Nov. 19, 1968 M. KNOBEL 3,411,513

METHOD AND APPARATUS FOR GAUGING AND CONTROLLING FIRMNESS IN CIGARETTES AND THE LIKE

Filed Nov. 18, 1966 2 Sheets-Sheet 1

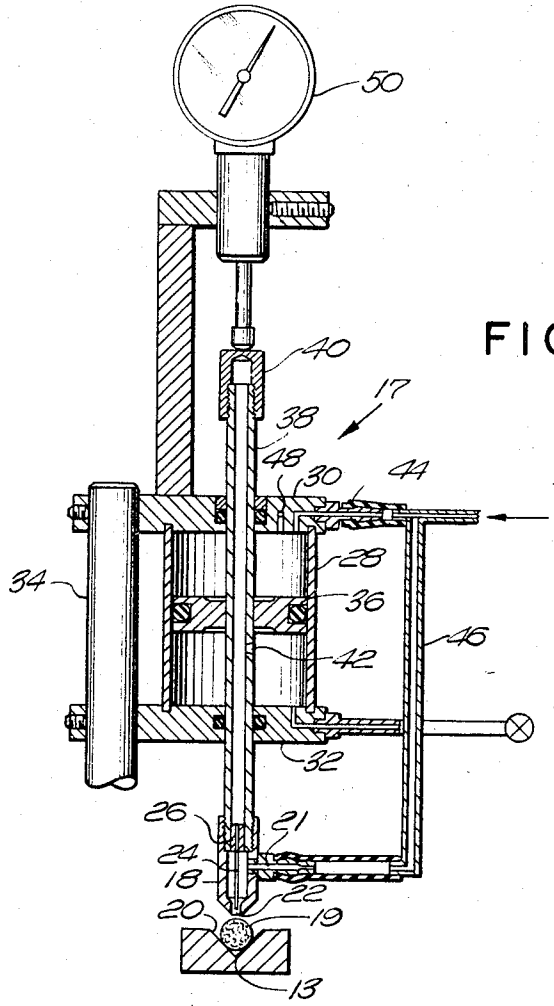


FIG. 1

INVENTOR.
MAX KNOBEL
BY
Morse, Altman & Oates
ATTORNEYS

Nov. 19, 1968 M. KNOBEL 3,411,513

METHOD AND APPARATUS FOR GAUGING AND CONTROLLING FIRMNESS IN CIGARETTES AND THE LIKE

Filed Nov. 18, 1966 2 Sheets-Sheet 2

FIG. 2

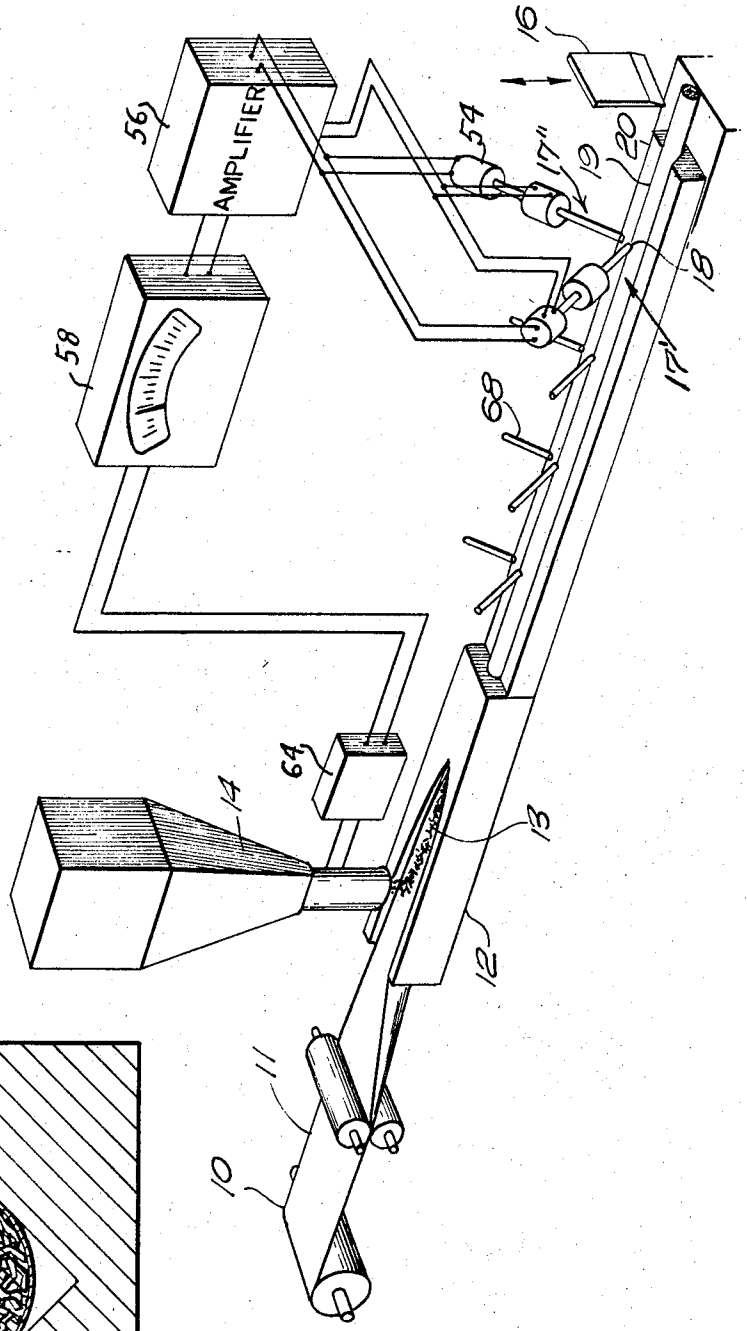
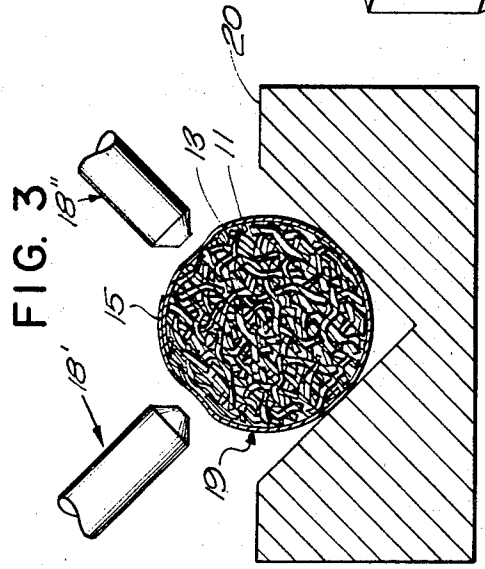


FIG. 3



INVENTOR.
MAX KNOBEL
BY
Morse, Altman & Oates
ATTORNEYS

United States Patent Office 3,411,513 Patented Nov. 19, 1968

3,411,513

METHOD AND APPARATUS FOR GAUGING AND CONTROLLING FIRMNESS IN CIGARETTES AND THE LIKE

Max Knobel, 453 Beacon St., Boston, Mass. 02169

Filed Nov. 18, 1966, Ser. No. 595,458
13 Claims. (Cl. 131—21)

ABSTRACT OF THE DISCLOSURE

An air follower device in which a movable nozzle directs a jet of air against the cylindrical surface of a moving cigarette rod. A loosely filled section of the rod will not be film and the paper wrapper will form a depression under the air jet. The nozzle of the follower is adapted to maintain a constant gap with the cigarette surface and will move inwardly towards the cigarette where a depression is formed. This movement can be measured and signals can be employed in a feedback system for adjusting the tobacco feeding apparatus.

This invention relates generally to a novel method and associated apparatus for gauging and controlling the firmness of an article and more particularly is directed towards a new and improved method and apparatus for gauging and controlling the firmness of cigarettes as they are being manufactured.

In the manufacture of cigarettes a considerable amount of waste is encountered by reason of improperly filled cigarettes. Those which do not receive a proper amount of tobacco fill during the manufacturing process are unsatisfactory for sale since they are lacking in the desired degree of firmness and shape characterized by well-made cigarettes. A cigarette which is not fully packed lacks firmness, is structurally weak, and does not smoke satisfactorily. For these reasons, cigarettes which do not have satisfactory firmness are rejected by manufacturers.

Heretofore, there has been no satisfactory means for gauging and controlling the firmness of cigarettes during the manufacturing process.

Accordingly, it is an object of the present invention to provide a novel method and apparatus for gauging the firmness of a yieldable article.

A more particular object of this invention is to provide a novel method and apparatus for gauging the firmness of cigarettes.

Another object of this invention is to provide a novel method and associated apparatus for use in producing cigarettes of uniform high quality.

More particularly, this invention features the method of gauging the firmness of cigarettes, comprising the steps of moving a cigarette lengthwise and directing the discharge of one or more air gauge following devices against the cylindrical outer surface of the moving cigarette. The air jet discharge will tend to form a depression in the cigarette wrapper, this depression being a function of the firmness of the cigarette. Any depression in the cigarette will cause a displacement of the follower which displacement is measured and produces a signal for use in a feedback system for controlling the feed of tobacco into the wrapper.

This invention also features a novel apparatus for gauging and controlling the firmness of cigarettes, comprising an air jet follower positioned to direct a jet of air against the outer cylindrical surface of a moving length of cigarette coming from a cigarette making machine. Means are provided for detecting movement of the air jet follower in response to changes in the firmness of the cigarette, and signal generating means associated with the follower provide a feed-back signal for increasing or decreasing the amount of tobacco being fed into the cigarette.

This invention also features the employment of one or more air nozzles adapted to direct jets of air against the cigarette in advance of the air follower so as to depress the cigarette wrapper to the maximum extent according to the cigarette firmness prior to moving past the air follower.

As a further feature of this invention two air jet followers are employed in gauging the firmness of a single length of a cigarette with the two followers being angularly disposed with respect to one another and directing separate jets of air at different angular points about the cylindrical surface of the cigarette. The two air jet followers serve to provide a composite signal representative of the firmness of the cigarette and also serve to position properly the cigarette during the gauging process as the cigarette moves along.

However, these and other features of the invention, along with further objects and advantages thereof, will become more readily apparent from the following detailed description of preferred embodiments of the invention, with reference being made to the accompanying drawings in which:

FIG. 1 is a sectional view in side elevation showing an air gauge follower in position to gauge the firmness of a cigarette,

FIG. 2 is a view of a modification in perspective, somewhat schematic, showing a pair of air jet followers and a feed-back system for controlling cigarette firmness, and

FIG. 3 is an enlarged cross-sectional detail view showing the cigarette support and a pair of air jet nozzles as shown in FIG. 2.

Referring now to the drawings, there is illustrated equipment employed in the practice of the invention. According to the invention and specifically as it applies to the gauging and controlling of the firmness of cigarettes during manufacture, the invention involves the use of air followers for monitoring the firmness of cigarettes discharging from the cigarette making machine.

Customarily, cigarettes are produced on mass production basis by means of a narrow roll **10** (FIG. 2) of cigarette paper **11** feeding into a tobacco filling and tube-forming apparatus. As the paper is fed into the apparatus initially in open width form, it is shaped by a die **12** first into a U-shaped configuration. While the paper is in the trough shape shredded tobacco **13** is delivered in a continuous stream onto the moving paper. The tobacco is delivered to the paper in a metered amount from a dispenser **14** and the paper is rolled over by the die to form a rod with the opposing marginal edges overlapped and bonded to form a seam **15**. The product is a continuous length of cigarette in rod form which is carried along to a cutting station where the rod is cut to selected lengths by an oscillating knife **16**. An air jet follower **17** is provided with a nozzle **18** which directs a jet of air against the cylindrical outer surface of the moving cigarette rod. The follower is constructed so that the nozzle tip remains at a constant distance from the cigarette surface so that should any section of the rod not be sufficiently firm a dimple or depression will be formed by the air jet in the paper wrapping and the nozzle tip will move towards the cigarette to the extent of the depression in order to maintain the constant distance. This movement of the nozzle may be measured by a conventional gauge or the movement may be employed to produce electrical signals which in turn will be fed back through a control system to increase the rate of tobacco feed and thereby return the packing density to the desired level and thus increase the cigarette firmness. The gauging of the cigarette firmness is carried out without mechanical contact since the air follower does not

touch the cigarette and therefore does not mar or otherwise damage the cigarette as it is being gauged.

According to the invention the method also includes directing other air jets against the cigarette as it moves along in advance of the air follower. Insofar as the cigarette rod moves at a high rate of speed, the cigarette itself may not respond to the air jet action of the follower quickly enough to produce a significant response. In order to improve the accuracy and response of the air follower and to provide a better indication of the firmness of the cigarette, one or more air jets are located in advance of the air follower and direct jets of air against the cigarette in order to depress the surface of the cigarette if its condition permits so that as each section of cigarette comes into register with the air follower any depression produced by lack of firmness will have been produced to be detected by the air follower.

Referring now to the drawings and to FIG. 1 in particular, there is illustrated an air follower indicated by the reference character **17** and of the sort disclosed in my Patent No. 3,194,055. Generally the air follower comprises the nozzle **18** mounted in spaced adjacent relation to a cigarette tube **19** moving along a trough **20**. The nozzle is directed radially against the cylindrical surface of the cigarette rod so as to push the cigarette down into the trough and also to form a depression in the surface of the cigarette rod where there is any looseness in the tobacco **13** which fills the cigarette. The nozzle is formed with an air inlet **21**, and air outlet orifice **22**, a tube **24** and a plug **26**. The particular nozzle is described more fully in my Patent No. 2,692,498. For purposes of description it will be understood that air, under pressure, is supplied through inlet **21** and exhausts through orifice **22** against the tubular cylindrical surface of the cigarette **19**. This develops a work reflected back pressure in the tube **24** which varies inversely, with the distance between the nozzle **18** and the cigarette **19**. Such back pressure is communicated by suitable means to other parts of the apparatus to be described.

Means are provided for causing the nozzle **18** to follow or float at a uniform distance from the cylindrical surface of the cigarette **19**. Typically, this gap between the nozzle and the cigarette is maintained about .010". The means includes a pneumatic cylinder **28** having its upper and lower ends closed by manifolds **30** and **32** both of which are mounted to a supporting bracket **34**. A piston **36** is mounted for reciprocation within the cylinder **28** and is carried by a tubular open-ended piston rod **38** extending lengthwise of the cylinder and projecting through opposing openings formed in the manifolds. The piston rod and the piston are suitably sealed against the sliding surfaces by O-rings or the like to preserve a substantially fluid-tight sliding fit.

The lower end of the piston rod is adapted to snugly receive the plug **26** of the nozzle **18** and is exteriorly threaded to accommodate the corresponding interiorly threaded upper portion of the nozzle. The upper end of the piston rod, on the other head, in sealed off by a cap **40**. Thus the back-pressure produced in the tube **24** of the nozzle **18** is communicated to the interior of the piston rod and thence through a passage **42** in the rod wall at a point below the piston to the interior of the lower chamber wherein it acts upon the piston.

Air under pressure is introduced to the upper chamber of the cylinder to provide a counter-force to the force due to the nozzle back pressure so as to balance the piston and thereby float the nozzle at a uniform distance from the cigarette. In practice, the air may be delivered from the same source as the air supplied to the nozzle. Accordingly, an air inlet **44** is connected to the upper manifold to deliver air to the upper cylinder. The inlet is connected by means of a flexible conduit **46** to the inlet **21** for the nozzle **18** and to an air supply source.

The bore of the inlet **44** is restricted so as to feed air into the upper chamber at a pressure preferably midway between the pressure extremes to be found in the lower chamber due to nozzle back pressure, and, in practice this may range about 15 p.s.i. The upper manfold is also provided with an air outlet approximately the same size as that of the inlet so that a static pressure of about 15 p.s.i. is maintained in the upper cylinder chamber to offset the back pressure in the lower cylinder and to balance the piston when the nozzle is spaced the desired distance from the cigarette. The gap between the nozzle and the cigarette is determined by the sensitivity of the nozzle. With a sensitive nozzle, the gap is small and the overall accuracy of following is high; larger gaps of .003" to .005" are obtained by a less sensitive nozzle with some loss of accuracy of following.

It will be understood that as the cigarette moves along the trough underneath the nozzle the air jet is directed radially inward against the outer paper wrapper of the cigarette tube. Should the cigarette be soft at a particular section because of insufficient tobacco filling, the air stream will cause the paper wrapper to yield and form a dimple or depression into which the nozzle will follow moving down towards the cigarette as the nozzle follows the contour of the cigarette. On the other hand, if the cigarette is relatively firm, little or no deformation will occur. The motion of the moving nozzle is thus a measure of cigarette firmness. This motion can be shown by a dial indicator, **50**, for example, as shown in FIG. 1. As shown, the dial indicator is mounted so that the lower end of its stem bears against the cap **40** on the end of the rod **38**. The movement of the rod in response to changes of position of the nozzle will cause movement of the dial indicator needle. Various other readout systems may be employed separately or in conjunction with the indicator. For example, the dial indicator may be employed to actuate switches which in turn will operate signal lamps for indicating whether or not the cigarette firmness is within a predetermined tolerance.

It has been found that the above motion of the nozzle is on the order of .020 between a firm and a soft cigarette while for one uniformly firm, the motion is only about .001" to .002". Thus there is ample range to set cut off limits. In practice, the gap between the nozzle and the cigarette should be about .010". One very important advantage of the arrangement is that there is no mechanical contact between the measuring instrument and the cigarette so that the fragile cigarette will not be marked or damaged as might be the case with a direct contact instrument.

Changes in the firmness of the cigarette show up as depressions in the cigarette wrapper under the action of the air jet with greater or lesser depth according to the degree of firmness. These depressions will be accompanied by a corresponding instantaneous change in the work reflected back pressure communicated to the lower cylinder chamber of the follower. This will cause the piston and nozzle to shift up or down accordingly until the pressure in the lower chamber equals that of the upper chamber, for example 15 p.s.i. The action is such that the nozzle follows the surface of the cigarette at a constant distance moving in and out of depressions formed in the cigarete surface as they occur under the air jet. The movement of the piston rod thus accurately reflects the changes in firmness of the cigarette.

Referring now more particularly to FIGS. 2 and 3, there is shown a modification of the invention and in this embodiment a pair of air followers **17'** and **17"** are arranged angularly about the axis of the cigarette **19**, both followers directing jets of air radially towards the cigarette about 90° apart. The use of the two followers has several advantages. First of all, the two jets cooperate in keeping the cigarette in the trough as it moves along, there being no tendency for the cigarette to be blown out of position. Also, the two followers obtain more information with respect to the firmness of the cigarette than would a single follower. It will be understood that one

circumferential portion of a cigarette may be more or less firmly packed than another portion. A single follower therebefore might not detect a section of cigarette which is not of the proper firmness throughout. Also, the two followers may be located on either side of the overlapping seam **15** formed by the paper wrapper. It will be appreciated that the overlapped seam **15** is double the thickness of the remaining portion of the paper wrapper and is somewhat stiffer. The increased thickness and stiffness of the seam prevents this portion of the wrapper from yielding as readily as the remaining portion of the wrapper. Accordingly, firmness of the cigarette may be better gauged by air jets directed on other parts of the wrapper.

The followers are identical with the follower illustrated and described in FIG. 1, however, in this embodiment in place of the dial indicator each follower is operatively connected to a signal generator such as a linear variable differential transformer indicated generally by the reference character **54**. The linear variable differential transformer (LVDT) **54** may be of the type disclosed in U.S. Patent No. 2,427,866. Generally, an LVDT is adapted to produce an electrical signal the amplitude of which is proportional to the movement of the nozzle and the piston rod. Thus an electrical signal is produced corresponding to the firmness of the cigarette.

As shown in FIG. 2, two LVDT's **54** are connected to an amplifier **56** which in turn is connected to a meter **58**. The meter **58** provides both a direct reading of the signal as well as having leads for controlling a motor **64** governing the tobacco feed dispenser **14**. The system constitutes a feedback loop whereby the firmness of the cigarette being produced is continuously monitored and the resulting signal is utilized to increase or decrease the rate of tobacco feed so as to produce a cigarette of substantially uniform firmness throughout. Various other feedback systems may be employed such as a pair of servo motors in a closed loop, or stepping relays responsive to the output of the LVDT and controlling the rate of tobacco feed.

Insofar as the cigarette tube is discharged from the cigarette making machine and moves along the trough at a high rate of speed, on the order of four feet per second, for example, its accuracy and response may be improved by locating one or more pairs of air jet nozzles **68** in advance of the pair of air followers **17'** and **17''** which are actually gauging the cigarette firmness. The function of the air jets provided by the nozzles **68** is to prepare the section of the cigarette in advance of the followers by forming depressions in the wrapper where they occur and prior to passing under the nozzles for the followers. Since the cigarette packing and the wrapper have a certain amount of inertia and stiffness, the air jet provided by the follower alone might not be sufficient to form a depression quickly enough where there is a soft spot in the cigarette, and where the cigarette is moving at a high rate of speed. The extra air jets thus form whatever depressions may occur before the cigarette is carried past the followers and the followers will thus generate accurate signals of the true condition of firmness of the cigarette.

Typically, two or three pairs of jets may be provided, spaced perhaps ¾ of an inch apart and located perhaps two inches in advance of the follower.

Having thus described the invention, what I claim and desire to obtain by Letters Patent of the United States is:

1. The method of gauging the firmness of a cigarette, comprising

(a) moving a cigarette longitudinally past an air follower device,

(b) directing an air jet from said device against the outer surface of said cigarette to produce surface depressions in loosely packed portions of said cigarette,

(c) moving said follower device towards said cigarette at said depressions to maintain a substantially constant gap with said cigarette, and

(d) obtaining an output from said follower device in response to said follower movement.

2. The method of claim **1** including the step of moving said cigarette past another air jet directed against the outer surface of said cigarette prior to moving said cigarette past said air follower device.

3. The method of claim **1** wherein said cigarette is moved past a pair of air follower devices each directing an air jet at a different circumferential angle against said cigarette.

4. The method of gauging and controlling the firmness of a cigarette as it is discharged from a cigarette making machine, comprising

(a) moving a cigarette rod longitudinally past at least one air follower device,

(b) directing an air jet from said device against the outer cylindrical surface of said cigarette rod to produce surface depressions in loosely packed portions of said cigarette rod

(c) moving said follower device towards said cigarette rod at said depressions to maintain a substantially constant gap with said cigarette rod,

(d) obtaining an output from said follower in response to said follower movement, and,

(e) utilizing said output to control said machine.

5. Apparatus for gauging the firmness of a cigarette, comprising in combination

(a) first means for supporting a cigarette for longitudinal movement,

(b) second means for moving said cigarette longitudinally along said first means,

(c) an air follower device mounted adjacent said first means and directing an air jet against the outer surface of said cigarette to depress soft portions of said cigarette,

(d) means to move said device to maintain a substantially constant gap with said cigarette, and,

(e) third means for monitoring the movement of said follower device in response to depressions formed in said cigarette by said jet.

6. Apparatus according to claim **5** in combination with other air jet means located in advance of said follower device and directed against said surface.

7. Apparatus according to claim **5** wherein said third means includes a linear voltage differential transformer.

8. Apparatus for gauging and controlling the firmness of a cigarette discharging from a cigarette making machine, comprising in combination

(a) first means for supporting a cigarette for longitudinal movement as it comes from said machine,

(b) at least one air follower device mounted adjacent said first means and directing an air jet against the outer surface of said cigarette to depress soft portions of said cigarette,

(c) means to move said device to maintain a substantially constant gap with said cigarette,

(d) signal generating means for monitoring the movement of said follower device in response to depressions formed in said cigarette by said jet, and,

(e) control means coupling said signal generating means to said cigarette making machine for increasing or decreasing the firmness of said cigarette in response to signals from said signal generating means.

9. Apparatus according to claim **8** wherein said signal generating means is a linear voltage differential transformer.

10. Apparatus according to claim **8** including a plurality of follower devices directing jets of air at said cigarette at different angular positions about said cigarette.

11. Apparatus according to claim **8** including at least one air nozzle located in advance of said follower and directing an air jet against said cigarette.

12. The method of gauging the firmness of a yieldable object, comprising

(a) moving said object longitudinally past an air follower device,

(b) directing an air jet of said device against the outer surface of said object to produce surface depressions in soft portions of said object,

(c) moving said follower device towards said object at said depressions to maintain a substantially constant gap with said object, and

(d) obtaining an output from said follower device in response to said follower movement.

13. Apparatus for gauging the firmness of a yieldable object comprising in combination

(a) first means for supporting said object for longitudinal movement,

(b) second means for moving said object longitudinally along said first means,

(c) an air follower device mounted adjacent said first means and directing an air jet against the outer surface of said object to depress soft portions of said object,

(d) means to move said device to maintain a substantially constant gap with said object, and

(e) means for monitoring the movement of said follower device in response to depression formed in said object by said jet.

References Cited

UNITED STATES PATENTS

2,163,415	6/1939	Stephano	131—21
2,692,498	10/1954	Knobel	73—37.5
2,952,262	9/1960	Pocock et al.	131—21
3,116,478	12/1963	Powell	73—37.5 X
3,194,055	7/1965	Knobel	73—37.7 X

FOREIGN PATENTS

982,001	2/1965	Great Britain.

SAMUEL KOREN, *Primary Examiner.*

J. H. CZERWONKY, *Assistant Examiner.*