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[54] CIGARETTE SMOKING MACHINE
6 Claims, 5 Drawing Figs.

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A24f 47/00

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[50] Field of Search..... 131/170,
171, 172; 73/23, 432

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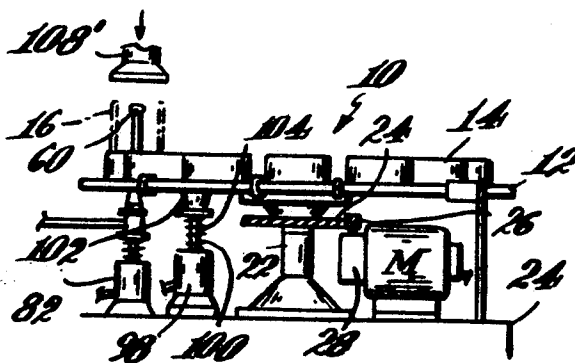
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ABSTRACT: An apparatus comprising a holder for one or more cigarettes, a low pressure condenser and a conductor connecting the holder to the condenser whereby large scale collection of the condensable components of the smoke from one or more cigarettes may be obtained for the purpose of analysis to determine the amount of such components inhaled by a cigarette smoker.



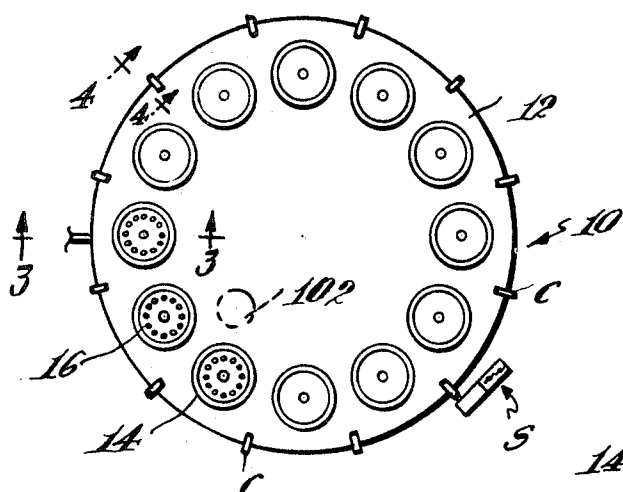


Fig. 2

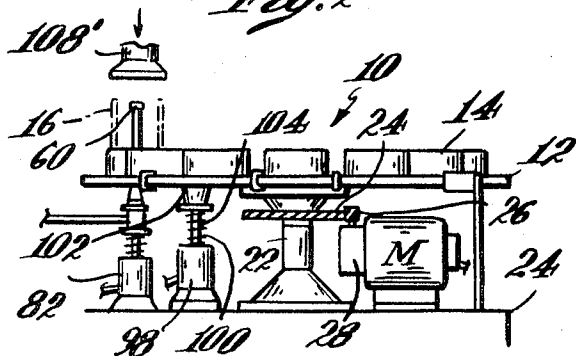


Fig. 1

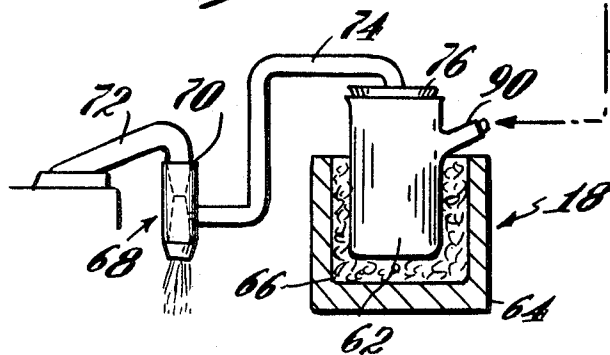


Fig. 3

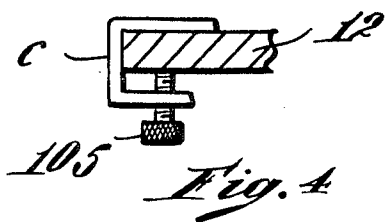


Fig. 4

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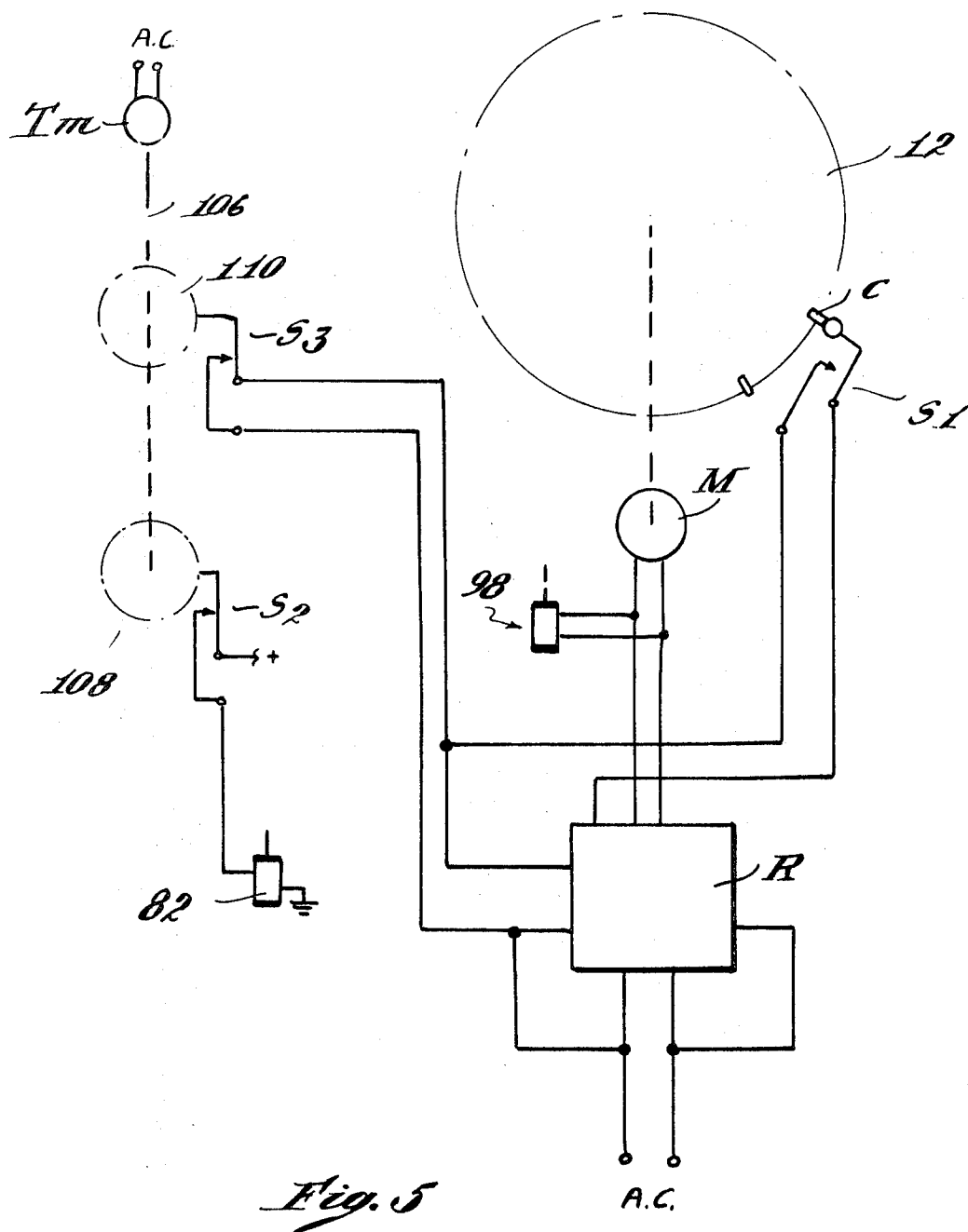


Fig. 5

CIGARETTE SMOKING MACHINE

BACKGROUND OF THE INVENTION

Smoking apparatus is not new but for the most part such apparatus is designed to break in tobacco pipes, that is, to precondition new pipes by automatically smoking them for a sufficient length of time to make them mellow. Such apparatus is illustrated in Pat. Nos. 1,840,334, 1,878,844, 2,260,206 and 2,639,716. Additionally, patents have been granted for apparatus designed to smoke cigarettes and/or cigars for the purpose of testing their burning qualities (Pat. No. 448,194); for analyzing the products of combustion (Pat. No. 2,228,216); and for comparing brands Pat. No. 3,200,648. In copending application of Colin A. Morrissey, Ser. No. 727,288, filed May 7, 1968 and now U.S. Pat. No. 3,528,435, dated Sept. 15, 1970, there is disclosed apparatus for drawing cigarette smoke into a specimen-treating chamber for determining the effect of the smoke on specimens, such as mice supported with their heads in the smoke-filled chamber. This invention has for its purpose to provide a method and apparatus for smoking cigarettes in such fashion as to obtain an accurate sampling of the condensable components of cigarette smoke inhaled by a cigarette smoker when smoking and collecting the condensable components of the cigarette smoke at a rate corresponding substantially to the average rate of consumption of a cigarette to enable determining the amount and concentration of the deleterious condensable components of smoke which may be expected to be inhaled by a cigarette smoker; to provide apparatus for large-scale collection of the condensable components of cigarette smoke at the aforesaid rate; to provide an apparatus for collecting the condensable components of cigarette smoke of a group of cigarettes and at the same time to enable making a collection of the condensable components in a relatively short time; and to provide apparatus which is of relatively simple construction and requires very little attention and upkeep apart from removing the burned stubs and replacing them with fresh cigarettes.

SUMMARY

As herein illustrated, the method comprises subjecting a cigarette to mechanical inhalation for a period corresponding to the average period of inhalation, terminating such inhalation, allowing the cigarette to cool for a period corresponding to the average interval between inhalations, and repeating the periods of inhalation and termination of inhalation until the cigarette is substantially consumed. The method includes during the intervals between inhalations of a given cigarette, subjecting additional cigarettes in succession to corresponding periods of inhalation and cooling. The apparatus for carrying out the method comprises a support on which a cigarette is mounted, a relatively low pressure condenser chamber, and means for effecting intermittent movement of the support periodically to effect connection of the cigarette to the condenser for a period corresponding to the average interval of inhalation and then disconnecting it therefrom for a period corresponding to the average interval between inhalations. The condenser chamber is a refrigerated receptacle maintained at a subatmospheric pressure and the low pressure is produced by a Venturi through which water flows and which is connected at the upstream side to the condenser chamber. The support is a hollow holder containing inlet and outlet openings and means for periodically connecting the support to the condenser chamber is a manifold supported for movement into communicating engagement with the outlet of the holder for a period of time corresponding to the average period of inhalation and then separating it from the holder for a period corresponding to the average interval between successive inhalations. During the interval between average inhalations additional cigarettes are subjected to corresponding treatment. To achieve this the support mounts a plurality of holders and is movable relative to the manifold to present each holder in turn to the manifold and each holder contains a plurality of

openings for receiving a corresponding number of cigarettes. The support is in the form of a table mounted for rotation about a vertical axis, the holders are distributed peripherally of the table, there is a motor and kinematic means for connecting it to the table to effect rotation, a brake for stopping the table with a holder in alignment with the manifold, and a cam-operated switch for stopping the motor and applying the brake at intervals corresponding to the spacing between holders. A motor-driven cam shaft timed to correspond to the intervals between average inhalations restarts the motor and simultaneously disables the brake.

The invention will now be described in greater detail with reference to the accompanying drawings wherein:

FIG. 1 is an elevation of the machine with the condenser chamber omitted and showing cigarettes mounted in one of the holders;

FIG. 2 is a plan view of FIG. 1;

FIG. 3 is a section taken on the line 3-3 of FIG. 2, to much larger scale, and shows in addition a condenser chamber connected to the manifold;

FIG. 4 is a fragmentary section taken on the line 4-4 of FIG. 2; and

FIG. 5 is a wiring diagram for controlling the operation of the apparatus.

Referring to the drawings (FIG. 1), the apparatus comprises a support 10 in the form of a circular table 12 mounted for rotation about a vertical axis and mounting a plurality of holders 14, each of which is adapted to support a plurality of cigarettes 16; a subatmospheric pressure condenser chamber 18 (FIG. 3) for collecting the condensable components of the smoke produced by a burning cigarette; and means 20 for periodically connecting the condenser chamber to the supported cigarettes to induce combustion and conduct the smoke to the condenser chamber 18.

The table 12 is supported for rotation about a vertical axis on a column 22 mounted on a base 24 and rotation of the table is effected by a motor M operably connected to the table by means of a gear 24 and pinion or the like 26, the latter being driven by the motor through a reduction element 28. The table has peripherally of it a plurality of openings 30 in which the holders 14 are mounted and each holder comprises a hollow head 32 and hollow stem 34, the latter extending downwardly through the opening 30 in the table. A sleeve 36 comprised of an elastic material is mounted on the stem at the underside of the table and by frictional engagement therewith holds the head engaged with the upper side of the table. Each holder 14 contains an annular shoulder 38 for receiving and supporting a grid 40 comprised of two circular plates 42 and 44 and a gasket 46 interposed between them. The plates 42 and 44 and the gasket 46 contain a plurality of peripherally located holes, the holes in the lower plate 42 having two diameters, a small diameter hole 48 which is smaller than the diameter of a cigarette and a large diameter hole 50 which is slightly larger than the diameter of a cigarette. The holes in the upper plate 44 correspond in diameter to the holes 50 in the lower plate and the holes 54 in the diaphragm 46 are of an intermediate diameter smaller than the holes 50 and 52 but larger than the holes 48. The holes 48, 50, 52 and 54 collectively provide sockets into which the lower ends of the cigarettes to be smoked can be pressed and held, the shoulder provided by the difference in diameter of the holes 48 and 50 providing an abutment for the lower ends of the cigarettes and the diaphragm 46 by downward displacement elastically sealing the cigarettes in the sockets. A sealing ring 56 is mounted on the shoulder 38 beneath the grid 40 to prevent leakage of air around the periphery of the grid and to insure a flow of the smoke undiluted to the condenser chamber. For convenience in removing burned stubs and replacing them with fresh cigarettes the grid is provided with an upstanding handle 58 secured at its lower end to the center of the grid and having at its upper end a knob 60 by means of which it may be grasped.

The condenser chamber 18 in the form herein illustrated is a simple glass flask 62 set into an insulated receptacle 64 with

dry ice 66 packed around it. Obviously, cooling or refrigeration of the flask could be accomplished by means of a refrigeration coil or any other cooling means and therefore the specific means herein illustrated is not considered to be restrictive. The flask 62 is maintained at a subatmospheric pressure by means of a Venturi 68 in the form of a nozzle 70 through which water flows from a spigot 72, the nozzle being connected by a conductor 74 to a stopper 76 pressed into the mouth of the flask.

The means 20 for connecting the holders 14 successively to the condenser chamber 18 comprises a manifold 78 mounted on the upper end of the core rod 80 of a solenoid 82, the latter being mounted on the base 24 below the table. The manifold contains a passage having a vertical portion 81 corresponding substantially in diameter to the inside diameter of the hollow stem 34, and a horizontal portion 83 extending from the lower end of the portion 81 through the side of the manifold. The outlet end of the portion 83 is enlarged and threaded for receiving a coupling element 86 by means of which one end of a conductor 88 is connected to the manifold. The other end of the conductor 88 is connected by suitable means to a spout 90 projecting laterally from the flask 62. The manifold 78 has at its top a flat plate 92 to which there is secured a gasket 94 comprised of a yieldable material, both of which contain openings corresponding in diameter to the passage 81. The gasket 94 provides a seal between the manifold and the lower end of the hollow stem 34 when pressed into engagement therewith and preferably is comprised of sponge rubber of the kind wherein the pores are closed.

A spring 96 mounted about the core rod 80 with one end resting on the top of the solenoid 82 and the other against the underside of the manifold 78 supports and presses the manifold into engagement with the lower end of the stem 34 when the solenoid is deenergized. Energization of the solenoid 82 pulls the manifold 78 downwardly to separate it from the lower end of the stem 34. Such separation is effected periodically as will appear hereinafter to permit moving one holder away from the manifold and moving the next holder into alignment therewith.

In operation of the apparatus a holder 14 is filled with cigarettes, each holder as herein illustrated being provided with enough holes to accommodate 12 cigarettes and the rotation of the table is timed so that each holder is presented to the manifold to induce combustion for a period corresponding to the average period of inhalation of an average smoker and then to move it on beyond the manifold and present the next holder to the manifold for a corresponding period. The number of holders is selected so that during the interval between disconnecting a given holder and reconnecting it to the manifold which is the average period between inhalations, each of the other holders is presented in turn to the manifold for a period of average inhalation. This is achieved by means of the circuitry shown in FIG. 5, wherein the motor M is shown diagrammatically connected to the table 12. The motor receives its power from an AC source as indicated through a relay R. A switch S1 is supported adjacent the table and cams C are mounted on the table at intervals corresponding to the spacing of the holders 14 so that as each holder approaches the manifold the switch S1 will be actuated to stop the motor M. To make sure that the table stops in a position such that the lower end of the stem is in alignment with the manifold a brake is provided. This brake, as shown in FIG. 1, comprises a solenoid 98 mounted beneath the table which has a core rod 100 projecting upwardly therefrom to the upper end of which is fixed a friction head 102. A spring 104 is mounted on the core rod between the solenoid 98 and the head 102 and when the solenoid is deenergized the spring forces the head 102 against the underside of the table. Activation of the switch S1 to stop the motor M simultaneously deenergizes the solenoid 98 so that the brake is applied to bring the table to a stop with the manifold in engagement with the lower end of the stem 34. The cams C are adjustably mounted on the table by means of screws 105 (FIG. 4) to enable compensating for the lag

between the time the switch is operated and the brake is applied. By careful adjustment of the positions of the cams the table may be caused to stop with the lower end of a stem in exact alignment with the upper end of the passage 81 in the manifold.

A motor driven cam shaft 106, shown diagrammatically in FIG. 5, provides for deenergizing and energizing the solenoid 82 to move the manifold into and out of engagement with the lower end of the stem of a holder which has been stopped above it and also to restart the motor M following retraction of the manifold. An intermittently operable timer motor T_m adapted to operate at repeated predetermined intervals is employed to drive the cam shaft so that the rotation can be closely controlled. The cams 108 and 110 are mounted on the camshaft. The cam 108 actuates a switch S2 after the table has been brought to a stop to deenergize the solenoid 82 to permit the manifold to be raised into engagement with the stem of the holder above it and after a predetermined period to reenergize it so as to effect retraction of the manifold. The cam is designed to effect deenergization and reenergization over a 2-second interval, the 2-second interval being selected as the average period of inhalation. The cam 110 actuates a switch S3 and is designed to start the motor M at the end of 5 seconds from the time that the motor was stopped. The interval between disconnecting and reconnecting is therefore 58 seconds which is approximately the average period between inhalations. Twelve holders are employed. By adjusting the speed of the timing motor and the shapes of the cams the interval between rotation of the table and the periods of smoking may be varied to provide for varying the periods between smoking and the length of time of the period of inhalation.

The method employed herein of smoking each cigarette for a period of time corresponding to the average inhalation period and then disconnecting it and allowing it to cool for a period corresponding to the average interval between inhalations insures obtaining a sampling which is much more accurately characteristic of the average smoker's intake than a cigarette smoked continuously and the use of the interval between periods of average inhalations for subjecting additional cigarettes to the same treatment enables making large volume collections in a relatively short time.

A lighter may be used in conjunction with the machine comprising a lighter head 108' (FIG. 1) containing, for example, a conventional electric resistance coil. The lighter may be mounted at the end of a flexible cable so that the operator can pick it up and place it against the upper ends of the cigarettes mounted in the holder, or it may, if desired, be mounted on an overhead linkage by means of which it may be lowered into engagement with the cigarettes to effect lighting and then raised to an out of the way position.

The apparatus as thus described is of relatively simple construction and operation and affords a means for accumulating a relatively large quantity of condensate free from dilution and accurately representative of the average quantity of foreign matter, to wit, products of combustion inhaled by a smoker in smoking a cigarette of a given length. The quantity of the condensable components of the smoke may be determined by dividing the total quantity of condensate by the number of cigarettes per holder and the number of holders.

We claim:

1. Apparatus for smoking cigarettes and collecting the condensable components of the smoke produced by burning cigarettes for predetermined intervals, comprising a movable support, at least one cigarette mounted on the support, means for effecting periodic movement of the support to move said cigarette thereon to and away from a predetermined position, a chamber maintained at subatmospheric pressure, a conductor having a part in continuous communication with the chamber and a part periodically movable with said support to said position and into intimate communication with said cigarette on the support at said position, and means for effecting synchronous movement of the support and the movable portion of the conductor to effect movement of the movable

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portion of the conductor to said position each time said cigarette is moved to said position.

2. Apparatus according to claim 1 wherein the support has a plurality of holders thereon for holding a plurality of cigarettes, a single manifold at said predetermined position movable relative to the support from a retracted position to a position of intimate communication with the cigarettes, the conductor being flexible and communicatively connecting the chamber to the manifold.

3. Apparatus according to claim 2, wherein the support is rotatable about a vertical axis and the means for effecting intermittent rotation of the support comprises a motor, kinematic means for drivably connecting the motor to the support, a switch operable to stop the motor, a cam on the support operable, by engagement with the switch, to effect operation thereof, at intervals corresponding to the distance between holders, and a brake operable to bring the support to a stop without overrun, operation of said brake being effected by said switch.

4. Apparatus according to claim 3, comprising a timer motor adapted to operate at predetermined intervals, said timer motor having an output shaft connected to said manifold and being operable following operation of the brake to effect operation of the means for moving the manifold into and out of communicative relation with the holder on the support.

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5. Apparatus according to claim 1, wherein the support is rotatable and there are a plurality of cigarette holders thereon at spaced intervals for movement with the support along a closed path relative to said predetermined position, so that a cigarette on a holder which has been moved out of communicative relation with the movable part of the conductor at said position is returned to said communicative position therewith at the end of a predetermined interval corresponding to the sum of the intervals between holders minus one.

6. The method of collecting condensable components of smoke produced by burning a cigarette at predetermined time intervals, comprising igniting one end of the cigarette, placing the other end of the cigarette in communicative relation with a chamber maintained at a subatmospheric pressure, for a period of time corresponding to said predetermined time intervals for drawing smoke from said cigarette into said chamber, removing said other end of the cigarette from said communicative relation with said chamber for a period of time corresponding to a selected interval for cooling between periods of burning and thereafter continuing to move said other end of the cigarette into and out of communicative relation with said chamber until the cigarette is substantially consumed.

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