Feb. 16, 1971 J. H. ROBERSON ET AL 3,562,866

DENSITY CONTROL FOR A TEXTILE LAP FORMER

Filed Oct. 23, 1968 2 Sheets-Sheet 1

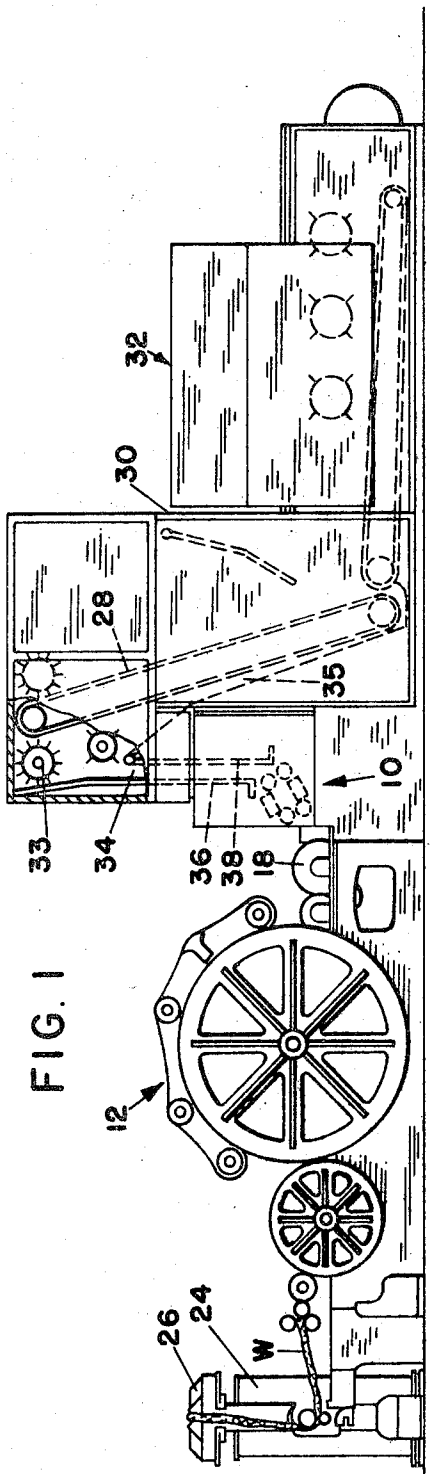

FIG. 1

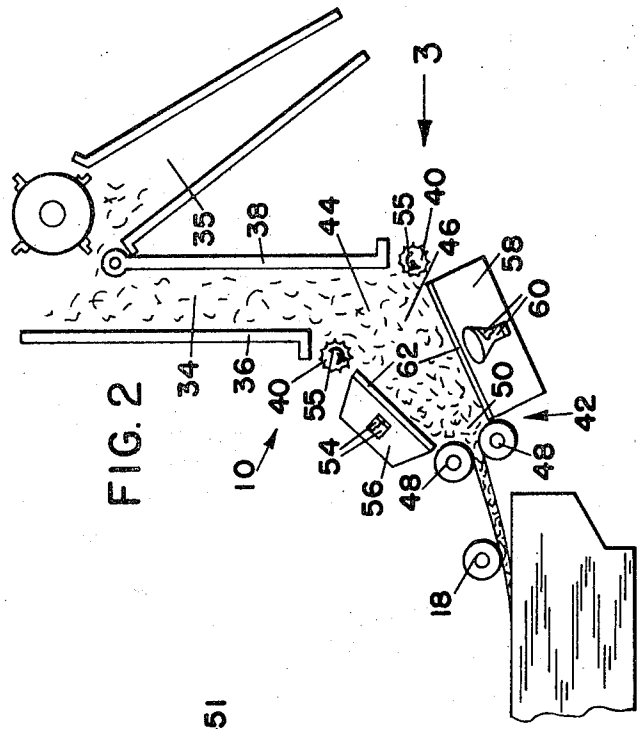

FIG. 2

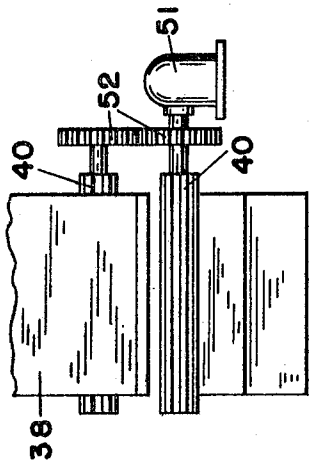

FIG. 3

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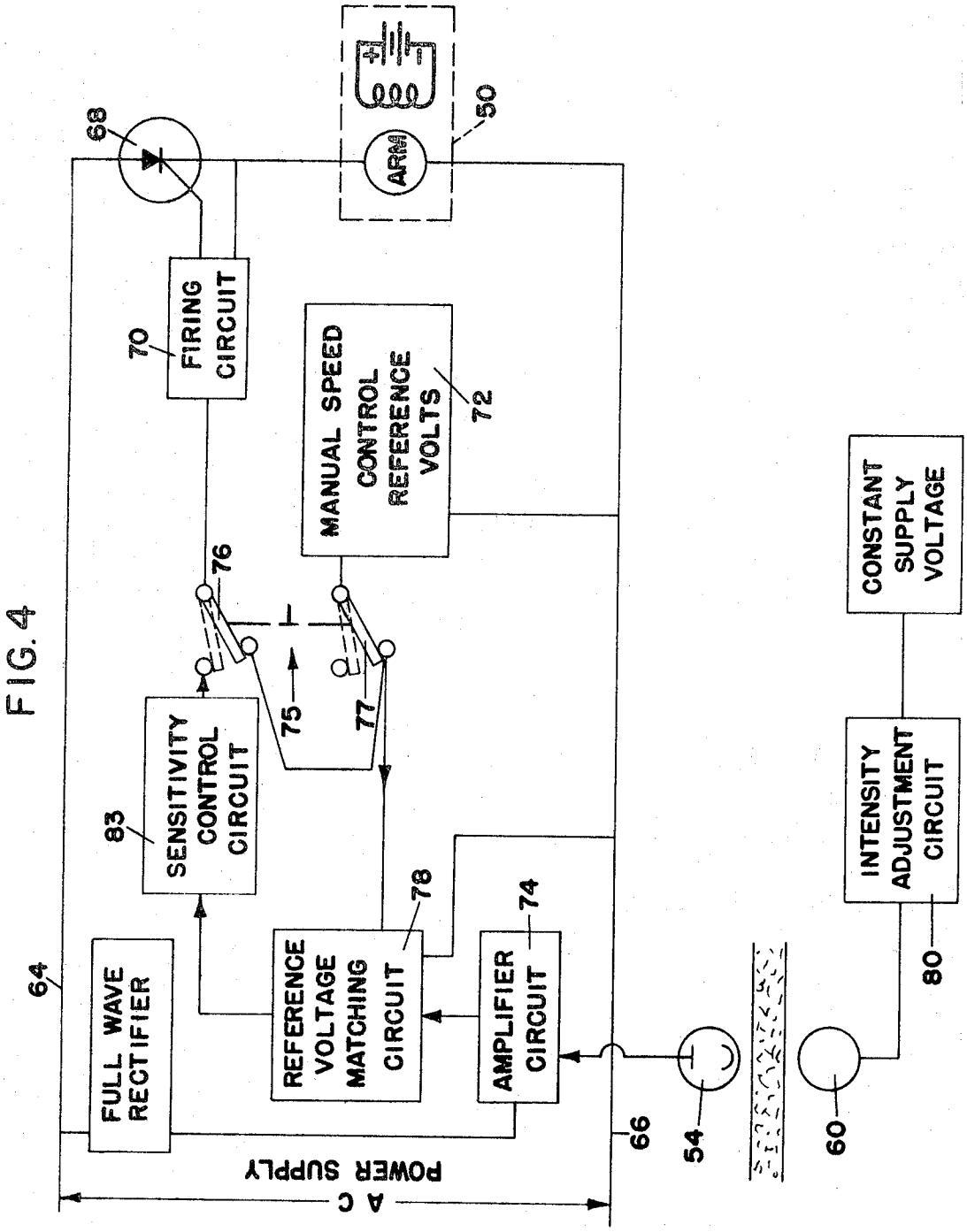
FIG. 4



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DENSITY CONTROL FOR A TEXTILE LAP FORMER

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Int. Cl. D01h 5/38
U.S. Cl. 19—240 7 Claims

ABSTRACT OF THE DISCLOSURE

A lap forming apparatus in which loose fibers are stuffed into an enclosure by stuffing rolls which are driven by a variable speed motor. The fibers are drawn from the other end of the enclosure and formed into a lap. Uniformity of the lap is controlled by measuring the average density of the fibers in the enclosure by photoelectric means. Variations in fiber density produce a signal to control the variable speed motor and thus vary the rate at which fibers are stuffed into the enclosure to maintain uniform fiber density.

BACKGROUND OF THE INVENTION

The invention relates to lap forming means and more particularly to means for controlling the density and weight per unit length of lap produced by said means.

The maintenance of uniformity of laps produced by lap forming machines has always been a problem. Automatic control devices have been developed to measure the lap and adjust the lap feeding means if the lap does not satisfy a set standard. U.S. Pat. No. 3,157,915 to C. F. Gilbo is one example of this approach to control of lap uniformity.

One drawback which results from mechanisms which attempt to control lap thickness or density by measuring the lap is that if the portion of the lap so measured is not the standard density, the automatic control cannot correct for the particular section measured. If the lap is too thick when measured, the speed of lap feed will be adjusted so that a thinner web is produced. When this thinner portion of the lap is measured and proves to be to thin, then the lap feed is adjusted to again make the lap thicker. It will be seen therefore that the average density of substantial length of lap produced in this manner will meet the standards based on average density and weight but real uniformity will be very difficult to achieve. Very minute and sensitive adjustments would be required to smooth out web variations due to adjustments to the lap feed but this becomes very complicated and costly and also has the drawback of not being able to react quickly enough if a significant change were required.

Other means to correct variations in lap density include drafting rolls which maintain the lap under tension and can adjust the lap density by increasing or decreasing lap tension. The tension of the lap is a result of the speed of the drafting rolls. Lap density measuring means control the speed of the drafting rolls in response to variations in lap density. One drawback in this approach to lap density control is that the measurement of a thick or dense portion of the lap will result in an increased tension of the lap, which is more likely to decrease the thinner or less dense portions of the lap rather than the thick or dense portions.

SUMMARY OF THE INVENTION

The lap forming machine is a constant mass flow machine which operates with well opened textile fibers which act very similar to a very viscous fluid. The mass flow rate through a given plane therefore may be said to be a product of the following variables: velocity, flow area and density. If any two of these variables are fixed, then the other variables must also be fixed.

The principal object of the invention, therefore, is to control the density of a lap produced by a lap forming machine by controlling the density before the lap is formed. To those skilled in the art, fixing the velocity and flow area for a given stock can be readily accomplished.

A specific object of the invention is to control the lap density by maintaining uniform fiber density before the lap is formed.

A further object of the invention is the provision of novel means for measuring the average density across a width of a fibrous mass.

The principal objects of the invention are accomplished by the use of stuffing rolls which stuff the loose fibers into an enclosure from which fibers are drawn to form the lap and providing photo-electric means which measure the average density of fibers in the enclosure. The photo-electric means produce an electrical signal to control a variable speed motor for driving the stuffing rolls. A control circuit utilizes the electrical signal to increase the speed of the stuffing rolls when the average density of the fibers in the enclosure measures less than a standard and decreases the speed of the stuffing rolls when the average density of the fibers in the enclosure measures more than a standard or desired density. Since fiber density is controlled before the lap is formed, true uniformity of lap density is achieved. The stuffing rolls can be much smaller than doffing rolls which are used to control lap density in other machines. Therefore, more minute corrections can be made with a faster response rate because of the lower mass inertia. Also, the tendency to overact is minimized. Because the fibers are stuffed into the enclosure, they are under compression and any change in the stuffing rate is immediately reflected at the point at which the density is measured. The disadvantage inherent in density control means which operate by varying lap tension are therefore eliminated.

BRIEF DESCRIPTION OF THE DRAWINGS

These objects and other advantages will become apparent from the following specifications when taken in conjunction with the accompanying drawings in which:

FIG. 1 is a side elevation of a lap forming machine to which the present invention is applied;

FIG. 2 is an enlarged schematic view of the invention;

FIG. 3 is a fragmentary rear elevation of drive means for the stuffing rolls, looking in the direction of arrow 3 in FIG. 2;

FIG. 4 is a schematic diagram of the electrical control circuitry of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring particularly to FIG. 1, the lap forming machine is generally indicated at **10** and is shown in association with a carding machine generally indicated at **12**. The lap produced by the lap former is fed to the carding machine through a feed roll **18**. The carding machine produces a web W in the usual manner after which it is drawn into can **24** by a conventional coiler **26**. Although the carding machine illustrates one use for the lap, the invention is not limited to any particular use as it may be used to feed a needle felting machine or any of the various nonwoven fabric forming machines. Lap forming machines are commonly known in the trade as: direct card feeds, chute feeds, pickers, blenders, etc. Referring to FIGS. 1 and 2, a conveyor **28** feeds opened fiber stock from a first hopper **30**. Fibers are fed to the first hopper

from a supply source generally indicated at **32**. The fibers are taken from the conveyor by a doffing roll **33** and deposited in a chute **34**. An excess of fibers are fed by the conveyor **28** so that chute **34** remains full and the excess is blown down a return chute **35** to the first hopper to be picked up again by conveyor **28**.

Chute **34** includes a fixed plate **36** and a vibrating plate **38** which keeps the fibers moving downward and serves to distribute the fiber stock uniformly widthwise in the machine and to present a fairly uniform density to the lap former **10**.

Referring particularly to FIG. 2, the lap former **10** includes a pair of stuffing rolls **40** which feed a secondary hopper **42** through an inlet **44**. Rolls **40** literally stuff the fiber into an enclosure **46**. A pair of lap former rolls **48** draw fibers from an outlet **50** of enclosure **46** from which they are led to the card feed roll **18**. The lap former rolls and feed roll **18** are driven in synchronism and at a constant rate so that if the density of fibers at the outlet **50** in enclosure **46** is held constant, the amount of fibers drawn by the lap former rolls will be constant and will result in the production of a uniform lap.

In order to maintain uniform fiber density in enclosure **46**, means are provided to control the rate of rotation of stuffing rolls **40**. Referring to FIGS. 2 and 3, a variable speed motor **51** is drivingly connected to one of the stuffing rolls which is in turn connected to the other stuffing roll through equal gearing **52** so that rolls **40** are driven in synchronism and in opposite directions as indicated by arrows **55** in FIG. 2.

The speed of the motor is controlled by the average density of the fibers in enclosure **46**. Referring to FIG. 2, there is a dustproof housing **56** on one side of enclosure **46** and a dustproof housing **58** on the other side. A series of photoelectric sensors **54** are arranged in housing **56** for intercepting light emanating from a light source **60** in housing **58**. The portions of enclosure **56** and **58** which border enclosure **46** are made of a transparent or translucent material such as glass or the like indicated at **62**.

The circuitry for controlling the speed of motor **51** is shown in FIG. 4. The motor **51** is connected across a pair of power lines **64** and **66**. Current flow through the motor armature is controlled by a silicon controlled rectifier **68** which, when conducting, feeds the positive half cycle of each electrical pulse to the motor. A firing circuit **70** is timed in synchronism with rectifier **68** and controls the firing angle of rectifier **68** so that it will be longer or shorter during the positive half cycles to supply more or less current to the motor. This part of the motor control is standard and is more fully described in the General Electric Manual GEK–4660 published May 1967.

The standard motor control circuit also includes a manually controlled potentiometer **72** which establishes a reference voltage. For a given motor speed, this reference voltage is constant. During the negative half cycle when the rectifier **68** is not conducting, the D.C. motor generates an E.M.F. which varies according to the motor speed. The firing circuit campares the differential between the E.M.F. and the reference voltage and holds it essentially constant by changing the firing angle of rectifier **68**. If the motor speed drops below the set speed, the generated E.M.F. decreases, thus causing an increase in the differential between the reference voltage and the E.M.F. The firing circuit **70** reacts to this differential by advancing the firing angle of the rectifier **68** so that it conducts longer during each half cycle, thus supplying more power to the armature and increasing motor speed. If the motor speed is above the set speed, the generated E.M.F. increases causing a decrease in the differential between the reference voltage and the E.M.F. The firing circuit **70** reacts to this decrease in differential by delaying the firing angle of the rectifier **68** so that it conducts for less of each half cycle, thus supplying less power to the armature and decreasing motor speed. The reference voltage in the potentiometer can be changed manually to set the motor speed at the level desired.

The standard circuit for controlling the motor speed has been modified as shown in FIG. 4 so that the speed of the motor can be automatically changed to maintain stock density at a fixed value instead of keeping the motor speed constant as in the case of the standard circuit.

In the modified circuit of the present invention, there are still two signals which are fed to the firing circuit. One signal is the E.M.F. and the other is produced by the photocell sensors **54**. The photocell signal is amplified and replaces the above-mentioned manual reference voltage. The sensors are stimulated by the light passing through enclosure **46** from light source **60**. Stimulation of the sensors produces a singal which is amplified through an amplifying circuit **74**. Sensors **54** are of the photo-emissive type which generate a small current when stimulated by light energy. Photoconductive sensors could also be used whose resistance changes in accordance with the light striking it. The latter requires a separate power source but either type will produce a small current proportional to the light intensity.

The circuit shown in FIG. 4 may function manually or automatically. A double pole, double throw switch **75** which has a pair of switch arms **76** and **77** enable the circuit to function manually when arms **76** and **77** are in the full line position shown in FIG. 4. When the circuit is thus set, the machine can be operated manually to vary the motor speed, until the desired nominal lap density is obtained. For this motor speed, the corresponding manual reference voltage is fed into a matching circuit **78**. The reference voltage obtained from the sensors **54** is also fed into the matching circuit. The difference between these references is indicated on a voltmeter located on the face of the panel. The sensor signal gain is varied until it is exactly equal to the manual reference singal so that the voltmeter reads zero volts difference. When the signals are thus matched, switch **75** is operated so that switch arms **76** and **77** are operated to assume their dotted line position in FIG. 4 thus changing the circuit to automatic.

When the circuit in FIG. 4 is changed to automatic for measuring variations in fiber density in enclosure **46**, the signal from the sensors is substituted for the previously described signal from the manual speed control **72**. As the density of the fiber stock passing between the light source and the sensors decreases, the increased amount of light source and the sensors decreases, the increased amount of light stimulation causes an increased sensor output. This increased output increases the differential between the sensor signal and the E.M.F. The firing circuit reacts to this difference by advancing the firing angle of the rectifier **68** which speeds up the motor. The increased speed of the motor drives the stuffing rolls at a faster rate and stuffs more stock between the light source and sensor.

If there is an increase in stock density passing between the light source and the sensors, there will be a decreased sensor output. This decrease in output decreases the differential between the sensor signal and the E.M.F. The firing circuit accordingly reacts to this difference by delaying the firing angle of the rectifier **68**, resulting in a decrease in motor speed. The stuffing rolls are therefore driven at a slower speed and less fiber stock is placed between the light source and sensors.

It is important that the signal received from the sensors be indicative of the average fiber density in a line taken across the full width of the enclosure **46**. For this reason, there are a plurality of sensors and they are spaced across the width of the enclosure so that each sensor receives light passing through a different portion of the enclosure **46** from light source **60**. If there are variations from one end of the enclosure to the other, the sensors will be stimulated to varying degrees. The outputs of all the sensors are integrated into one output so that the resulting signal will therefore be a reflection of the average density of fibers across the enclosure **46**.

Light source **60** may be series of lights, one for each sensor or fluorescent light source which gives off a homogeneous light through the entire translucent surface **62** of enclosure **58**. If desired, the intensity of the light source can be varied by any conventional intensity adjustment circuit indicated at **80** in FIG. 4. The amount of light may therefore be increased or decreased depending on the particular type of fiber used or density of lap produced.

The amplified signal is fed through a sensitivity circuit **83** which can be adjusted to modify the photoelectric signal which is fed to the firing circuit. Circuit **83** will control the rate that the motor accelerates and decelerates in response to changes in the photoelectric signal. Any standard sensitivity circuit may be used which may include a pair of manually-operated potentiometers for determining the charging and discharging rates of a capacitor.

The electrical control means which has been described provides flexibility in that it is adjustable for a wide range of fiber and lap conditions. It is also sensitive in that very minute changes can be made in the motor speed in very short intervals. Operating on normal sixty cycle current, for example, the silicon controlled rectifier will produce sixty pulses per second to the motor, each one of which is influenced by the intensity of the photocell signal. Any change in fiber density measured across enclosure **46** is immediately reflected in motor speed.

Having particularly described the invention, what is now claimed is:

1. Lap forming apparatus comprising:

(a) an enclosure having an inlet opening and an outlet opening;

(b) spaced stuffing means disposed near said inlet opening for stuffing loose fiber into said enclosure through said inlet opening, said stuffing means being spaced apart a distance substantially equal to said inlet opening;

(c) lap former rolls for evacuating fiber from said outlet opening and forming it into a lap;

(d) variable drive means for driving said stuffing means;

(e) means for measuring the average density of textile fiber in said enclosure and for generating a signal corresponding to the density measured in said enclosure; and

(f) control means responsive to said signal for controlling said variable drive means, whereby said stuffing means will maintain a substantially uniform density in said enclosure.

2. The lap forming apparatus as described in claim **8** wherein said variable drive means is a variable speed electric motor and said means for measuring the average density of fibers in said enclosure comprises:

(a) a light source on one side of said enclosure for transmitting light to the other side of said enclosure; and

(b) a plurality of spaced photoelectric sensors on the other side of said enclosure opposite said light source for sensing light emanating from said light source and generating an electrical signal to said control means, said signal being a total result of said sensors.

3. The lap forming apparatus as described in claim **2** wherein said sensors and said light source are enclosed by translucent dust-free enclosures.

4. The lap-forming apparatus as described in claim **8** wherein said stuffing means are rolls.

5. Lap forming apparatus comprising:

(a) an enclosure having an inlet opening and an outlet opening and having at least two walls that converge toward said outlet opening;

(b) lap former rolls for evacuating fiber from said outlet opening and for forming said fiber into a lap;

(c) spaced stuffing means disposed near said inlet opening for stuffing loose fiber into said enclosure through said inlet opening, said stuffing means being spaced apart a distance substantially greater than the distance between said lap former rolls;

(d) variable drive means for driving said stuffing means;

(e) means for measuring the average density of textile fibers in said enclosure and for generating a signal corresponding to the density measured in said enclosure; and

(f) control means responsive to said signal for controlling said variable drive means, whereby said stuffing means will maintain a substantially uniform density in said enclosure.

6. The lap forming apparatus as described in claim **5** wherein said variable drive means is a variable speed electric motor and said means for measuring the average density of fibers in said enclosure comprises:

(a) a light source on one side of said enclosure for transmitting light to the other side of said enclosure; and

(b) a plurality of spaced photoelectric sensors for sensing light emanating from said light source and generating an electrical signal to said control means, said signal being the total result of said sensors.

7. The lap forming apparatus as described in claim **6** wherein said sensors and said light source are enclosed by translucent dust-free enclosures.

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DORSEY NEWTON, Primary Examiner

U.S. Cl. X.R.

19—105

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,562,866 Dated February 16, 1971

Inventor(s) James H. Roberson and Robert J. Poterala

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

Column 5, line 49, and column 6, line 6 -- The claim reference numeral "8", each occurence, should read --1--.

Signed and sealed this 15th day of June 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR
Commissioner of Patents