

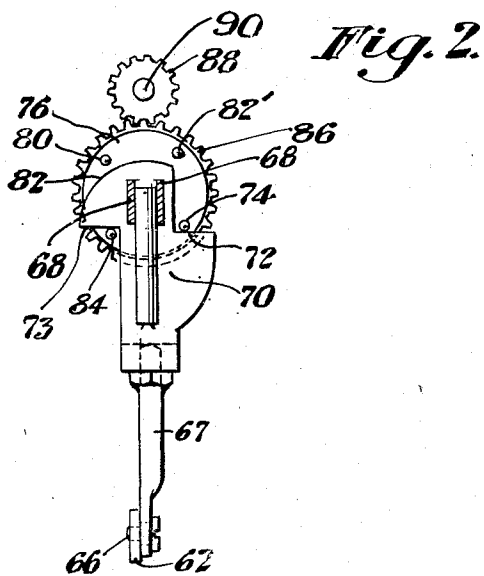
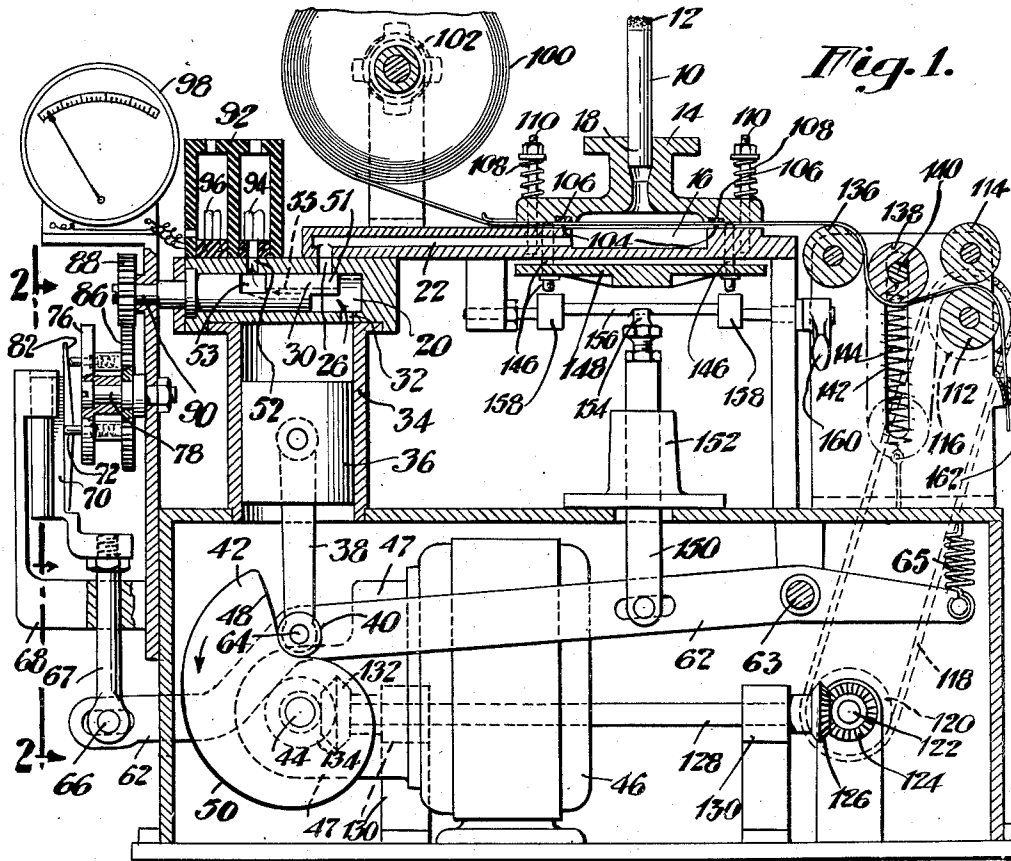
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APPARATUS FOR TESTING CIGARETTES AND THE LIKE

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APPARATUS FOR TESTING CIGARETTES AND THE LIKE

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The present invention relates to cigarette and cigar testing, and more particularly to apparatus adapted for analyzing the smoke from cigarettes and cigars.

The invention can best be understood from the following description taken in connection with the drawing, in which:

Fig. 1 is a view of the apparatus in vertical section, with parts shown in elevation; and

Fig. 2 is a vertical front elevation view of a plunger element of the apparatus taken on the line 2—2 of Fig. 1.

For convenience of description, the apparatus will be described in reference to its use in analyzing the smoke from a cigarette, although it is to be understood that smoke from cigars and pipes can be analyzed in a like manner.

Referring to the drawing, 10 is a cigarette, an end 12 of which is lighted prior to its being placed in a cigarette holder or smoking block 14. The holder 14 is designed as a separate cap closure for a chamber 16 into which smoke is drawn from the unlighted end 18 of the cigarette. The chamber 16 is connected with a valve housing 20 chamber 20 by a conduit 22. The conduit 22 opens into the valve chamber 20 adjacent a rotatably mounted valve 30. Chamber 20 is located directly above and connected by a port 32 with a pump cylinder 34. A piston 36 mounted within cylinder 34 has a connecting rod 38 which, extends down through the cylinder and a roll 40 mounted on the rod, bears on the face of a cam 42. The downstroke of piston 36 is the puff stroke to draw smoke from the burning cigarette through passageway 22 past the valve chamber 20, and into the cylinder 34. The speed with which the puff is effected is controlled by the contour of cam 42. Cam 42 is fixed on a shaft 44 which is in turn driven by a constant speed motor 46. A speed reduction mechanism enclosed in a housing 47 of motor 46 is directly geared to the shaft 44. The speed of the shaft is preferably so regulated that the cam 42 completes one revolution each thirty seconds. The down-stroke or suction stroke of piston 36 is preferably timed to take about two seconds while the roller 40 is riding over a section 48 of the cam surface.

The two-second suction stroke was chosen to simulate the time consumed by the average puff of many smokers. The up-stroke or exhaust stroke of the pump proceeds while the roller 40 is riding over a surface 50 of cam 42, the upstroke taking about 28 seconds. The surface 50 connects with both ends of the surface 48. While the roller is riding over the surface 50 the piston 36 is gradually raised in the cylinder thereby forcing the smoke contained in cylinder 34 through port 32 into chamber 20.

5 The primary object of the invention is to provide an apparatus adapted for making uniform comparable tests of cigarettes and cigars with respect to their smoking properties and products of combustion present in their smoke.

10 Another object of the invention is to provide in a smoke testing apparatus, means for obtaining comparable visual records of condensable constituents present in the smoke of different cigarettes.

15 Another object is to provide means whereby comparable measurements can be made of the relative smoke producing capacities of different tobacco fillings, as for example by keeping records of the number of uniform puffs of smoke obtainable from each of several different cigarettes.

20 A particular object of the invention is to provide an apparatus which will smoke a cigarette at a rate simulating the normal smoking rate, and analyze the smoke therefrom for deleterious combustible components such as carbon monoxide.

25 The principal features of the preferred form of the smoke testing apparatus comprise a suction pump, a cigarette holder, a gas analyzer, and a conduit connecting these elements in such a way that smoke from a cigarette is drawn or forced through the analyzer by the operation of the pump.

30 The pump is preferably actuated on a cycle which will produce a rapid puff or suction stroke, followed by a slow discharge stroke, for the purpose of simulating normal smoking conditions. The gas analyzer preferably analyzes the gas discharged by the pump on the exhaust stroke.

40 The ratio of velocity of flow to volume of the gas during this slow exhaust stroke of the pump is low enough to allow a combustion analysis to reach equilibrium conditions in the gas analyzer.

45 The present apparatus is operative to apply a suction puff to the unlighted end of a lighted cigarette, draw a sample of the smoke of combustion through a tar filter, and thence past an inlet valve into the cylinder of a suction pump. Following the puff intake stroke of the suction pump there is an exhaust stroke during which the sample of smoke is forced from the pump cylinder through a valve controlled exhaust port into a gas analyzer. During this exhaust stroke the tar filter may be changed preparatory to a new puff cycle.

The movement of the smoke into and out of the cylinder 34 is controlled by the rotary valve 30. The valve 30 has a semi-cylindrical portion 51 which is arranged to cover the port 26 during one half of the revolution of the valve, and a slotted portion 53 which is arranged to cover an outlet port 52 during a half revolution of the valve 30. The cut-away portion of the valve 30 adjacent the portion 51 is opposite the port 26 to allow smoke to enter the valve chamber 20 during the puff or suction stroke. At this time a portion of the valve 30 is closing the port 52. An axial bore 55 in the valve 30 extends from the portion 51 to the portion 53 of the valve. This bore allows communication between the valve chamber 20 and the portion 53 by which smoke exhausts from the cylinder 34 and passes out through the port 52 during the exhaust or up-stroke of the piston.

In order to synchronize rotation of the valve 30 with the movement of piston 36 so as to close port 26 as smoke is being exhausted from chamber 34, a connecting link mechanism is provided between piston 36 and said valve. The preferred link mechanism includes an arm 62 pivoted near one end to a shaft 63 and carrying near the other end the roller 40 mounted on a pin 64. The roller 40 is yieldingly held on the surface of cam 42 by a spring 65. The end of the arm 62 has a slot and pin connection 66 with a rod 67 which is slidably mounted in a bracket 68 secured to the machine frame. A cam ratchet 70 is secured to the upper end of rod 67, this ratchet having a cylindrical guide slidably mounted in the upper end of the bracket 68.

The arm 62 has a reciprocating motion which is the same motion that is imparted to the piston by the cam 42. Thus the valve 30 is rotated rapidly during the suction stroke of the piston and reciprocated slowly during the exhaust stroke of the piston. As the ratchet 70 is moved upwardly by the motion of the arm 62 a surface 72 on the ratchet engages a pin 74 mounted in a plate 76. The plate 76 is rotatably mounted on an axle 78 and therefore the upward movement of the ratchet plate tends to rotate the plate 76 about its axis. As the pin which engages the surface 72 is moved upwardly by the ratchet, another pin 80 yieldably mounted in the plate 76 engages a cam surface 82 on the face of the ratchet plate 76 which acts to depress the pin 80 so that the rotary motion of the plate 76 will not be interfered with by the pin 80. It will be noted that each reciprocating movement of the ratchet plate 70 rotates the plate 76 through an arc of 90° and there are four pins 74, 80, 82' and 84 yieldably mounted in the plate 76. As the pin 80 gets into the position formerly occupied by the pin 84, the spring behind the pin 80 will project the pin outwardly so that it will engage the surface 73 of the ratchet plate 70. The mechanism therefore tends to give a rotary motion to the plate 76, the motion being rapid during the suction stroke of the piston and slow during the exhaust stroke of the piston. A gear 86 is mounted on the axle 78 and attached to the plate 76 so that it rotates in unison with the plate 76. This gear, in turn, meshes with a gear 88 which is secured to an outwardly extending stem 90 on the valve 30. The rotation of the gears 86 and 88 by the ratchet wheel tends to rotate the cam for the purpose of opening the ports for the travel of gas through the valve chamber 20 whereby smoke is drawn from the lighted cigarette, cigar or pipe which is being subjected to

test. The smoke passing from the chamber 16 flows to the chamber 20 in going to a gas analyzer 92. The valve 30 is designed and operated to open communication between the chamber 16 and the pump at the beginning of the down-stroke of the pump and to cut off communication between the pump and the chamber 16 on the upstroke of the pump while opening the port 52 to admit gas to the analyzer 92.

The analyzer 92 which is used in this apparatus is the well-known type of analyzer for determining the combustible constituents in a gas, particularly hydrogen and carbon monoxide. An analyzing apparatus of this type is illustrated and described in my Patent No. 2,083,522, granted June 8, 1937. In making the analysis the gas is passed through the analyzer into contact with a catalyst wire 94 of the analyzer which forms one arm of a Wheatstone bridge. The other arm of the Wheatstone bridge consists of a similar catalyst wire 96 which does not come in contact with the smoke being analyzed. The catalyst wires are heated by an electrical circuit to make them active so that when the smoke having combustible material therein comes in contact with the catalyst, usually a palladium-vanadium alloy, the gas in contact with the wire will be burned. This combustion will set up a resistance in the wire which will unbalance the Wheatstone bridge circuit, this unbalancing being indicated by a millivoltmeter 98. The calibration of the voltmeter is such as to indicate directly the amount of combustible material in the smoke being analyzed. When a smoke sample is forced through the port 52 a measured quantity of air is mixed with the smoke for the purpose of burning the combustible constituents in the smoke.

At the time that the smoke is drawn into the cylinder 34, or during the puff stroke, the smoke is passed through a filter to give a record of the amount of tar or other condensable constituents that may be contained in the smoke. To accomplish this a filter paper is sealed over the top of the smoke-receiving chamber 16 and the smoke is drawn through the filter paper by the suction of the piston 36. The filter paper is sealed over the top of the smoke chamber 16 during the puff and that part of the filter paper previously released from its position on top of chamber 16, is continuously moved during the exhaust stroke of the piston.

The apparatus to give the graphical record of the condensable constituents in the smoke is shown in the drawing. The filter paper in the form of a roll 100 is mounted on a reel 102 and passes from the roll under the holder 14 and across the top of the smoke chamber 16. Around the upper edge of the chamber 16 is formed a sealing flange 104 which is arranged to be engaged by a gasket 106 mounted in the lower face of the holder 14 opposite the flange 104. The holder 14 is normally held in a yielding position to press the filter paper upon the sealing flange and tightly close the smoke chamber and the cavity in the bottom of the holder 14. Therefore, the smoke in reaching the chamber 16 must pass through the filter paper. The holder 14 is yieldingly held on the flange 104 by means of springs 108 which surround bolts 110 that are mounted in the top of the frame and surround the smoke chamber 16.

The filter paper is positively drawn across the smoke chamber 16 by driving rolls 112 and 114 which are located respectively below and above the filter paper. The roll 112 is positively driven

by means of a spur gear 116 and drive chain 118, said chain passing over a gear 120 mounted on a shaft 122. The shaft 122 is driven by bevel gears 124 and 126, the gear 126 being fixed on the end of a shaft 128. The shaft 128 is mounted in bearings 130 and has a bevel gear 132 fixed on one end thereof which meshes with a bevel gear 134. The bevel gear 134 is fixed on the cam drive shaft 44, the cam shaft 44 being driven by the motor 46. The motor 46 continuously rotates the shafts 44, 128 and 120 and thus continuously rotates the roll 112 through the driving mechanism. The roll 114 is yieldingly held in engagement with the filter paper which passes between the rolls 112 and 114 by means of springs which place a downward tension on the axle of the roll 114. Thus the paper is positively gripped between the rolls 112 and 114 and is continuously drawn therethrough.

In order to allow the filter paper to be stationary during the smoke filtering operation, a take-up mechanism is provided whereby a sufficient amount of slack filter paper is provided in front of the driving rolls to permit the rolls to continuously draw paper through them. To this end the filter paper passing out from under the holder 14 goes over a guide roll 136 and under a take-up roll 138. The take-up roll is made heavy and has an axle 140 which is mounted in slots 142 at the sides of the machine frame. The axle is normally moved downwardly in the slots 142 by its own weight and by means of springs 144 which tend to draw the roll into the dotted line position shown in the drawing. When the paper is clamped between the holder 14 and top of the chamber 16 the driving rolls lift the take-up roll into the full line position shown in the drawing.

In order to release the filter paper so that it may be drawn across the smoke chamber 16 during the exhaust stroke, pins 146 are mounted in a plate 148 which is positioned immediately under the smoke chamber 16. The pins 146 extend upwardly through the top of the frame in position to engage the underside of the holder 14. The plate 148 and pins 146 are positively raised during the exhaust stroke to release the paper. This lifting operation is accomplished by the motion of the lever 62, which is given a reciprocation motion by the cam 42. A link 150 is connected with the lever 62 and passes through a guide 152 mounted on the machine frame. The upper end of the link is connected with an arm 154 which is linked to a shaft 156. The shaft 156 is rotatably mounted in bearings secured to the frame and has arms 158 arranged to engage the lower ends of the pins 146 when the shaft is rotated by the movement of the lever 62. The arms 158 are mounted on an eccentric portion of the shaft 156 and the oscillatory movement of the shaft 156 acts to positively lift the pins 146 and table 148 to raise the smoke holder 14 and release the paper. The motion of the lever 62 is such as to hold the holder 14 in elevated position to release the paper during the entire exhaust stroke of the piston. A hand lever 160 is secured to the shaft 156 by which the paper may be manually released and the holder lifted at any time desired for the purpose of threading the paper or for the purpose of inspecting the paper. The paper emerging from the drive rolls 112 and 114 passes under a cutting plate 162 by which the paper may be cut off from the strip when desired.

With the apparatus described above, it will be

apparent that the smoke being drawn from the cigarette, cigar or pipe mounted in the holder 14, is continuously being analyzed as it is drawn through the apparatus. At the same time the smoke is passed through a filter paper during each puff stroke and spots are formed in the paper to give a record of the type and amount of tar or other condensable liquids in the smoke. By making proper indications on the filter paper the analysis of the combustibles in the smoke can be placed opposite the tar spots on the filter paper to keep a record of the combustible analysis along with the tar indication.

The contour of the cam 42 has been designed with the idea of imitating as closely as possible the operations of a cigarette or pipe by a smoker, the puffs being made at fixed intervals and the exhaust being carried over a much longer interval. By means of a counter attached to the releasing mechanism on the holder the number of puffs required to consume a predetermined portion of a cigarette or cigar or pipeful of tobacco may be counted and, in fact, a definite measurement may be made volumetrically of the amount of smoke produced by different types of cigarettes and cigars. For example, the volume of smoke displaced by the cylinder multiplied by the number of strokes will give a comparatively accurate volumetric measurement of the amount of smoke produced. The analysis will indicate also whether there is any carbon monoxide present in the smoke. The analysis also may be used for detecting any other poisonous constituents which would appear as a combustible in the smoke.

The preferred form of the invention having been thus described, what is claimed as new is:

1. In cigarette and cigar testing apparatus, a suction pump having a working cylinder and a piston reciprocally mounted therein, a valve chamber communicably connected with said working cylinder, smoke inlet and discharge ports for said pump, both opening into said valve chamber, a valve rotatably mounted in said chamber and operable to alternately connect the cylinder with the inlet and discharge ports, an analyzer for combustible smoke constituents communicably connected to the pump discharge port, an apertured cigarette holder adapted for mounting the unlighted end of a lighted cigarette and a closed conduit communicably connecting said holder aperture with the smoke inlet port of said pump cylinder.

2. Apparatus as defined in claim 1, together with a mechanism for intermittently actuating the rotatably mounted valve in synchronizing cycle with the pump piston.

3. In smoke testing apparatus, an apertured holder adapted for mounting the unlighted end of a lighted article to be smoked, a gas analyzer adapted to analyze smoke for combustible constituents, a conduit communicably connecting the aperture of the holder with the gas analyzer, and a suction pump having a working cylinder and piston mounted therein, said pump being operatively connected to the conduit between the article holder and analyzer to cause air and smoke to flow successively through the article, the apertured holder, the conduit and the gas analyzer, together with a motor and driving mechanism for actuating the pump piston on a cycle including a rapid suction stroke followed by a relatively slow discharge stroke.

4. In smoke testing apparatus, an apertured holder adapted for mounting the unlighted end

of a lighted article to be smoked, a suction pump having a working cylinder and a piston mounted therein, a conduit communicably connecting the aperture of the holder with the pump, said pump being operatively connected to cause air and smoke to flow successively through the article, the apertured holder, the conduit and the pump, together with a strip paper filter mounted in the conduit connecting the holder and the pump, a filter changing device, and mechanism for synchronizing the operation of said device with the movement of the pump piston.

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