timer 10. A DC voltage of +12 volts is applied to the pulse shaper 7. A DC voltage of minus 24 volts is applied to the output stage 118 and a DC voltage of +100 volts is applied to all the other components of the logical circuit 8.

The various components of the logical circuit 8 such as, for example, the bistable multivibrators 106 and 108, the AND gate 112 and the shift registers 114 and 115 may comprise any suitable type known in the art such as, for example, those shown and described in *Computer Basics*, by Technical Education and Management, Inc. published in April 1962 by Howard W. Sams & Co., Inc., vol. 3, "Digital Computers, Mathematics and Circuitry" and vol. 6, "Solid-State Computer Circuits."

The operation of the logical circuit 8 will be described with reference to FIG. 5. The signal generator 222 of the timer 10 supplies to the logical circuit signals indicated by the waveform 122. The timer signals are transmitted at the exact moment when an article enters or leaves the testing station, i.e., at the exact rate at which the articles travel through the testing station. The trigger 106 converts the waveform 122 into an integrated or square wave 126. The pulse shaper 7 transmits to the logical circuit 8 signals of the waveform 124 produced by the variable capacitor or signal generator 52. The trigger 108 converts the pulses 124 into integrated or square wave pulses 128. The signals provided by the variable capacitor or signal generator 52 of the pulse shaper 7 are negative signals, i.e., the pulse shaper produces either negative pulses or no pulses. Both signals produced by the pulse shaper 7 and timer 10 are supplied to the AND gate 112 which transmits or conducts a signal only when a signal of the same polarity or zero is applied simultaneously from the triggers 106 and 108. The output of the AND gate 112 is shown by pulses 130.

At the moment or time instant indicated by the line A, the AND gate 112 does not conduct or transmit a signal although the trigger 108 produces a negative pulse output signal at the time A. This is due to the fact that, at the moment A, the signal generator 222 of the timer 10 provides a signal which is a positive pulse.

At the moment or time instant indicated by the line B, signals supplied to the AND gate 112 are zero from the trigger 106 and negative from the trigger 108. The AND gate 112 therefore transmits an output pulse to the first shift register 114. The shift register 114 stores this signal until it receives a signal from the amplifier 117 and then provides an output signal to the second shift register 115. The output signals of the shift register 114 are shown as pulses 132. The output signals of the shift register 115 are shown as pulses 134. At the time instant C the output signal of the shift register 114 is supplied to the shift register 115 and the shift register 115 supplies an output signal to the output stage 118 until the next signal from the amplifier 117 is supplied to said shift register 115.

At the time instant indicated by the line D, the variable capacitor or signal generator 52 of the pulse shaper 7 provides a second signal which is indicative of a defective article, and said signal is supplied as a zero signal from the trigger 106 and as a negative signal from the trigger 108 to the AND gate 112 so that said AND gate supplies a signal to the first shift register 114. The shift register 114 supplies a signal to the shift register 115 from time D

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to time E. At the time instants D and E the shift register 115 is supplied with a signal from the amplifier 117 and continues to supply a sole signal to the output stage 118. Thus, the shift register 115 actually supplies a single signal of double length to the output stage 118 which extends from the time C to the time F, and such signal causes the ejection of two consecutive articles. The output stage 118 functions to change the magnitude of the signals supplied to it and transmits them to the ejector 12. The output stage 118 may thus comprise any suitable amplifier arrangement.

During the intervals between the time instants indicated by the lines E and F, the variable capacitor or signal generator 52 does not provide an output signal, as shown in the waveform 124. The output stage 118 thus does not produce a signal in the time interval between the time instants indicated by lines F and H. At the time instant indicated by the line G, the logical circuit 8 receives a new signal from the pulse shaper 7, as shown in waveform 124. This signal is converted by the trigger 108 and is supplied to the AND gate 112. The AND gate 112 supplies the signal to the shift register 114, as shown by pulses 130, together with a signal from the amplifier 117. The shift register 114 stores the signal until the time instant indicated by the line H when it receives a signal from the signal generator 222 of the timer 10, and then transmits the signal to the shift register 115. The shift register 115 transmits the signal during the time interval between the time instants indicated by the lines H and I, and the output stage 118 causes the ejector 12 to remove the respective defective article from its normal path.

It is clear that the variable capacitor or signal generator 52 may be used in other types of apparatus, for example, to send signals in response to detection of an unsatisfactory cigarette pack, in response to detection of an unsatisfactory wrapper on a cigarette pack, or in response to detection of another defect.

The ejector 12 is operated in response to such signals which are generated during actual testing of an article. Signals which are generated in the intervals between consecutive testing operations are not transmitted. Such undesirable signals could develop when testing fluid escapes during movement of sleeves 292, 296 to or from sealing portions. The AND gate 112 serves as a means for preventing transmission of undesirable signals to the ejector 12.

The variable capacitor or signal generator 52 of FIG. 2 may be replaced by a signal generator of the type disclosed, for example, in the aforementioned copending application of Julius Hellmann, and the signals produced by the Hellmann generator may then be amplified and delayed in a manner as disclosed in connection with FIGS. 3 to 5. Any suitable signal generator known may be utilized as the signal generator 52.

FIG. 6 shows a portion of a circuit including two pulse shapers 140 and 144 which are connected in parallel. The pulse shaper 140 produces signals when the pressure of testing fluid is higher than a predetermined maximum permissible pressure (e.g., higher than 50 mm. water column), and the pulse shaper 144 produces signals when the pressure of testing fluid is below a minimum permissible pressure (e.g., above a pressure of 20 mm. water column). In order to insure that the pulse shapers 140 and 144 will produce similar signals in response to excessive and insufficient fluid pressures, the circuit of FIG. 6 comprises an inverter 142 which is connected in series with the pulse shaper 140. The output of the inverter 142 is connected with the output of pulse shaper 144 and both outputs are supplied to the trigger 108 of the logical circuit 8 via a lead 146. Thus, the portion of the circuit shown in FIG. 6 may be utilized to replace the pulse shaper 7 of FIG. 4. The remainder of the circuit of FIG. 6 is the same as that of FIG. 4.

The pulse shapers 140 and 144 are assembled in a manner substantially as shown in FIG. 3 with the ex-

ception that the diaphragm of the signal generator in the pulse shaper 144 is adjusted in such a way that the oscillator sends a signal whenever the pressure of testing fluid drops below a permissible minimum pressure. The diaphragm of the pulse shaper 140 will cause the respective signal generator to generate signals whenever the pressure of testing fluid is less than a maximum permissible pressure, and such signals are shifted by the inverter 142 of FIG. 6 so that they have the same polarity as the signals produced by the variable capacitor of the pulse shaper 144. Thus, the inverter 142 may comprise a NOT or inverter circuit, as described and shown in the aforementioned textbooks, or any suitable circuit arrangement which functions to supply a signal to the trigger 108 whenever the pulse shaper 140 does not produce a signal and to supply no signal or a zero signal when the pulse shaper 140 does produce a signal. This means that signals supplied by the pulse shaper 149 and transmitted to the trigger 108 via the lead 146 indicate excessive fluid pressure in the diaphragm chamber of the housing for the pulse shaper 140. The output stage 118 transmits signals whenever the pressure of testing fluid drops below or rises above the permissible pressure range, such pressure range (e.g., between 20-50 mm. water column) being indicative of satisfactory articles. A drop in pressure of testing fluid below the permissible range indicates that a cigarette has a leak, that its wrapper is torn and/or that it contains a filler of loosely compacted tobacco and/or filter particles. A rise in fluid pressure above the permissible range will indicate that the filler is too dense.

FIG. 7 illustrates the housing 150 of a modified signal generator 52a. The housing 150 comprises a cupped section 154 having an open end sealed by a second section or lid 152 secured thereto by screws 152a. The bottom wall 154a of the section 154 is provided with an annular projection 156 which extends toward the lid 152 and surrounds an aperture 154b of the bottom wall 154a. This aperture 154b accommodated an insular 158 having a central bore 158a. The end face of the annular projection 156 abuts against one side of a diaphragm 162 whose marginal portion is clamped between two rings 160, 161 provided with registering bores for bolts 164 which are screwed into the bottom wall 154a. The diaphragm 162 is subjected to initial tension so that its central portion is normally flat. This central portion of the diaphragm 162 is connected with an iron core 166 which projects with clearance into the bore 158a of the insulator 158. The core 166 is surrounded by an induction coil 168.

The central portion of the lid 152 is formed with an inlet to receive the discharge end of a feed conduit 170 serving to admit testing fluid which impinges against the exposed side of the diaphragm 162 and causes it to flex in response to a predetermined pressure. The mantle of the section 154 has an outlet connected to a nozzle 172 whose orifice is smaller than the bore of the feed conduit 170.

The signal generator 52a of FIG. 7 operates as follows:

The testing fluid enters through the feed conduit 170 at a rate which exceeds the rate of outflow through the orifice of the nozzle 172. Consequently, the pressure prevailing in the diaphragm chamber 162a will change in response to changes in the pressure of fluid entering at 170. The diaphragm 162 is flexed in response to such pressure changes and moves the core 166 axially of the coil 168 whereby the inductance of the coil changes proportionally with changes in the pressure of testing fluid. The underside of the diaphragm 162 is subjected to constant pressure, for example, by the provision of one or more openings which admit atmospheric air into the bore 158a.

The signal generator 52a is preferably utilized in testing apparatus which operate with strongly compressed testing fluid.

FIG. 8 shows a dual signal generator 52b accommo-

dated in a housing consisting of two cupped sections 174, 175 sealingly secured to each other by bolts or the like to define a small diaphragm chamber 197. The bottom wall of each section is provided with an annular projection 176, 178 and these projections extend toward but short of each other. Insulators 188, 190 are mounted in the bottom walls of sections 174, 175 in the same way as described in connection with FIG. 7, and each of these insulators has a top face which is closely adjacent to the end face of the respective annular projection. Plate-like electrodes 180, 182 are recessed into the top faces of the insulators 188, 190 in such a way that their exposed sides remain slightly spaced from the corresponding diaphragms 198, 200. The marginal portions of the diaphragms 198, 200 are clamped between rings 192, 193 and 195, 196, and such rings are attached to the respective sections 174, 175 by bolts 202. Thus, the diaphragms 198, 200 are subjected to initial tension by being biased against the end faces of the projections 176, 178. These diaphragms form with the electrode plates 180, 182 a pair of variable capacitors and are separated from the respective electrodes by narrow air gaps analogous to the gap 39 shown in FIG. 2. Bores 204 in the insulators 188, 190 allow atmospheric air to flow to the concealed sides of the diaphragms 198, 200.

The section 174 is formed with an inlet which receives the discharge end of a feed conduit 206, and the section 175 is provided with an outlet which communicates with the orifice of a nozzle 208. The orifice of the nozzle 208 is smaller than the bore of the feed conduit 206.

The testing fluid enters through the conduit 206 and the diaphragms 198, 200 are flexed in response to changes in fluid pressure. Such changes in fluid pressure will be felt because the orifice of the nozzle 208 is smaller than the bore of the conduit 206. The capacity of the capacitors including the diaphragms 198, 200 and electrodes 180, 182 changes in accordance with and proportionally to changes in the pressure of testing fluid. The leads 184, 186 conduct signals to the coil 53 (see FIG. 3).

Since the volume of the chamber 197 is small, the diaphragms 198, 200 will be flexed in response to minimal changes in the pressure of testing fluid.

If the diaphragms 198, 200 are to produce signals in response to different pressures of testing fluid, one of the diaphragms may be coated with a layer of dielectric material which abuts against the electrode plate 180 or 182 and prevents further flexing of the respective diaphragm while the other diaphragm continues to undergo deformation in response to increasing pressure of testing fluid. The oscillator of the other diaphragm then continues to oscillate.

A suitable timer 10 is illustrated in FIG. 9. The numeral 210 denotes a drum-shaped conveyor (corresponding to the conveyor 294 of FIG. 1) whose periphery is provided with axially extending pockets or holders 210a serving to accommodate cigarettes or other articles which are tested by the device including the structure shown in FIGS. 2, 7 or 8. The lands 210b between the adjoining pockets 210a are formed with protuberances in the form of cams 212 which rock one arm 218 of a two-armed lever 216. The lever 216 is pivotable about the axis of a fixed shaft 214 and its other arm 220 may extend into a slot 222a provided at one end of the signal generator 222. The tip of the arm 220 will extend into the slot 222a when the lever 216 has been rocked in a counterclockwise direction, as the parts appear in FIG. 9, and through a maximum angle, i.e., just before the tip of the arm 218 is released by the nearest cam 212. The signal generator 222 may be of the type produced by AEG and sold under the factory number SJ1. A torsion spring 224 returns the lever 216 to its starting position following disengagement of the arm 218 from one of the cams 212. One end of the spring 224 is anchored in the shaft 214 and its other end bears against the arm 220, thus tending to pivot the lever 216 in a clockwise direction. A fixed stop 225 is

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located in the path of the arm 220 and arrests the lever 216 in its starting position into which the lever moves in response to the bias of the return spring 224. In other words, when the lever 216 abuts against the stop 225, the arm 220 is withdrawn from the slot 222a.

The arrow 210c indicates the direction in which the conveyor 210 rotates to advance the cams 212 past the arm 218 of the lever 216. Each pocket 210a accommodates a cigarette which is being tested at the testing station, not shown in FIG. 9. Each cam 212 entrains the arm 218 and causes the lever 216 to pivot in a counter-clockwise direction and to move away from the stop 225 against the bias of the return spring 224 whereby the arm 220 enters the slot 222a of the signal generator 222. This signal generator sends a signal to the logical circuit 8 while the arm 220 extends into the slot 222a, namely, whenever an article either enters or leaves the testing station.

It is clear that the signal generator of FIG. 9 may be modified or replaced by a different signal generator. For example, the conveyor 210 may drive a shaft which performs one revolution during the intervals between entry of two consecutive articles into the testing station. The shaft carries an angularly adjustable cam which enters the slot 222a during each revolution of the shaft to thereby produce a signal which is supplied to the trigger 106. In such signal generators, the exact timing of signals to the trigger 106 may be regulated by changing the angular position of the cam.

The circuit of FIG. 10 comprises the same basic components as the circuit of FIG. 1a with the exception that the oscillator 226 receives signals from a testing device which includes the signal generator 52a of FIG. 7. An amplifier 228 is connected to the output of the oscillator 226, a rectifier 230 is connected to the output of the amplifier 228, a logical circuit 232 is connected to the output of the rectifier 230 and an ejector 236 is connected to the output of the logical circuit 232. A timer 234 is connected to the logical circuit 232. The two resonant circuits of the oscillator 226 are balanced in the same way as described in connection with FIGS. 3 and 3a. If the pressure of testing fluid drops below a predetermined pressure range, the oscillator 226 ceases to oscillate and supplies to the amplifier 228 a signal which is indicative of a defective article. The rectifier 230 rectifies the signal and sends it to the logical circuit 232 which treats such signal in the manner described in connection with FIG. 5. The ejector 236 removes the defective article from the pocket 210a of the conveyor 210.

FIG. 11 illustrates a circuit comprising an oscillator 240, a capacitive bridge circuit 242 connected to the output of the oscillator 240, an amplifier 244 connected to the output of the bridge circuit 242, a rectifier 246 connected to the output of the amplifier 244, a logical circuit 248 connected to the output of the rectifier 246 and an ejector 250 connected to the output of the logical circuit 248. A timer 252 is connected to the logical circuit 248. The oscillator 240 is of conventional design and continuously produces an AC output. The bridge circuit 242 includes a variable diaphragm capacitor 254 which corresponds, for example, to the variable capacitor 52 of FIG. 2, a variable capacitor 256, and two resistors 258 and 259. One output terminal 260 of the diagonal branch of the bridge circuit 242 is grounded and the other output terminal 262 is connected to the input of the amplifier 244 which includes three transistors 266, 267 and 268. A variable resistor 264 is connected between the output terminal 262 and the base of the first transistor 266. The collectors of the transistors 267 and 268 are connected to a DC power source (not shown) and the emitters of said transistors are connected to ground. Resistors 270 and 271 are respectively connected between ground and the emitters of the transistors 266 and 268. A resistor 272 is connected between the col-

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lector of the transistor 267 and the DC power source (not shown). The base of the transistor 267 is connected to the emitter of the transistor 266 and the base of the transistor 268 is connected to the collector of the transistor 267. The emitter of the transistor 268 is connected to the rectifier 246 which may be similar to the rectifier 4 of FIG. 3. The logical circuit 248 and the timer 252 respectively correspond to their counterparts 8 and 10 of FIG. 4.

The circuit of FIG. 11 operates as follows:

The oscillator 240 supplies to the bridge circuit 242 a high-frequency AC current. If the pressure of testing fluid remains within the desired range, the capacity of the diaphragm capacitor 254 also remains within the desired range. The bridge circuit 242 is balanced for such pressure range by suitable adjustment of the variable capacitor 256. If the capacity of the diaphragm capacitor 254 changes in response to excessive changes in the pressure of testing fluid (such as will be indicative of a defective article), a voltage is produced at output terminals 260, 262 of the diagonal branch of the bridge circuit 242 due to unbalance of said bridge circuit, so that a current is supplied to the amplifier 244. The variable resistor 264 permits the magnitude of the current to be amplified by the amplifier 244 to be varied; that is, the resistor is utilized to prevent amplification of any current signals which are indicative of satisfactory articles. The signals which are permitted to pass through the variable resistor 264 are amplified in the amplifier 244 and are then rectified by the rectifier 246. The rectified signals are supplied to the logical circuit 248 which feeds them on to the ejector 250 during a full time interval between two consecutive signals from the timer 252. Thus, the operation of the logical circuit 248 is the same as that of the logical circuit 8 of FIG. 4. Consequently, the ejector 250 can effect removal of a defective article during the entire interval between entry of two consecutive articles into the testing station.

FIG. 12 shows a portion of the circuit of FIG. 11 with a modified bridge circuit 274. The bridge circuit 274 includes a signal generator 276 corresponding to the signal generator 52a of FIG. 7, a variable inductance 278 and two fixed resistors 279 and 280. One output terminal 282 of the bridge circuit 274 is grounded and the other output terminal 283 of the bridge circuit is connected to the amplifier 244. The remainder of the circuit of FIG. 12 is similar to the circuit of FIG. 11. The operation of the modified circuit of FIG. 12 is also analogous to that of the circuit of FIG. 11 with the exception that the changes in inductance of the signal generator 276 of FIG. 12 correspond to changes in the capacity of the variable capacitor 254 of FIG. 11.

The bridge circuit 274 is utilized in testing apparatus which operate with strongly compressed testing fluid and wherein the range of pressures which cause the generation of a signal is rather narrow.

FIG. 13 shows a portion of the circuit of FIG. 11 with a further modified bridge circuit 286. In FIG. 13, the oscillator 240 and the remainder of the circuit (not shown) is similar to the circuit of FIG. 11. That is, the amplifier 288 is connected to a rectifier corresponding to the rectifier 246, the rectifier is connected to a logical circuit, and the logical circuit is connected to an ejector and with a timer. The bridge circuit 286 of FIG. 13 includes two variable induction coils 284 and 285 which are connected in parallel with the variable capacitors 254 and 256. The amplifier 288 corresponds to the amplifier 244 of FIG. 11, but does not include the variable resistor 264. The resonance band in which the bridge circuit 286 is tuned may be widened by the variable inductances 284 and 285. Since the inductance of the coils 284 and 285 may vary, the range between the maximum and minimum permissible pressures of testing fluid may be selected by proper adjustment of said coils. In other words, the coils

284 and 285 perform the same function as the variable resistor 264 of the amplifier 244 of FIG. 11.

FIG. 14 illustrates a further modification of my testing apparatus. This apparatus comprises a drum-shaped conveyor 302 having axially parallel pockets or holders 304 which accommodate cigarettes 306 or similar articles to be tested. The conveyor 302 rotates about an axis which is parallel to the longitudinal extensions of the pockets 304 and carries pairs of aligned coupling sleeves 306, 307 (only one pair shown). The sleeves are reciprocable in directions indicated by double-headed arrows so that they may engage or release the end portions of the respective articles 316. The sleeve 306 constitutes a sealing plug for the right-hand end of the respective article 316, but the sleeve 307 is provided with a passage which introduces into the wrapper of the article 316 a stream of testing fluid flowing from a source 312 and through a supply conduit 310. The conduit 310 has a branch 310a which corresponds to the feed conduit 24 of FIG. 2 and delivers testing fluid into the chamber of a housing 314 corresponding to the housing 13 of FIG. 2 and containing a signal generator in the form of a variable capacitor 52 or a variable inductance 52a.

The source 312 discharges a stream of testing fluid at constant pressure, and such fluid travels through the supply conduit 310, through the sleeve 307 and into the wrapper of the article 316. Since the fluid cannot escape from the sleeve 306, it exerts a pressure against the internal surface of the wrapper on the article 316 and some such fluid will escape through the pores of the wrapper. The thus evacuated portion of the fluid stream is replaced by the source 312 so that the conduits 310, 310a normally contain fluid which is maintained at constant pressure. However, if the wrapper of the article 316 has a leak, the quantity of testing fluid which escapes after passing through the sleeve 307 exceeds a predetermined quantity and the pressure in the housing 314 drops. In other words, whenever the wrapper of the article has a leak, the source 312 delivers less fluid than the total quantity of fluid which escapes through the pores of a satisfactory wrapper; therefore, the pressure in the conduits 310, 310a drops and the signal generator in the housing 314 produces a signal which is then utilized to eject the defective article in the same way as described, for example, in connection with FIGS. 2 to 5. In this embodiment of my invention, the housing 314 does not have an outlet (see the nozzle 26 in FIG. 2) because such outlet is replaced by the pores of the wrapper on the article 316.

Referring finally to FIG. 15, there is shown a portion of a further testing apparatus which comprises a housing 320 defining an internal chamber 320a and having a side wall 324 provided with a bore for a reciprocable plunger 322. The plunger 322 has a stop collar 326 which is located in the chamber 320a and serves as a retainer for one end of a helical expansion spring 328 tending to bias the collar 326 toward and into abutment with the side wall 324. The other end of the spring 328 bears against the opposite side wall 324a of the housing 320.

The piston 322 is formed with an axially extending bore 330 which communicates with a radially extending port 332 normally located in the chamber 320a or within the confines of the apertured side wall 322. The piston 322 constitutes a sensing element and is provided with a rounded head 322a which comes in engagement with the corresponding end of an article 342, e.g., a cigarette rod or a filter cigarette of unit length or double unit length. The head 322a seals the outer end of the axial bore 330 so that the testing fluid cannot escape from the piston 322 excepting in response to such axial displacement that the port 322 is free to communicate with the atmosphere.

The side wall 324a is connected with two conduits 334, 336 which communicate with the chamber 320a. The conduit 334 is a supply conduit and is connected with a source 338 of testing fluid. The conduit 336 is a feed

conduit and is connected with a housing 340 corresponding to the housing 13 of FIG. 2.

The apparatus of FIG. 15 tests the density of tobacco or filter material at the right-hand end of the article 342. If the wrapper of the article 342 is properly filled with tobacco or filter material, the axial movement of the piston 322 is limited so that the port 332 cannot communicate with the atmosphere. If the filler of the article 342 is too loose or if the right-hand end of the article 342 is empty, the head 322a of the piston 322 penetrates into the wrapper and the port 332 advances beyond the side wall 324 so that some testing fluid will escape from the chamber 320a. The source 338 delivers testing fluid at a constant rate so that the pressure in the housing 340 drops as soon as the port 332 is permitted to communicate with the atmosphere. The signal generator in the housing 340 then produces a signal which is utilized to eject the defective article with a requisite delay.

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 this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. An apparatus for testing the integrity of cigarettes and similar rod-shaped articles, comprising conveyor means for moving the articles seriatim in a predetermined path through and past a testing station; first signal generating means for producing signals at the rate at which the articles travel through said station; testing means for testing the articles at said station with a testing fluid whose characteristics are indicative of the quality of tested articles, said testing means comprising second signal generating means for producing signals in response to such changes in the characteristics of testing fluid which are outside of a predetermined range indicative of satisfactory articles; ejector means located past said station and operative to remove defective articles from said path; and a signal storage arrangement for receiving said signals and for operating said ejector means during intervals between consecutive signals from said first signal generating means following a signal from said second signal generating means.

2. An apparatus as defined in claim 1, wherein said conveyor means is arranged to move a series of equidistant articles sideways and wherein said testing means comprises means for conveying testing fluid axially through the articles during travel of articles through said testing station, said testing means further comprising means for measuring changes in the characteristics of testing fluid in response to introduction of such fluid into the articles and said second signal generating means being operative to produce said signals when the result of a measurement indicates that the testing fluid has been introduced into a defective article.

3. An apparatus for testing the integrity of cigarettes and similar rod-shaped articles, comprising conveyor means for moving the articles seriatim in a predetermined path through and past a testing station; first signal generating means for producing electric signals at the rate at which the articles travel through said station; testing means for testing the articles at said station with a testing fluid whose characteristics are indicative of the quality of tested articles, said testing means comprising second signal generating means for producing electric signals in response to such changes in the characteristics of testing fluid which are outside of a predetermined range indicative of satisfactory articles; amplifier means for amplifying the signals from said second signal generating means; ejector means located past said station and opera-

tive to remove defective articles from said path; and a signal storage arrangement for receiving said signals and for operating said ejector means during intervals between consecutive signals from said first signal generating means following an amplified signal from said second signal generating means.

4. An apparatus as set forth in claim 3, wherein said signal storage arrangement comprises a logical circuit including a pair of serially connected shift registers each connected with said first signal generating means, one of said shift registers being connected with said ejector means and the other shift register being connected with said second signal generating means.

5. An apparatus as set forth in claim 4, wherein said logical circuit further includes an output stage connected between said one shift register and said ejector means, a first bistable multivibrator connected between said first signal generating means and said shift registers, second amplifier means connected between said first multivibrator and said shift registers, a second bistable multivibrator connected between said second signal generating means and said other shift register, and an AND gate connected between said second multivibrator and said one shift register.

6. An apparatus as set forth in claim 5, further comprising lead means connecting said first bistable multivibrator with said AND gate.

7. An apparatus as set forth in claim 5, further comprising signal delaying means provided between said output stage and said ejector means.

8. An apparatus for testing the integrity of cigarettes and similar rod-shaped articles, comprising conveyor means for moving the articles seriatim in a predetermined path through and past a testing station; first signal generating means for producing signals at the rate at which the articles enter said station; testing means for testing the articles at said station with a testing fluid whose characteristics are indicative of the quality of tested articles, said testing means comprising second signal generating means for producing signals in response to such change in the characteristics of testing fluid which are outside of a predetermined range indicative of satisfactory articles; ejector means located past said station and operative to remove defective articles from said path; and a signal storage arrangement for receiving said signals and for operating said ejector means during intervals between consecutive signals from said first signal generating means following a signal from said second signal generating means.

9. An apparatus for testing the integrity of cigarettes and similar rod-shaped articles, comprising conveyor means for moving the articles seriatim in a predetermined path through and past a testing station; first signal generating means for producing signals at the rate at which the articles travel through said station; testing means for testing the articles at said station with a testing fluid whose characteristics are indicative of the quality of tested articles, said testing means comprising second and third signal generating means for producing signals in response to such changes in the characteristics of testing fluid which are respectively below the lower and upper limits of a predetermined range indicative of satisfactory articles; ejector means located past said station and operative to remove defective articles from said path; a signal storage arrangement for receiving said signals and for operating said ejector means during intervals between consecutive signals from said first signal generating means following a signal from one of said second and third signal generating means; and inverter means connected between said signal storage arrangement and said third signal generating means for producing signals in response to absence of signals from said third signal generating means so that signals produced by said inverter means are indicative of changes in the characteristics of testing fluid above the upper limit of said predetermined range.

10. An apparatus for testing the integrity of cigarettes and similar rod-shaped articles, comprising conveyor means for moving the articles seriatim in a predetermined path through and past a testing station; first signal generating means for producing signals at the rate at which the articles travel through said station; testing means for testing the articles at said station with a testing fluid whose pressure is indicative of the quality of tested articles, said testing means comprising a housing defining a chamber having an inlet for entry of testing fluid and a restricted outlet for such fluid, and second signal generating means including a diaphragm bounding a portion of said chamber and arranged to be flexed by testing fluid to produce electric signals in response to such changes in fluid pressure which are outside of a predetermined range indicative of satisfactory articles; ejector means located past said station and operative to remove defective articles from said path; and a signal storage arrangement for receiving said signals and for operating said ejector means during intervals between consecutive signals from said first signal generating means following a signal from said second signal generating means.

11. An apparatus as set forth in claim 10, wherein said second signal generating means is a variable capacitor and said diaphragm constitutes one plate of said variable capacitor.

12. An apparatus as set forth in claim 11, wherein said testing means comprises oscillator means including a plurality of resonant circuits and wherein said variable capacitor is connected in one of said resonant circuit.

13. An apparatus as set forth in claim 11, wherein said testing means comprises a bridge circuit and wherein said variable capacitor is connected in one branch of said bridge circuit.

14. An apparatus as set forth in claim 10, wherein said second signal generating means further comprises an induction coil and a core connected to said diaphragm and extending into said coil so that the inductance of said coil changes in response to flexing of said diaphragm.

15. An apparatus as set forth in claim 14, wherein said second signal generating means comprises oscillator means having a plurality of resonant circuits and wherein said coil is connected in one of said resonant circuits.

16. An apparatus as set forth in claim 14, wherein said second signal generating means comprises a bridge circuit and wherein said coil is connected in one branch of said bridge circuit.

17. An apparatus for testing the integrity of cigarettes and similar rod-shaped articles, comprising conveyor means for moving the articles seriatim in a predetermined path through and past a testing station; first signal generating means for producing signals at the rate at which the articles travel through said station; testing means for testing the articles at said station with a testing fluid whose pressure is indicative of the quality of tested articles, said testing means comprising a housing defining a chamber having an inlet for entry of testing fluid and a restricted outlet for such fluid, said housing comprising an annular portion extending into said chamber, and second signal generating means including a diaphragm overlying said annular portion in said chamber and means for biasing said diaphragm against said annular portion, said diaphragm bounding a portion of said chamber and being arranged to be flexed by testing fluid to produce electric signals in response to such changes in fluid pressure which are outside of a predetermined range indicative of satisfactory articles; ejector means located past said station and operative to remove defective articles from said path; and a signal storage arrangement for receiving said signals and for operating said ejector means during intervals between consecutive signals from said first signal generating means following a signal from said second signal generating means.

18. An apparatus as set forth in claim 17, further com-

prising means for regulating the initial tension of said diaphragm.

19. An apparatus for testing the integrity of cigarettes and similar rod-shaped articles, comprising conveyor means for moving the articles seriatim in a predetermined path through and past a testing station; first signal generating means for producing signals at the rate at which the articles travel through said station; testing means for testing the articles at said station with a testing fluid whose pressure is indicative of the quality of tested articles, said testing means comprising a housing defining a chamber having an inlet for entry of testing fluid and a restricted outlet for such fluid, and second signal generating means including a diaphragm bounding a portion of said chamber and arranged to be flexed by testing fluid to produce electric signals in response to such changes in fluid pressure which are outside of a predetermined range indicative of satisfactory articles, said housing comprising a removable portion for affording access to said diaphragm; ejector means located past said station and operative to remove defective articles from said path; and a signal storage arrangement for receiving said signals and for operating said ejector means during intervals between consecutive signals from said first signal generating means following a signal from said second signal generating means.

20. An apparatus for testing the integrity of cigarettes and similar rod-shaped articles, comprising conveyor means for moving the articles seriatim in a predetermined path through and past a testing station; first signal generating means for producing signals at the rate at which the articles travel through said station; testing means for testing the articles at said station with a testing fluid whose pressure is indicative of the quality of tested articles, said testing means comprising a housing defining a chamber having an inlet for entry of testing fluid and a restricted outlet for such fluid, and second signal generating means including a diaphragm bounding a portion of said chamber and arranged to be flexed by testing fluid to produce electric signals in response to such changes in fluid pressure which are outside of a predetermined range indicative of satisfactory articles, said housing having window means located substantially opposite and permitting observation of said diaphragm; ejector means located past said station and operative to remove defective articles from said path; and a signal storage arrangement for receiving said signals and for operating said ejector means during intervals between consecutive signals from said first signal generating means following a signal from said second signal generating means.

21. An apparatus for testing the integrity of cigarettes and similar rod-shaped articles, comprising conveyor means for moving the articles seriatim in a predetermined path through and past a testing station; first signal generating means for producing signals at the rate at which the articles travel through said station; testing means for testing the articles at said station with a testing fluid whose pressure is indicative of the quality of tested articles, said testing means comprising a housing defining a chamber having an inlet for entry of testing fluid and an outlet for such fluid, nozzle means detachably received in said outlet for restricting the outflow of testing fluid from said chamber, and second signal generating means including a diaphragm bounding a portion of said chamber and arranged to be flexed by testing fluid to produce electric signals in response to such changes in fluid pressure which are outside of a predetermined range indicative of satisfactory articles; ejector means located past said station and operative to remove defective articles from said path; and a signal storage arrangement for receiving said signals and for operating said ejector means during intervals between consecutive signals from said first signal generating means following a signal from said second signal generating means.

22. An apparatus for testing the integrity of cigarettes and similar rod-shaped articles, comprising conveyor means for moving the articles seriatim in a predetermined path through and past a testing station; first signal generating means for producing signals at the rate at which the articles travel through said station; testing means for testing the articles at said station with a testing fluid whose pressure is indicative of the quality of tested articles, said testing means comprising a housing defining a chamber having an inlet for entry of testing fluid and a restricted outlet for such fluid, and a second signal generating means including a plurality of diaphragms each bounding a portion of said chamber and arranged to be flexed by testing fluid to produce electric signals in response to such changes in fluid pressure which are outside of a predetermined range indicative of satisfactory articles; ejector means located past said station and operative to remove defective articles from said path; and a signal storage arrangement for receiving said signals and for operating said ejector means during intervals between consecutive signals from said first signal generating means following a signal from said second signal generating means.

23. An apparatus for testing the integrity of cigarettes and similar rod-shaped articles, comprising conveyor means for moving the articles seriatim in a predetermined path through and past a testing station; first signal generating means for producing signals at the rate at which the articles travel through said station; testing means for testing the articles at said station with a testing fluid whose pressure is indicative of the quality of tested articles, said testing means comprising a housing defining a pair of separate chambers, one of said chambers having an inlet for entry of testing fluid and a restricted outlet for such fluid, second signal generating means including a diaphragm bounding a portion of said chamber and arranged to be flexed by testing fluid to produce electric signals in response to such changes in fluid pressure which are outside of a predetermined range indicative of satisfactory articles, a plurality of electrical units including signal rectifying means provided in the other of said chambers and connected with said second signal generating means; ejector means located past said station and operative to remove defective articles from said path; and a signal storage arrangement for receiving signals from said first signal generating means and from said electrical units and for operating said ejector means during intervals between consecutive signals from said first signal generating means following a signal from said units.

24. An apparatus for testing the integrity of cigarettes and similar rod-shaped articles, comprising conveyor means for moving the articles seriatim in a predetermined path through and past a testing station; first signal generating means for producing signals at the rate at which the articles travel through said station; testing means for testing the articles at said station with a testing fluid whose pressure is indicative of the quality of tested articles, said testing means comprising a housing defining a chamber having an inlet for entry of testing fluid and a restricted outlet for such testing fluid, and second signal generating means including oscillator means having a pair of resonant circuits, one of said circuits comprising a first variable capacitor for varying the resonance curve of said one circuit and the other circuit comprising a second variable capacitor including a diaphragm bounding a portion of said chamber and arranged to be flexed by testing fluid to produce electric signals in response to such changes in fluid pressure which are outside of a predetermined range indicative of satisfactory articles, and means for subjecting said diaphragm to such initial tension that the resonance curve of said other circuit cannot fully coincide with the resonance curve of said one circuit; ejector means located past said station and operative to remove defective articles from said path; and a signal storage arrangement for receiving said signals and for operating said ejector means during intervals between consecutive signals from

said first signal generating means following a signal from said second signal generating means.

25. In a device for testing the integrity of cigarettes and similar rod-shaped articles by means of a testing fluid whose pressure changes are indicative of the quality of tested articles, a housing defining a chamber having an inlet for entry of testing fluid and a restricted outlet of unvarying size for such fluid; and electric signal generating means including a diaphragm provided in said housing and bounding a portion of said chamber, said inlet and said outlet being provided at the same side of said diaphragm and said diaphragm being arranged to be flexed by testing fluid flowing from said inlet to said outlet to produce electric signals in response to predetermined changes in fluid pressure.

26. A structure as set forth in claim 25, further comprising adjustable tensioning means for subjecting said diaphragm to initial tension and means for adjusting said tensioning means.

27. A structure as set forth in claim 25, wherein said housing comprises an annular portion extending into said chamber and said diaphragm overlies said annular portion, the flexing of that zone of said diaphragm which is located within the confines of said annular portion being utilized to produce said electric signals.

28. A structure as set forth in claim 25, further comprising detachable nozzle means provided in said outlet for regulating the rate at which testing fluid escapes from said chamber.

29. A structure as set forth in claim 25, wherein said signal generating means comprises a variable capacitor and wherein said diaphragm constitutes one plate of said variable capacitor.

30. A structure as set forth in claim 25, wherein said signal generating means further comprises a fixed induction coil and a core extending into said coil and secured to said diaphragm so that flexing of said diaphragm will change the inductance of said coil.

31. A structure as set forth in claim 25, wherein said housing comprises a removable portion to afford access to said diaphragm and a window located substantially opposite and arranged to permit observation of said diaphragm.

32. A structure as set forth in claim 25, further comprising a second diaphragm bounding a second portion of said chamber and arranged to be flexed with said first named diaphragm said inlet and said outlet being located at the same side of said second diaphragm.

33. A method of testing the integrity of cigarettes and similar discrete rod-shaped articles, comprising conveying the articles sideways in a predetermined path through and past a testing station and holding the articles against axial movement during travel through said testing station; testing the articles at said station by a conveying therethrough a testing fluid whose characteristics are indicative of the quality of tested articles; generating a signal in response to each such change in the characteristics of testing fluid which is outside of a predetermined range indicative of satisfactory articles; delaying the signal until an article trailing the tested defective article enters said station; and utilizing the thus delayed signal to eject the defective article from said path.

34. A method of testing the integrity of cigarettes and similar rod-shaped articles normally having only two spaced openings connected by a restricted flow path whereby the flow path in a satisfactory article offers to a testing fluid a resistance which is different from the resistance offered by the flow path of a defective article, comprising conveying a series of equidistant articles sideways in a predetermined path through and past a testing station and holding the articles against axial movement during travel through said testing station; testing the articles seriatim at said station with consecutive streams of a testing fluid by sending such streams through the flow paths in the respective articles during first intervals of pre-

terminated length whereby the changes in characteristics of fluid streams are indicative of the quality of tested articles measuring the changes in said characteristics during said first intervals; generating a signal in response to such changes in the characteristics of said fluid streams which are outside of a predetermined range indicative of satisfactory articles; delaying the signal; and utilizing the thus delayed signal to eject the defective article from said path during a second interval of predetermined length.

35. A method as defined in claim 34, wherein such change in the characteristics of a fluid stream which is outside of said predetermined range takes place during a fraction of the respective first interval.

36. A method as defined in claim 34, wherein the length of said second intervals equals the length of said first intervals.

37. A method as defined in claim 34, wherein defective articles are ejected from a predetermined portion of said path and wherein each of said signals is delayed for such a period of time that a satisfactory article preceding a defective article advances beyond said predetermined portion of the path.

38. A method as defined in claim 34, wherein said measuring and signal generating steps are completed during a fraction of the respective first interval.

39. A method of testing the integrity of cigarettes and similar rod-shaped articles, comprising conveying the articles seriatim in a predetermined path through and past a testing station; testing the articles at said station with a testing fluid whose characteristics are indicative of the quality of tested articles; generating a signal of unit length in response to such changes in the characteristics of testing fluid which, during testing of a single article, are outside of a predetermined range indicative of satisfactory articles; delaying the signal until an article trailing the tested defective article enters said station; utilizing the thus delayed signal to eject the defective article from its path; generating a signal of multiple unit length in response to each such change in the characteristics of testing fluid which during testing of a series of consecutive articles, is outside of said predetermined range; delaying the signal of multiple unit length until an article trailing said series of tested defective articles enters said station; and utilizing said signal of multiple unit length to eject said series of tested defective articles from their path.

40. A method of testing the integrity of cigarettes and similar rod-shaped articles normally having only two spaced openings connected by a restricted flow path whereby the flow path in a satisfactory article offers to a testing fluid a resistance which is different from the resistance offered by the flow path of a defective article, comprising conveying a series of equidistant articles sideways in a predetermined path through and past a testing station; testing the articles seriatim at said station with consecutive streams of a testing fluid by sending such streams through the flow paths in the respective articles during first intervals of predetermined length whereby the changes in characteristics of fluid streams are indicative of the quality of tested articles; measuring the changes in said characteristics during said first intervals; generating a signal in response to such changes in the characteristics of said fluid stream which are outside of a predetermined range indicative of satisfactory articles; delaying the signal; utilizing the thus delayed signal to eject the defective article from said path during a second interval of predetermined length; and combining signals produced during a successive first intervals into a single signal.

41. A method of testing cigarettes and similar rod-shaped articles normally having only two spaced openings connected by a restricted flow path whereby the flow path in a satisfactory article offers to a testing fluid a resistance which is different from the resistance offered by the flow path of a defective article, comprising conveying a series of equidistant articles sideways in a predetermined path through and past a testing station; testing the articles

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seriatim at said station with consecutive streams of a testing fluid by sending such streams through the flow paths in the respective articles during first intervals of predetermined length whereby the changes in characteristics of fluid streams are indicative of the quality of tested articles; measuring the changes in said characteristics during said first intervals; generating an electrical signal in response to such changes in the characteristics of said fluid streams which are outside of a predetermined range indicative of satisfactory articles; delaying the signal; utilizing the thus delayed signal to eject the defective article from said path during a second interval of predetermined length; and converting said signals into a square wave.

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