March 18, 1969 W. F. MUTTER 3,433,054

MACHINE FOR TEST SMOKING CIGARETTES

Filed Jan. 24, 1967

Sheet 1 of 3

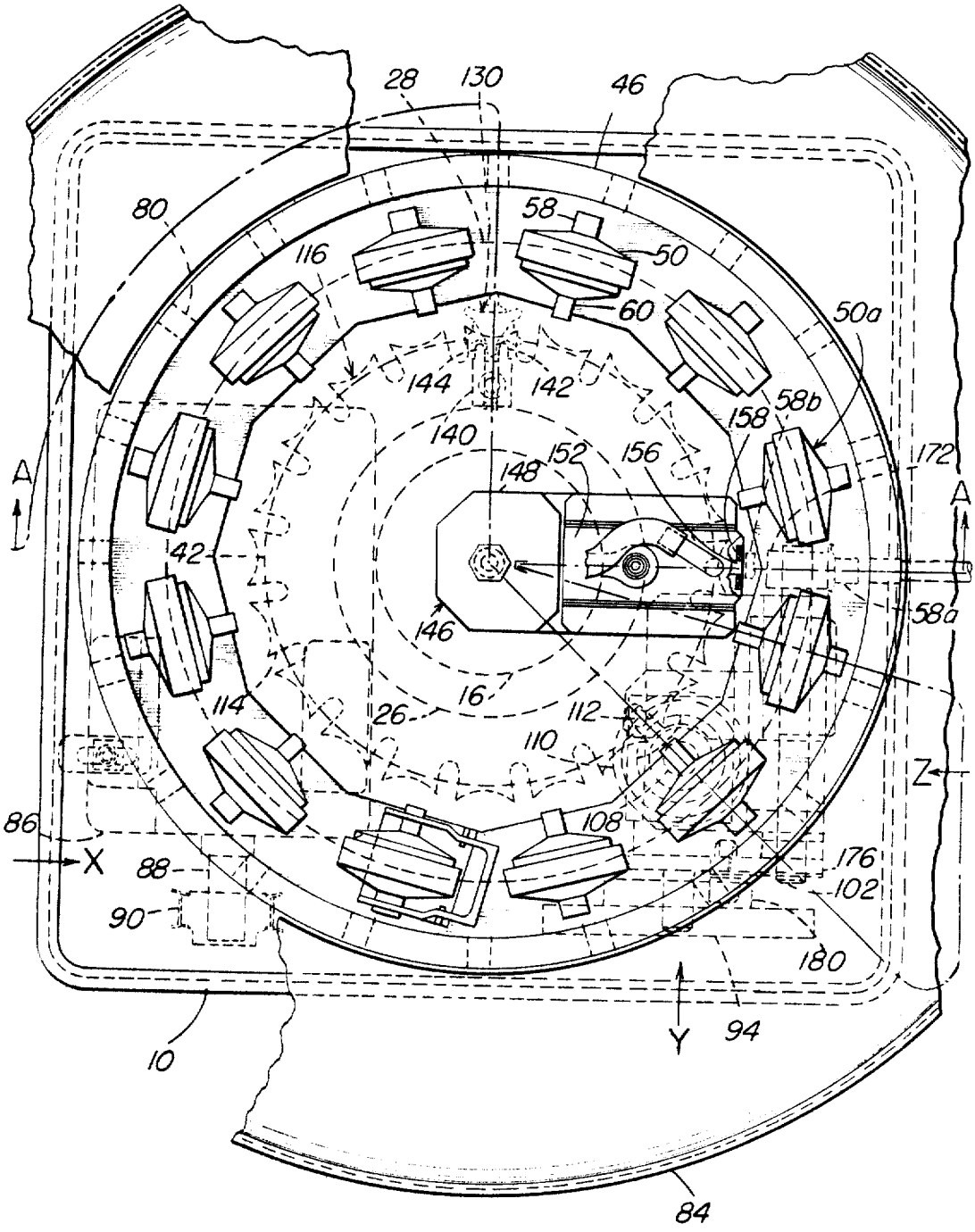
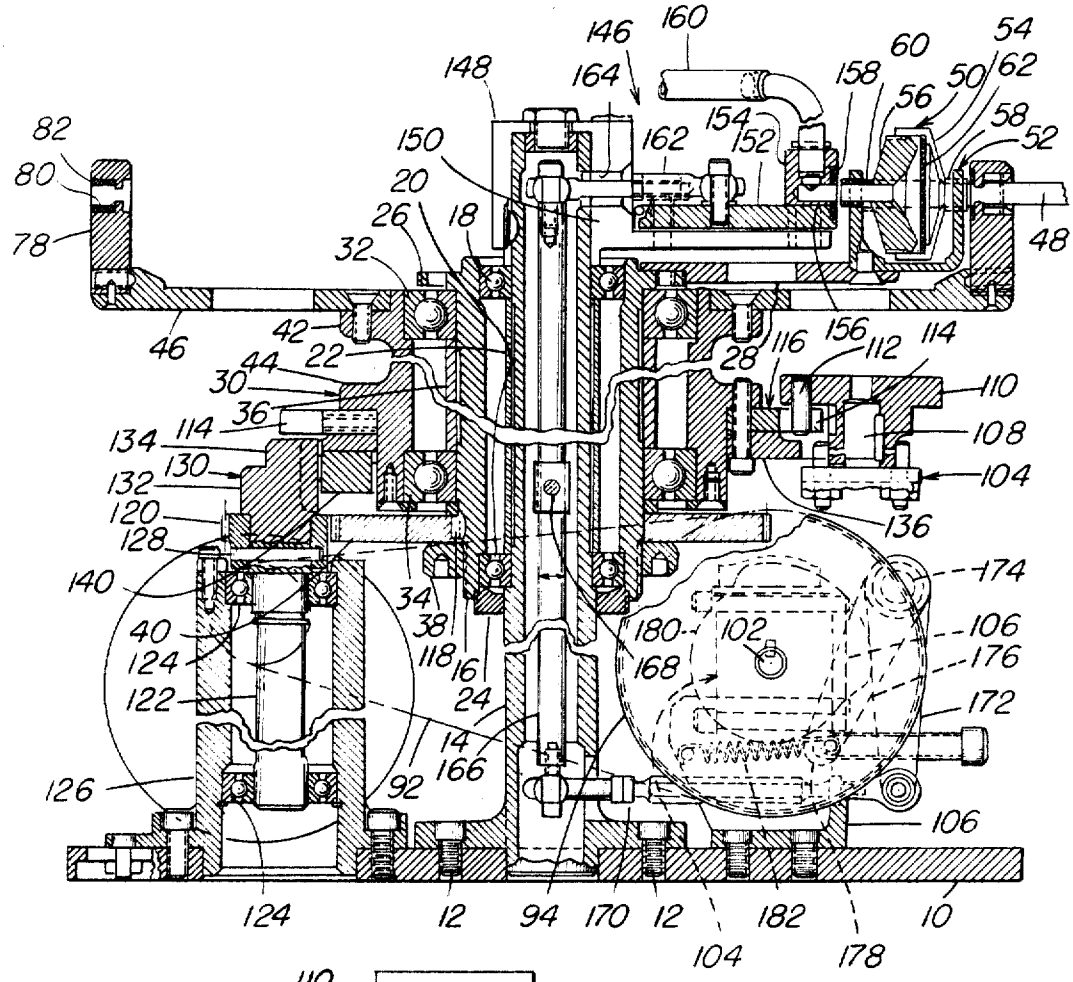


FIGURE 1

FIGURE 2



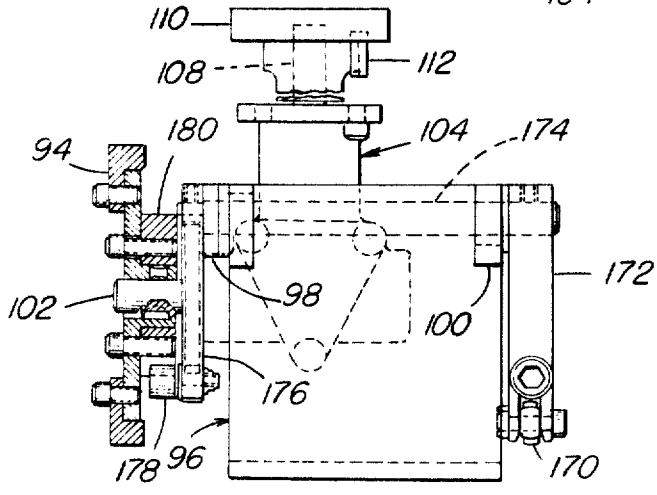


FIGURE 4

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FIGURE 3

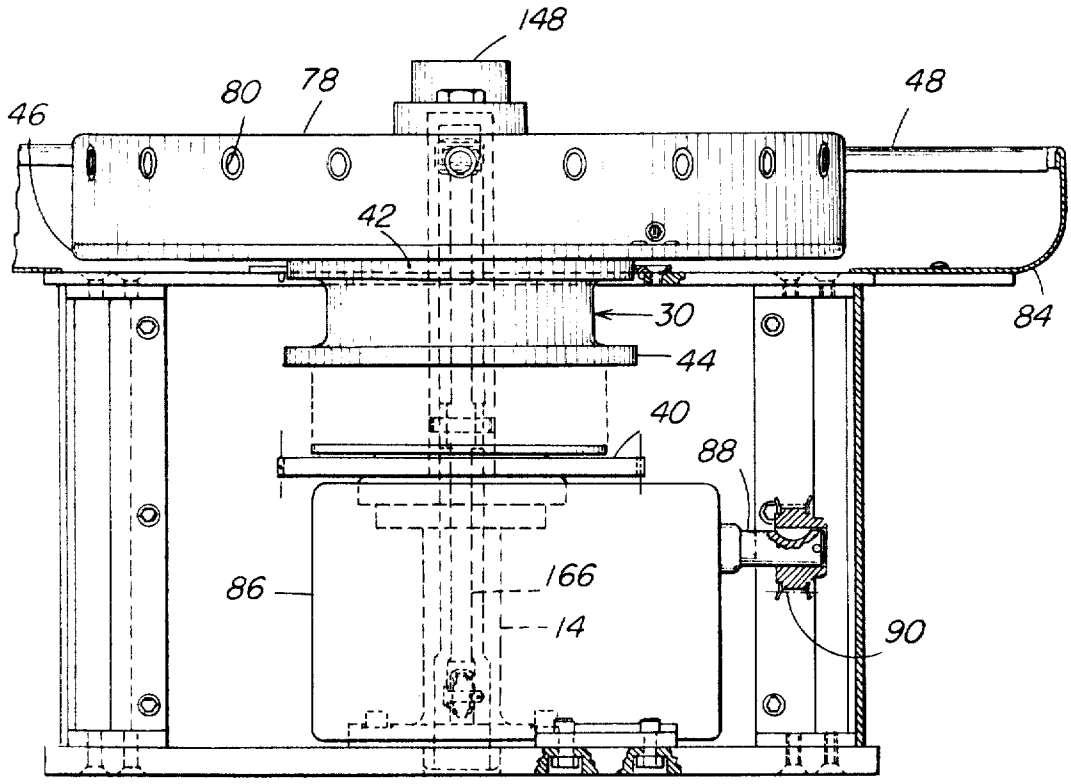
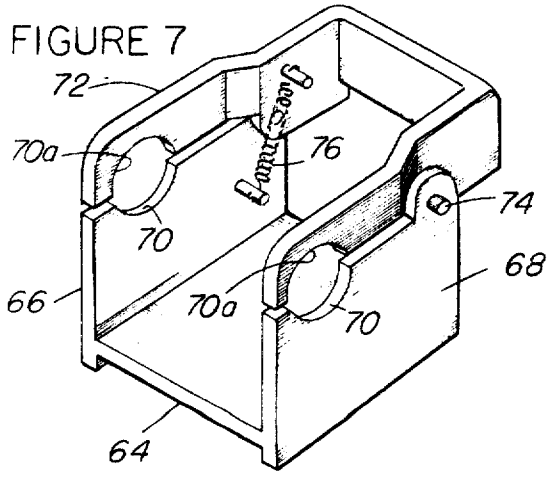


FIGURE 7



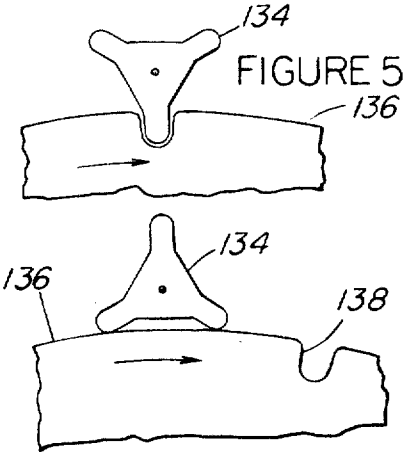


FIGURE 5

FIGURE 6

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3,433,054

MACHINE FOR TEST SMOKING CIGARETTES

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Int. Cl. G01n 31/00

ABSTRACT OF THE DISCLOSURE

A machine for smoking cigarettes in which the cigarettes are carried on a wheel which is rotated to bring the cigarettes successively adjacent a puffing unit at which each is puffed. A series of smoke filter units are mounted on a second wheel which is rotated to position the filter units successively in a smoking position at the puffing unit so that the smoke puffed from the cigarettes is drawn through them. The two wheels are operated in timed relation with each other in such manner that the first puff taken from each cigarette is drawn through a first filter unit, the second puff taken from each cigarette through a second filter unit, and so on until the cigarettes are smoked completely.

BACKGROUND OF THE INVENTION

The present invention relates to a machine for test smoking a plurality of cigarettes for the purpose of gathering qualitative and quantitative data concerning the solids constituents of tobacco smoke. According to the invention, the machine operates cyclically with one puff being taken successively from each cigarette in the plurality during each cycle. The smoke puffed during each cycle is drawn through one of a series of filter units which are provided to trap and retain substantially all of the solids contained in the smoke. During each succeeding cycle of operation, a different filter unit in the series is used for filtering the smoke puffed from the cigarettes during the respective cycles. Thus the smoke solids contained in the first puff of smoke taken from each cigarette are collected in one filter, the smoke solids contained in the second puff taken from each cigarette are collected in a second filter, and so on. In this manner it is possible to collect analytical data more accurately denoting the smoke composition of each of the smoke puffs taken from a cigarette.

Testing machines for mechanically smoking cigarettes are well known in the art and are widely used in the tobacco industry. Known art machines include types capable of smoking cigarettes either singly or in a plurality. However, in these machines, the smoke puffed from each cigarette is drawn through either a single, central filter element or through separate filter elements associated with each cigarette. Hence, it is not possible with prior art smoking machines to obtain discriminating analytical data concerning composition of the smoke produced during any particular puff of the cigarette during the course of smoking same.

SUMMARY OF THE INVENTION

The machine of the present invention is designed to provide an effective, compact machine for test smoking a plurality of cigarettes with the smoke puffed from the cigarettes being drawn through a series of filter units. An important object of the invention is to provide a smoking machine with which the first puff taken from each cigarette is drawn through the same filter unit, the second puff through a second filter unit and so on. In this manner discriminating analysis of the successive smoke puffs is possible.

In general, the machine includes a first wheel which is rotatable on a stationary shaft and which carries the series of filter units spaced circumferentially around one face of the wheel adjacent its periphery. A second larger wheel is also mounted on the stationary shaft and is rotatable thereon independently of the rotation of the first wheel. The second wheel is provided with an axially directed flange at its periphery the arrangement being such that the flange encloses the first wheel. The cigarettes being smoked are supported in passages formed in the flange and extend radially outwardly of the second wheel. A puffing unit is provided for puffing the cigarettes, being fixed to the stationary shaft and extending radially therefrom a distance such that the filter units on the first wheel may be successively stationed adjacent thereto in a smoking position wherein an outlet in each filter unit registers with an inlet to the puffing unit when the first wheel is rotated. The arrangement provides that the first wheel during each complete revolution thereof moves through a number of index positions corresponding in number to the number of filter units in the series thus allowing each to be moved into a smoking position. Similarly, the second wheel during each complete revolution moves through a number of index positions corresponding in number to the number of cigarettes in the plurality thereby allowing each cigarette to be moved into register with the inlet of a fitler unit which is in a smoking position.

The drive means associated with the first and second wheels is effective to continuously index the second or cigarette carrying wheel so that during each complete revolution thereof, each cigarette in the plurality is puffed once. The drive, however, provides that the first wheel is indexed only after each complete revolution of the second wheel and then only one index step so as to advance the next filter unit to a smoking position in order that the smoke puffed from each cigarette during the succeeding revolution of the second wheel is drawn through said next filter unit. The timed relationship of this drive is produced by a Geneva drive unit connected with the second wheel which indexes the second wheel in steps of equal time increments. A Geneva escapement wheel is connected with the second wheel and has mounted thereon, a gear segment which meshes once each time the second wheel completes a revolution with a jacking gear arrangement advancing same a predetermined distance. The jacking gear arrangement includes a bull gear connected to the first wheel and is effective to index the first wheel one step when the jacking gear arrangement is advanced the predetermined distance.

The puffing unit with which the cigarettes are puffed includes means to establish fluid communication between the respective cigarettes, filter units and a source of vacuum during actual puffing. This is accomplished with a sliding member which operates each time a cigarette is in register with the inlet of a filter unit in smoking position. The sliding member upon being slid into engagement with the outlet of the filter unit in turn causes the inlet of the filter unit to move into tight contact with the inner face of the flange on the second wheel covering the passage therein in which the particular cigarette being smoked is supported. To facilitate the engagement of the respective inlets and outlets of the foregoing elements, the filter units are supported on the first wheel in cradles which allow for limited radial movement of the filter units but prevents any circumferential movements thereof relatively of the first wheel thereby insuring that proper registration of the filter unit and cigarettes occurs with each indexing step. The stroking of the puffing unit sliding member is controlled in timed relation with the indexing movements of the second wheel, being slid in one direction during

actual movement of the second wheel between succeeding index positions to disengage it from the filter unit, whereas, during the dwell of the cigarette wheel in each index position, the sliding member is slid in an opposite direction to lock up the filter unit against the second wheel flange. The stroking of the sliding member is effected with an oscillating linkage connected therewith and also connected with an oscillating motion producing cam connected with the drive means operating the Geneva unit.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts, which will be exemplified in the construction hereinafter set forth and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

A fuller understanding of the nature and objects of the invention will be had from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a top plan view of a cigarette test smoking machine constructed in accordance with the principles of the present invention, some parts being broken away for purposes of clarity.

FIGURE 2 is a vertical sectional view of the machine as taken on the line A—A in FIGURE 1 as supplemented by a view taken in the direction of arrow Y in FIGURE 1, portions of the machine being broken away to facilitate illustrating the construction thereof.

FIGURE 3 is an elevational view of the machine as taken in the direction of arrow X in FIGURE 1, the side cover plate facing the viewer being removed.

FIGURE 4 is an elevational view of the drive unit employed for operating the Geneva mechanism and puffing unit as viewed in the general direction of arrow Z in FIGURE 1.

FIGURE 5 is a fragmentary view of the periphery of the segment wheel which moves in unison with the cigarette wheel and which serves as the mounting for a gear segment used to drive a stem pinion gear connected with a suitable gear reduction mechanism the latter being effective to index the filter wheel one-twelfth of a revolution for each full revolution of the cigarette wheel, the stem pinion being shown in mesh with a notch at the segment wheel periphery as occurs during the indexing of the filter wheel.

FIGURE 6 is the same as FIGURE 5 showing the position of the stem pinion after it is disengaged from drive with the segment wheel in which position it acts as a lock-up device during the interval between indexing of the filter unit wheel.

FIGURE 7 is a perspective view of one of the cradles carried on the filter wheel which is used to support the respective cigarette filter units.

Throughout the description like reference numerals are used to denote like parts in the drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The smoking machine of the present invention is described herein in representative embodiment form as being suited for use in test-smoking twenty cigarettes with up to twelve puffs being taken on each cigarette during the course of smoking. Since each of the respective puffs taken from each cigarette is associated with and drawn through a different one of a series of filter units, and since the smoking of the cigarettes can involve taking up to a maximum of twelve puffs on each, the machine is adapted to carry twelve filter units although a lesser number can be employed to that purpose if the test criteria or cigarette length precludes taking a greater number of puffs before the cigarette is smoked to minimum butt length. In consonance with test procedures well established in the tobacco industry, the machine is designed to operate to take one puff per minute from each cigarette as this is the puffing interval most generally used in the industry during test smoking and substantially approximates the puffing interval associated with human smoking. It will be apparent, however, to those skilled in the art, that the machine of the present invention is suited for smoking different numbers of cigarettes, as for example, twelve cigarettes could be smoked and only eight puffs taken on each. Thus the machine can be modified to suit test requirements involving corresponding numbers of cigarettes and filter units associated with the puffs to be taken.

In the preferred embodiment of the machine, the puffing interval between succeeding puffs on the same cigarette is one minute. Smoking twenty cigarettes thus requires a cigarette wheel indexing interval of three seconds between succeeding indexing steps. As used herein, "indexing interval" means the time lapse between the initiation of movement of the second or cigarette wheel in moving from one to a succeeding index position and the initiation of the next succeeding wheel movement. The indexing interval of the first or filter unit wheel is one minute. "Indexing time" is used to denote the actual time involved in moving from one to a succeeding index position. The indexing time of the second or cigarette wheel is one second. Since the first or filter unit wheel must index in a manner that does not encumber the uniform indexing movement of the cigarette wheel, it must have an indexing time that is not greater than one second to provide that a filter unit is always in smoking position whenever a cigarette is in position to be puffed. "Indexing dwell" is intended herein to mean the time period the repective wheels are at rest in a given index position. The indexing dwell for the cigarette wheel is two seconds and that for the filter unit wheel is fifty-nine seconds. In the course of the description "order of puff" is intended to denote the respective numbers of the puffs taken from each cigarette. Thus the first order puffs are the first ones taken from each cigarette and so on.

The smoking machine of the present invention is a very compact unit and can be located advantageously on a table, workbench or shelf in a laboratory or other testing area with facility. In general, the overall dimensions of the unit need not exceed about three feet square. Referring now to FIGURES 1 to 3 of the drawings, the machine includes a base **10** on which it is mounted with suitable fasting means **12**, a hollow stationary shaft or upright post **14**. The post serves as the support on which is mounted the cigarette and filter unit wheels to be described shortly, providing a common axis about which the two wheels can rotate. Mounted at the upper part of the stationary shaft **14**, is a first tubular hub member **16**, which as may be noted best in FIGURE 2, is supported to rotate about the axis of the stationary shaft. The assembly mounting the first hug **16** on the stationary shaft includes upper and lower bearing units **18** and **20**, a bearing spacer element **22** extending between the bearing units **18** and **20** and a retainer ring **24** which can be fixed to the stationary shaft in known manner to prevent axial movement of any of the elements in the assembly. The first hub member **16** has an annular flange **26** at the upper end thereof to which is fixedly connected a disc **28** constituting a first wheel hereinafter referred to by way of convenience as the filter wheel. Thus the filter wheel **28** is rotatable about the axis of the stationary shaft **14** and in operation can be indexed in the manner to be described later on. The first hub member **16** also serves as a support on which is mounted a second hub member **30**, the second hub member being rotatable independently of the first hub member and also rotatable about the stationary shaft. The second hub member **30** is secured on the first hub member by an assembly which includes upper and lower bearing units **32** and **34**, a spacer sleeve **36** and a retainer ring **38**, with a bull gear **40** intervening between the retainer ring **38** and the spacer sleeve **36** as shown. The second hub member **30** is formed with upper and lower annular flanges **42** and **44** with a sec-

ond larger disc **46** being secured to the upper flange **42** on the second hub member and serves as a cigarette wheel, that is, it supports the cigarettes **48** to be smoked.

The filter unit wheel **28** is designed to carry a series of cigarette filter units **50** adjacent the periphery thereof with the cigarette filter units being supported in cradles **52** at uniformly circumferentially spaced locations on the upper face of the filter wheel **28** in the manner best seen in FIGURE 1. The filter units **50** used with the cigarette testing machine of the present invention are of conventional construction being known in the art as Cambridge filters. Each Cambridge filter unit is comprised of two body portions **54**, **56** of substantially cylindrical cup shape which screw together to form a fluid tight body of circular cross section. The fluid tight body is provided at opposite ends with a hollow inlet stem **58** and a hollow outlet stem **60** as shown best in FIGURE 2. The filter unit itself includes an internal filter media **62** which generally is a disc of cotton or similar fibrous material, the disc being used to trap and retain substantially all of the solids particles contained in cigarette smoke. In accordance with procedures known in the art, the disc **62** are removed from the respective filter units at the end of a test and weighed and subjected to other testing procedures to analyze the composition of the solids which have been trapped therein. The smoking machine of the present invention is intended to answer the requirements of tobacco industry testing procedures for large volume smoking capacity. Thus a feature of the unit is the speed and facility with which the filter units **50** can be replaced at completion of a smoking test. The cradles **52** used on the unit not only make for rapid filter unit replacement, but they function to hold the filter units securely without hazard of circumferential movements on the filter wheel **28** while at the same time allow for some radial sliding of the filter units as occurs as an adjunct of the puffing operations. As seen in FIGURE 7, each cradle **52** is comprised of a lower body portion **64** having opposed side walls **66** and **68**, the side walls being provided with aligned notches **70** corresponding in shape to the outer surface configuration of the inlet and outlet stems, **58** and **60** respectively, of the filter units and constituting nesting surfaces for supporting the filter units. The upper body portion of the cradle is formed of a generally U-shaped clamp element **72** which is similarly notched as at **70***a* to allow for tight abutment of its structure against the filter unit stems to securely hold each filter unit against circumferential movement within the cradle. It will be apparent, however, that the foregoing described structure permits the filter units **50** to slide axially within the cradle structure and radially relatively of the stationary shaft **14**. The clamp element **72** is pivoted to the lower body portion **64** at one end as at **74**, and is normally held in closed position by means of a spring **76**.

Turning now to the specific constructionad details of the second or cigarette wheel **46**, which are best seen in FIGURES 1 and 2, the cigarette wheel includes an axially directed flange **78** which extends around the periphery thereof and is secured to the upper face of the wheel with machine screws **80** or other suitable fastener means. The flange serves **78** as a supporting structure in which is received the cigarettes **48** to be smoked, and to that purpose is provided with passages **80** which are circumferentially uniformly spaced around the flange and which are directed radially of the cigarette wheel so as to have an outer or cigarette receiving end and an inner or outlet end adapted to be engaged by the inlet stems **62** of the filter units **50** in the manner as will appear later in the description. The passages **80** each receive one of the cigarettes in the plurality to be smoked with the passages having resilient inserts **82** therein which facilitate ready insertion of the cigarettes on the cigarette wheel and which grip the cigarettes sufficiently tightly to preclude external aspiration during puffing. The manner of mounting the cigarettes **48** on the cigarette wheel **46** provides that they extend a distance radially outwardly of the cigarette wheel as shown in FIGURES 1 and 3 and above a pan **84** in which the ashes accumulating during smoking are collected. Since the cigarette wheel **46** has a larger diameter than the filter unit wheel **28**, the flange **78** of the former encloses the filter unit wheel and during the course of the rotation of the cigarette wheel, the cigarettes carried thereby are successively advanced into a position adjacent to and in register with the inlet **62** of each smoke filter unit **50** when the latter are in a smoking position.

As was previously mentioned, the cigarette test smoking machine is designed to provide for the smoking of twenty cigarettes with up to an average of twelve puffs being taken on each cigarette **48** during the course of smoking with the first puff from each cigarette being drawn through one filter unit **50**, the second puff from each cigarette through a second filter, and so on for the succeeding orders of puffs. Furthermore, as was mentioned, the interval between the puffs taken on each cigarette is one minute. Thus, the cigarette wheel **46** has to rotate during the course of the test smoking at a speed of one revolution per minute to present each of the twenty cigarettes carried thereby adjacent to and in register with the inlet stem of the filter unit associated with the particular order of puffs being taken at any given moment. On the other hand, the number of filter units employed is only twelve for the reason that on the average, not more than twelve puffs can be taken from a cigarette before it has been smoked down to a butt size considered no longer representative of that produced in the course of human smoking. This then requires that the respective wheels be rotated at different speeds and that the rotation of each be according to a specific and exact timed relationship.

The drive means employed for indexing the cigarette wheel **46** and filter unit wheel **28** will be described herein in a preferred embodiment thereof. However, it will be readily discerned by those skilled in the art that various drive means can be used for generating intermittent rotational movement of each wheel provided it is effective to operate the respective wheels in the timed relationships to be described herein.

The manner in which the different rotational speeds of the cigarette wheel **46** and the filter unit wheel **28** are produced will now be described. As seen in FIGURES 1 to 3, the machine includes a constant speed drive motor **86** which powers all the operating devices in the machine and is mounted on the base plate **10** in the manner illustrated at the left-hand side of FIGURE 3. The output shaft **88** of this unit rotates at a constant speed of 60 r.p.m. and carries a pulley **90** which is used to drive by means of a belt **92**, a larger drive wheel **94** shown at the right-hand side of FIGURES 1 and 2. The drive wheel **94** is mounted in a mounting frame structure **96** secured to base plate **10** and having a number of journal brackets thereon as at **98** and **100**. The drive wheel **94** is mounted on the horizontal shaft component **102** of a right angle drive unit **104** fixedly connected to the upright **106** of the mounting frame structure **96**. The speed reduction between the pulley **90** and the drive wheel **94** is 3 to 1 so that the drive wheel and the horizontal shaft component **102** of the right angle drive unit rotate at a constant speed of 20 r.p.m. The right angle drive **104** also includes a vertical shaft component **108** driven by the horizontal shaft component without speed reduction and utilized for rotating the cigarette wheel **46** one revolution per minute in the manner to be described shortly. In addition to being rotated at 1 r.p.m., the cigarette wheel must have a rotational movement of an intermittent nature, that is, it must be indexed in steps to bring each of the twenty cigarettes **48** to the correct smoking position. The indexing of the cigarette wheel can be achieved advantageously with a Geneva drive mechanism. As was mention, right angle

drive unit **104** has a vertical output shaft component **108** to which is connected a Geneva drive disc **110**, the disc carrying a drive pin **112** at the periphery thereof. The drive pin **112** in turn is adapted to engage periodically in each of the slots **114** of a Geneva escapement wheel **116** which is fixedly secured to the lower flange **44** of the second hub member **30** and thereby rotatable therewith. The escapement wheel **116** has twenty drive slots **114** associated each with one of the cigarettes in the plurality being smoked and corresponding to an index position of the cigarette wheel. Since the vertical shaft component **108** of the right angle drive unit **104** rotates at a speed of 20 r.p.m., the Geneva drive disc **110** makes one revolutiton in three seconds, the time period corresponding to the indexing interval of the cigarette wheel. During the course of each revolution of the Geneva drive disc **110**, the pin **112** thereon will engage in one of the Geneva escapement wheel slots **114** and will rotate it, the second hub member **30** to which it is secured, and consequently, the cigarette wheel **46** a distance corresponding to $\frac{1}{20}$ of the circumference of the cigarette wheel. The Geneva drive disc **110** is effective to rotate the escapement wheel **116** for a period of one second which is the time period involved in moving the cigarette wheel from one to a succeeding index position and referred to herein as the indexing time of the cigarette wheel. During the remaining two seconds of the three-second cycle of the revolution of the Geneva drive disc **110**, the pin **112** is out of contact with the Geneva escapement wheel **116**, and the escapement wheel and hence the cigarette wheel **28** does not move, but remains stationary for the indexing dwell period.

The filter unit wheel **28**, on the other hand, is required to be rotated at $\frac{1}{12}$ of a revolution per minute having, therefore, an indexing interval of one minute, i.e., it is indexed one step each time the cigarette wheel **46** makes one complete revolution since it is only after each cigarette in the plurality has been puffed once, that a fresh filter unit **50** is moved into place to filter the smoke drawn on the next order of puffs. The manner and mechanism for indexing the filter unit wheel **28** will now be described. The first hub member **16** to which the filter unit wheel is connected and which rotates with the hub member, carries a bull gear **40** which is keyed to and rotates with the first hub member, the bull gear being keyed to the hub as at **118**. In mesh with the bull gear is a jack pinion gear **120** which has a diameter only ¼ that of the diameter of the bull gear so that for each revolving movement of the jack pinion a predetermined distance, the bull gear will rotate only ¼ as far. As will appear later in the description, the jack pinion **120** is rotated by other gear means rotated in timed relation with the indexing of the cigarette wheel and connected with the jack pinion and accounting for a further 3 to 1 reduction between the cigarette wheel and bull gear so as to produce only $\frac{1}{12}$ of a revolution of the bull gear for each complete revolution of the cigarette wheel. The jack pinion **120** is supported for rotation in the machine in the manner shown in detail in FIGURE 2. From that figure it will be noted that the jack pinion is connected to a jack shaft **122** which in turn is supported by means of ball bearing units **124** in a vertical tubular pedestal **126** fixed to the base plate **10**. The jack shaft **122** is fixed to the jack pinion **120** by means of a pin as at **128**, with the jack pinion having an enlarged top structure formed as a stem pinion **130**. The construction of the latter will be described in detail shortly. An essential requirement for supporting the jack pinion **120** is that it be capable of rotating about an axis extending parallel with the axis of the stationary shaft. Since the jack pinion is fixed to the jack shaft and since the latter includes as an integral part thereof, stem pinion element **130**, the latter will rotate in unison with the jack pinion. The stem pinion **130** has two portions, a lower portion **132** which is provided with six teeth, and an upper portion **134** which is provided with only three teeth, the teeth being of the same size on each portion so that the three teeth on the upper portion are in superposition with alternate teeth on the lower portion. The reason for this latter arrangement of the teeth will be made apparent shortly. The stem pinion **130** is used to transmit drive from the escapement wheel **116** of the Geneva mechanism to the bull gear **40** in a timed relation. For that purpose, the escapement wheel **116** carries secured at the underside thereof a segment wheel **136** of disc shape having smooth upper and lower faces as well as a smooth outer periphery with the exception that a single notch **138** is formed therein, the notch conforming in shape with the profile of the teeth on the stem pinion **130**, its actual shape being more readily discernible in FIGURES 5 and 6. The segment wheel **136** in turn carries a gear segment assembly **140** secured to the lower face of the segment wheel adjacent the periphery thereof, with the planar outline of the gear segment assembly being best seen in FIGURE 1. The gear segment assembly **140** essentially is a block-like element, the pair of gear teeth **142** and **144** thereon being of the same profile as the teeth on the stem pinion and adapted to mesh therewith. The gear segment assembly **140** is connected with the segment wheel **136** at a location such that the space intermediate the two teeth **142** and **144** corresponds in shape with and is in planar alignment with the notch **138** formed at the periphery of the segment wheel. The gear segment assembly is designed to mesh with the teeth on the lower portion **132** of the stem pinion and by this motion cause indexing of the filter wheel **28** in the following manner. After the cigarette wheel **46** has rotated one complete revolution, the gear segment assembly **140** will be located just to the left of the top dead center position shown in dotted lines in FIGURE 1 which position corresponds to the commencement of a new smoking cycle. During the indexing time that the cigarette wheel **46** is indexing from a position corresponding to the twentieth cigarette in smoking position in one cycle to a first cigarette in smoking position in a succeeding cycle of cigarette wheel rotation, the right hand tooth **142** on the gear segment assembly will strike one of the six teeth on the lower portion of the stem pinion and initiate rotation of the stem pinion unit. The next succeeding tooth of the six teeth on the stem pinion lower portion then comes into mesh in between the two teeth on the gear segment assembly and in turn is struck by the advance of the lefthand tooth **144** of the gear segment assembly as the latter moves out of mesh with the stem pinion thus effecting a rotation of the stem pinion **130** a predetermined distance which in this instance is ⅓ of a revolution. Since the stem pinion **130** is fixed to rotate in unison with the jack pinion **120**, the jack pinion also will rotate ⅓ of a revolution. Since the gear reduction between the jack pinion and the bull gear is 4 to 1, the first hub member **16** will be caused to rotate $\frac{1}{12}$ of a revolution. This corresponds with a magnitude of revolution sufficient to advance a succeeding filter unit into a smoking position. A filter unit **50** is in smoking position when the outlet stem **60** thereof is in register with the inlet of the puffing unit forming part of the machine and to be described later on in the description.

As was previously described, the sequence of the events involved in advancing the cigarette wheel between index positions requires three seconds. One second of this (indexing time) is required to actually advance or index the wheel **46** to bring a succeeding cigarette to smoking position. During the other two seconds of that time period (indexing dwell), the puffing of the cigarette is effected. As seen in FIGURES 1 and 2, the test smoking machine includes a puffing unit **146** which comprises a housing **148** secured to the top of the stationary shaft **14** and having a lower housing portion or base **150** directed radially of the cigarette wheel **46** and filter wheel **28**, the base being spaced a distance from the upper face of the filter

wheel. Included as part of the housing is a slide member **152** which slides in the base **150** of the housing in a direction radially of the stationary shaft **14** along a fixed line of movement. Secured to the outer end of the slide member is a seal block **154** which has a suitable passage **156** formed therein, the passage terminating at one end at the outer face of the seal block. The seal block **154** includes a seal ring **158** of resilient material which extends around the inlet to the passage **156** and which serves to effect a tight fluid seal of the block **154** when the latter is forced into contact with the outlet stem **60** of a filter unit which is in a smoking position. During the two-second indexing dwell of the cigarette wheel, it is necessary to move the slide member **152** radially outwardly relatively of the cigarette and filter unit wheels so as to force the filter unit in a smoking position at its inlet end against the resilient insert **82** in the corresponding passage of the cigarette wheel and also to bring the seal ring in the seal block into fluid tight contact with the outlet of the filter unit establishing an intimate fluid communication between said filter unit, the puffing unit and a cigarette, so that a puff of smoke can be taken on the cigarette by means of a constant suction source which is placed in communication under continuous condition with the seal block passage by means of a flexible hose **160**. The respective filter units **50** are in smoking position when the inlet and outlet stems **58** and **60** thereof are aligned with the inlet to the seal block passage **156** in the manner shown in FIGURE 1 in dashed lines as applicable to the stems **58***a* and **60***a* of filter unit **50***a* which in FIGURE 1 is shown just forward of its smoking position, FIGURE 1 illustrating the filter wheel in a position about midway between two index positions. At the end of the two seconds of indexing dwell associated with the puffing of each cigarette, the beginning of the next indexing step of the cigarette wheel **46** occurs and as a consequence the slide member **152** must be retracted inwardly relatively of the cigarette and filter unit wheels to free the filter unit which is in smoking position from the condition of fluid tight contact with the puffing unit to permit the cigarette wheel to rotate unencumberedly.

The manner in which the slide member is stroked will now be described. The mechanism for effecting this motion is constituted of an oscillating linkage which includes an upper connecting rod **162** which is slidably fixed in the puffing unit housing as at **164** and secured at one end to the slide member **152**. The upper connecting rod **162** in turn is connected at its opposite end to the upper part of an oscillator shaft **166** supported within the hollow stationary shaft **14** on a pivot **168** extending through both and arranged perpendicular to the axis of the stationary shaft. The lower end of the oscillator shaft **166** in turn is connected with a turn buckle rod assembly **170** in the manner shown in FIGURE 2 with the outer end of the turn buckle rod assembly being connected with a rocker arm **172**. The rocker arm **172** in turn is connected to one end of a rocker shaft **174** which is rotatably mounted in the journal brackets **98, 100** of the mounting frame **96** secured to the base plate **10**. The opposite end of the rocker shaft **174** supports a follower arm **176** which has secured to the lower end thereof a roller type cam follower **178**. The roller type cam follower **178** in turn is maintained in constant engagement with the camming surface of a rotary cam member **180** which is designed to produce oscillatory motion. Constant engagement of the cam follower with the rotary cam **180** is provided by means of a spring **182** secured to the mounting frame **90** and the rocker arm **172**. The effect of the spring is to tend to rotate the rocker shaft **174** clockwise as viewed in FIGURE 2, hence tending to rotate the follower arm in the same direction. The rotary cam member **180** is fixed to the horizontal shaft component **102** of the right angle drive unit **104** in the manner best seen in FIGURE 4, being located behind the drive wheel **94** and thus it rotates at the same speed as the Geneva drive disc **110**, i.e., one revolution each three seconds. The rotary cam is designed such that its camming surface high point engages the roller cam follower **178** during the one second indexing time of the cigarette wheel. The camming surface high point causes the follower arm **176** to rotate in a counterclockwise direction as seen in FIGURE 2 so that this movement when translated through the rocker arm **172** to the oscillating linkage is effective to move the slide member **152** from right to left as shown in FIGURE 2 and out of engagement with the outlet end of the filter unit. On the other hand, during the two seconds on indexing dwell of the cigarette wheel in which period the puffing of the cigarette occurs, the spring member **182** connected with the rocker arm **172** maintains the roller cam follower in contact against the low point on the rotary cam so that the oscillating linkage is caused to pivot in a clockwise direction and slide member is slid radially outwardly relatively of the stationary shaft **14** and into firm, fluid tight contact with the outlet stem of the filter unit and in turn causing the filter unit to slide into fluid tight contact at its inlet stem with the resilient insert of the cigarette wheel flange passage holding the cigarette being smoked.

A feature of the machine of the present invention is that it incorporates means which preclude spurious rotational movements of the filter unit wheel **28** during its dwell period. This lock up feature is an adjunct of the construction of the stem pinion **130**, gear segment assembly **140** and segment wheel **136** and its mode of functioning may be discerned by referring to FIGURES 5 and 6. During the time the two teeth **142, 144** on the gear segment assembly **140** engage in mesh with an upper portion tooth of the stem pinion member **130**, the said one tooth on the upper portion enters the notch **138** formed in the periphery of the segment wheel **136** in the manner illustrated in FIGURE 5, this occurring during the indexing time of both wheels. On the other hand, as soon as the filter wheel **28** has been indexed one step to present a new filter unit in smoking position and at the commencement of the indexing dwell of said wheel, the said one tooth of the upper portion **134** of the stem pinion **130** rides free of the notch **138**, and the other two teeth on the stem pinion upper portion come into contact with the smooth peripheral face of the segment wheel **136** in the manner shown in FIGURE 6. Since these two teeth cannot move, the stem pinion **130** cannot rotate and, therefore, acts as a locking means to prevent spurious rotation of the cigarette filter wheel. In other words, with the two teeth in the position shown in FIGURE 6, the stem pinion **130** and hence the jack pinion **120**, bull gear **40** and first hub **16** are locked together as a unit, and no rotation of any of the respective elements can occur. Thus with a filter unit properly positioned adjacent the puffing unit, it is insured that each of the twenty cigarettes will properly register with that filter unit's inlet end to insure proper puffing of the respective cigarettes until once again the filter unit wheel is indexed, at which time a stem pinion upper portion tooth can enter the notch in the periphery of the wheel to permit the stem pinion to make ⅓ of a revolution.

From the foregoing description, it will be apparent that the smoking machine of the present invention offers a number of advantages for the test smoking of cigarettes. It has large capacity allowing for convenient compilation of considerable test data under standardized test conditions. Most notably the machine makes it possible to connect data concerning the composition of smoke of selected puffs of smoke from the cigarettes inasmuch as the smoke is filtered through separate filter collecting media associated with the particular selected puffs.

While there is above disclosed but one embodiment of the smoking machine of the present invention, it is possible to produce still other embodiments without departing from the scope of the inventive concept herein disclosed, and accordingly it should be understood that all matter contained in the above description and in accompanying

drawings should be interpreted as illustrative and not a limiting sense.

I claim:

1. A machine for test smoking a plurality of cigarettes under test conditions which require that the first smoke puff puffed from each cigarette be drawn through a first one of a series of smoke filter units, each of which has an inlet and an outlet, and that the succeeding orders of smoke puffs be drawn through a correspondingly different one of the other smoke filter units in said series, said machine comprising:

a stationary shaft,

a puffing unit fixed relative to the axis of said stationary shaft and having an inlet therein,

a first wheel mounted rotatably on said stationary shaft and incorporating means for supporting the filter units at circumferentially spaced locations thereon, said first wheel being indexable in steps to move each of said filter units successively into a smoking position wherein the outlet thereof registers with the inlet of said puffing unit,

a second wheel mounted on said stationary shaft concentric with said first wheel for rotation independently of said first wheel, said second wheel incorporating means for supporing the cigarettes at circumferentially spaced locations thereon, said second wheel being indexable in steps to position successively each of said cigarettes in register with the inlet of a filter unit which is in said smoking position,

means operable whenever a cigarette is in register with the inlet of a filter unit which is in said smoking position to establish intimate fluid communication between said cigarette, said filter unit and the inlet of said puffing unit,

means for indexing said second wheel,

means for indexing said first wheel one step each time said second wheel is indexed a number of steps corresponding to the number of cigarettes in said plurality, and

means for connecting said puffing unit with a source of suction.

2. The machine of claim 1 wherein the means for supporting the filter units on said first wheel comprises:

a series of cradles each of which is associated with one of said filter units, said filter units being removably supported in said cradles.

3. The machine of claim 2 wherein each of said cradles comprises:

a base fixed to said first wheel on which the associated filter unit rests,

a clamp member pivoted to said base and closable against the filter unit for securing same to the base, and

resilient means connected with said clamp member and normally urging it into closed position, said base and said clamp member having cooperating notches therein conforming with corresponding surfaces of the filter unit and effective to prevent movement thereof circumferentially of said first wheel but adapted to allow movement of said filter unit radially of said first wheel.

4. The machine of claim 1 wherein the means for supporting the plurality of cigarettes on said second wheel comprises:

an axially directed flange extending around the periphery of said second wheel and having a corresponding plurality of passages extending radially therethrough at uniformly circumferentially spaced locations, said passages each having an outer end for receiving one of said cigarettes, and resilient members supported in each of said passages at the inner ends thereof.

5. The machine of claim 1 wherein said puffing unit includes a housing fixed to said stationary shaft and having an elongated slide member supported thereon for sliding movement radially of said stationary shaft;

a seal block fixed to said slide member and having a conduit extending therethrough which terminates at opposite ends at an inlet and an outlet formed in the surfaces of said seal member, said source of suction being connected with the outlet of said conduit, movement of said slide member in one direction being effective to move the inlet of said conduit into contact with the outlet of a filter unit which is in smoking position and the inlet of said filter unit into contact with the cigarette in register therewith, the means operable to establish intimate fluid communication between said cigarette, said filter unit and the inlet of said puffing unit comprising oscillatory linkage including a connecting rod connected with said slide member, and

a motion producing drive means coupled to the linkage for producing oscillatory movement of said linkage effective to slide said slide member in said one direction whenever a cigarette is in register with the inlet of a filter unit which is in a smoking position, said motion producing drive means being effective to slide said slide member in an opposite direction during the movement of said cigarette wheel between successive index positions.

6. The machine of claim 5 wherein the means for indexing said second wheel comprises:

a Geneva escapement wheel fixed to and rotatable with said second wheel, said escapement wheel having slots extending circumferentially spaced around the periphery thereof and corresponding in number to the number of cigarettes in said plurality,

a disc rotatable about a fixed axis adjacent said escapement wheel and having a pin at the periphery thereof, said pin engaging in one of said escapement wheel slots each time said disc is rotated one revolution for rotating said escapement wheel whereby said second wheel is advanced from one to a succeeding index position, and

means for rotating said disc.

7. The machine of claim 6 wherein the means for rotating said disc comprises:

a constant speed drive unit having a first drive shaft component connected with said disc, and a second drive shaft component connected with said motion producing drive means.

8. The machine of claim 1 further comprising locking means operable at times other than when said first wheel is moving from one to a succeeding index position to lock said first wheel against rotation.

9. The machine of claim 1 wherein the means for indexing said first wheel comprises:

a bull gear connected with said first wheel to rotate as a unit therewith,

a jack pinion in mesh with said bull gear,

a stem pinion fixed to said jack pinion and rotatable about a common axis therewith,

a segment of a gear,

means for connecting said segment of a gear with said second wheel whereby rotation of the latter moves said segment of a gear into and out of mesh once with said stem pinion each time said second wheel is indexed a number of steps corresponding to the number of cigarettes in said plurality thereby rotating said stem pinion a predetermined distance, the gear arrangement of said jack pinion and said bull gear being such that said first wheel is rotated from one to a succeeding index position for each rotational movement of predetermined distance of said stem pinion.

10. The machine of claim 9 wherein the means for connecting said segment of a gear with said second wheel includes:

a segment wheel connected with said second wheel to

rotate as a unit therewith, said segment of a gear being connected to a face of said second wheel adjacent the periphery thereof and having at least two gear teeth, said segment wheel having a notch in the periphery thereof aligned with the space between said two gear teeth, said notch receiving the teeth on said stem pinion when said segment of a gear is in mesh with said stem pinion, the teeth on said stem pinion engaging against the periphery of said segment wheel with said segment of a gear is out of mesh with said stem pinion to prevent rotation of said stem pinion.

11. A machine for test smoking a plurality of cigarettes under test conditions which require that the first smoke puff puffed from each cigarette be drawn through a first one of a series of smoke filter units, each of which has an inlet and an outlet, and that the succeeding orders of smoke puffs be drawn through a correspondingly different one of the other smoke filter units in said series, said machine comprising:

a stationary shaft,

a puffing unit fixed to said stationary shaft, said puffing unit including a housing, and a seal block supported on said housing for movement radially of said wheel, said seal block having a conduit extending therethrough which terminates at opposed ends at an inlet and an outlet formed in the surfaces of said seal member,

a first wheel mounted rotatably on said stationary shaft and incorporating means for supporting the filter units at circumferentially spaced locations thereon and for movement radially of said stationary shaft, said first wheel being indexable in steps to move each of said filter units successively adjacent said puffing unit and into a smoking position wherein the outlet thereof registers with the inlet the conduit in said member,

a second wheel mounted on said stationary shaft concentric with said first wheel for rotation independently of said first wheel, said second wheel incorporating means for supporting the cigarettes at circumferentially spaced locations thereon, said second wheel being indexable in steps to position successively each of said cigarettes in register with the inlet of a filter unit which is in said smoking position,

means operable whenever a cigarette is in register with the inlet of a filter unit which is in said smoking position for moving said seal block in a direction away from said stationary shaft and into contact with the outlet of said filter inlet, the movement of said seal member being effective to urge the inlet of said filter unit into contact with said cigarette whereby intimate fluid communication is established between said cigarette, said filter unit and the inlet of said puffing unit,

means for indexing said second wheel,

means operable during the movement of said second wheel between succeeding index positions to move said seal member in the direction of said stationary shaft,

means for indexing said first wheel one step each time said second wheel is indexed a number of steps corresponding to the number of cigaretes in said plurality, and

means for connecting the outlet of said seal block with a source of suction.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,433,054 Dated March 18, 1969

Inventor(s) Walter F. Mutter

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 30, "purpose" should read --purposes--. Column 4, line 30, "repective" should read --respective--. Column 4, line 53, "hug" should read --hub--. Column 5, line 55; "constructionad" should be --constructional--. Column 6, line 75, "mention" should read --mentioned--. Column 7, line 60, after "pinion" and before "is" --120-- should be inserted. Column 10, Line 66, "connect" should read --collect--.

SIGNED AND
SEALED
MAR 3 - 1970

(SEAL)
Attest:

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