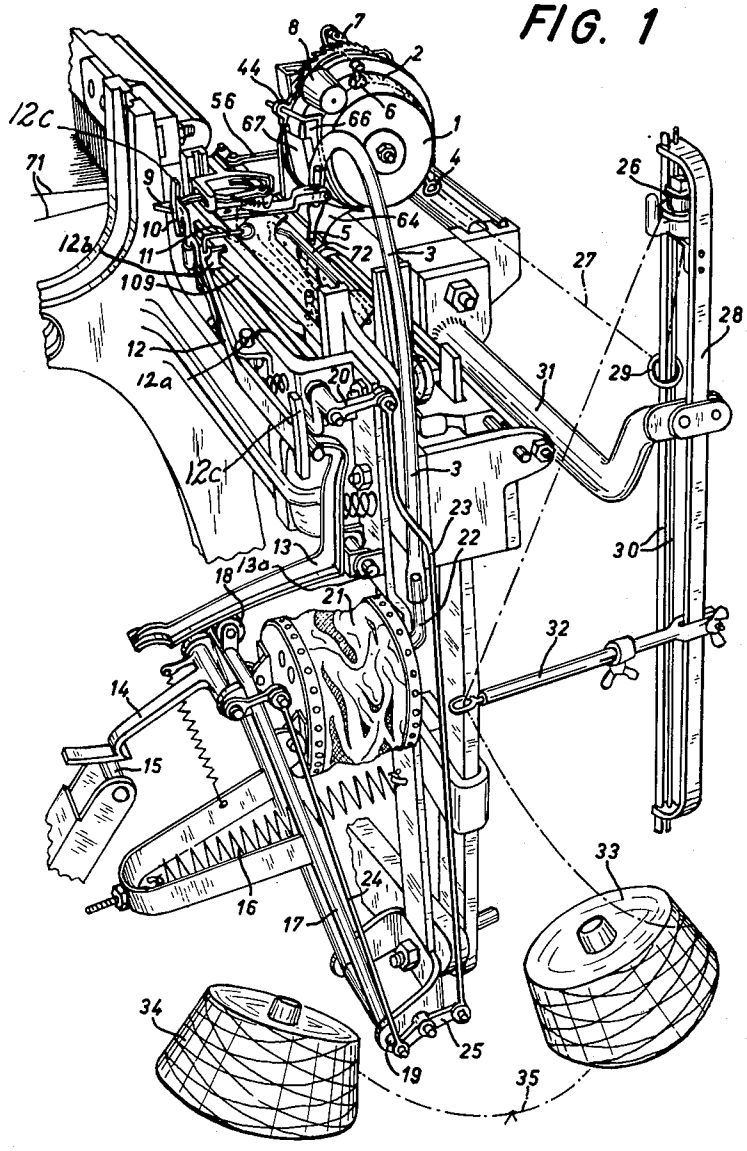
June 21, 1966 E. W. HORTMANN 3,256,914

WEAVING METHOD AND PNEUMATIC LOOM

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FIG. 1



INVENTOR
Erich Walter Hortmann

BY

Michael J. Striker
ATTORNEY

June 21, 1966 E. W. HORTMANN 3,256,914

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FIG. 2

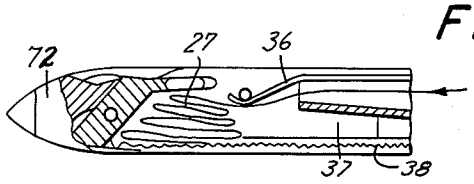


FIG. 3

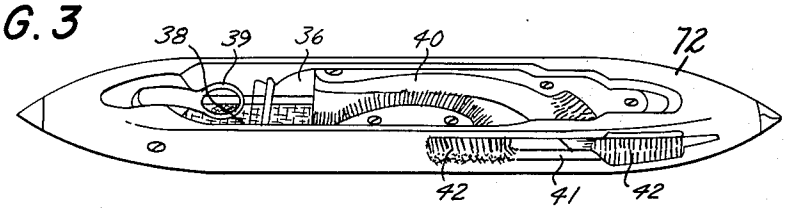


FIG. 8

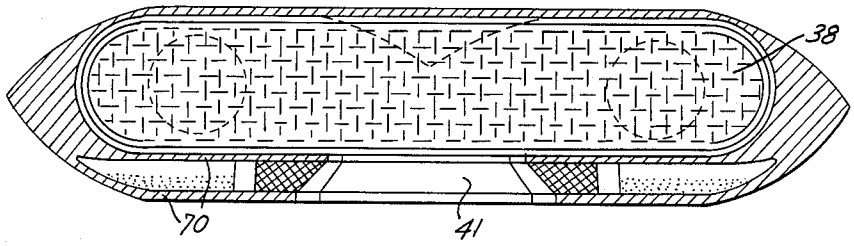


FIG. 9

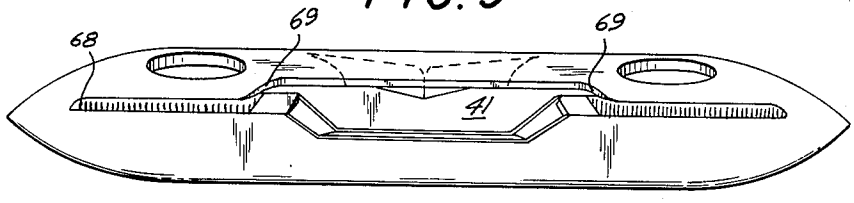
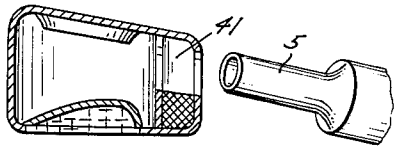


FIG. 10



INVENTOR.
Erich Walter Hortmann

BY

Richard S. Striker
Atty

June 21, 1966 E. W. HORTMANN 3,256,914

WEAVING METHOD AND PNEUMATIC LOOM

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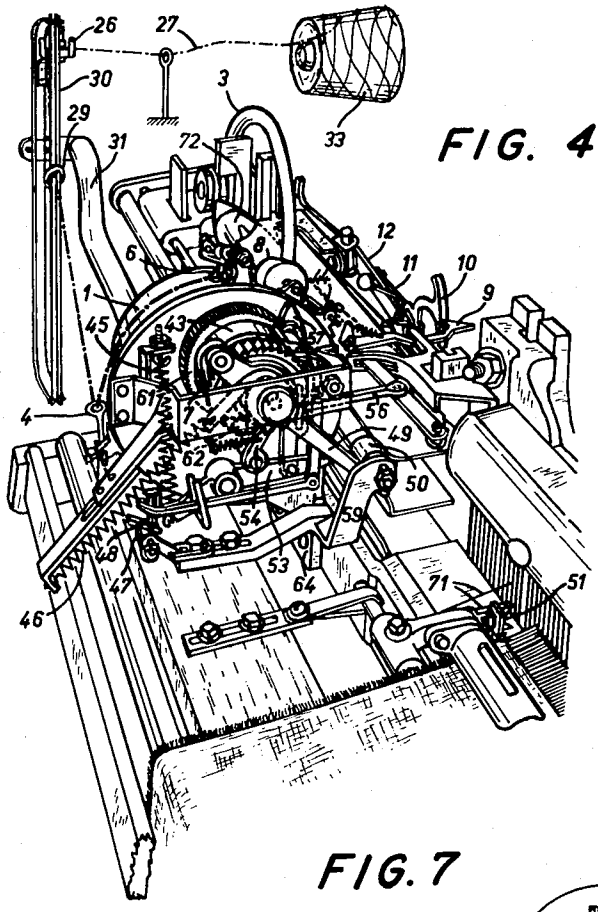
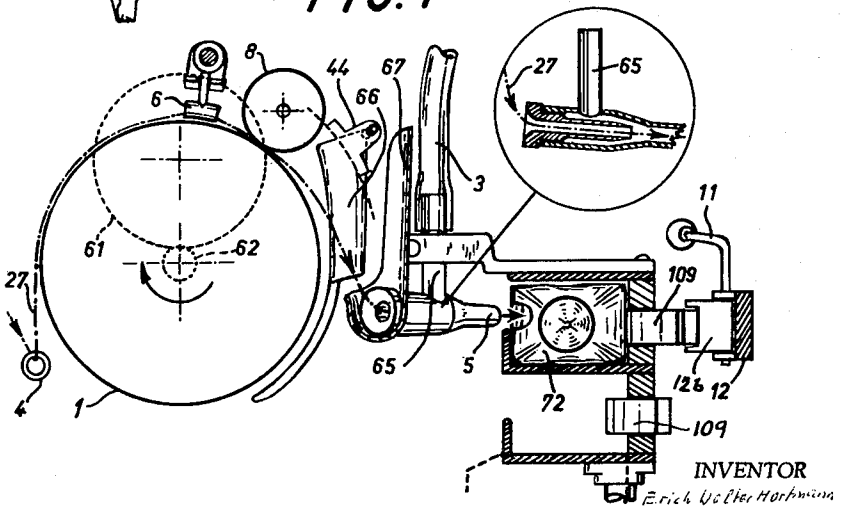


FIG. 4

FIG. 7



INVENTOR
Erich Walter Hortmann

BY

Michael J. Striker
ATTORNEY

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WEAVING METHOD AND PNEUMATIC LOOM

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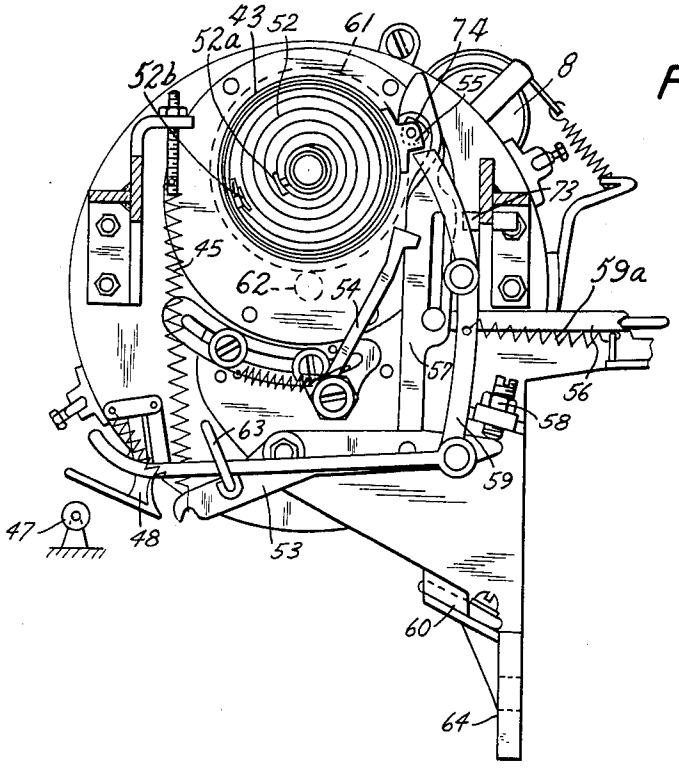


FIG. 5

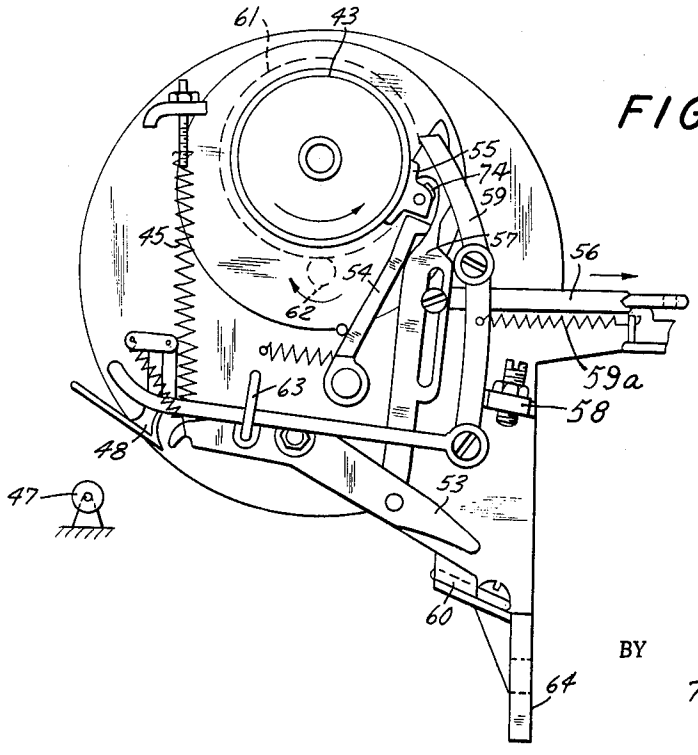


FIG. 6

INVENTOR.
Erich Walter Hortmann

BY

Michael S. Striker

June 21, 1966 E. W. HORTMANN 3,256,914

WEAVING METHOD AND PNEUMATIC LOOM

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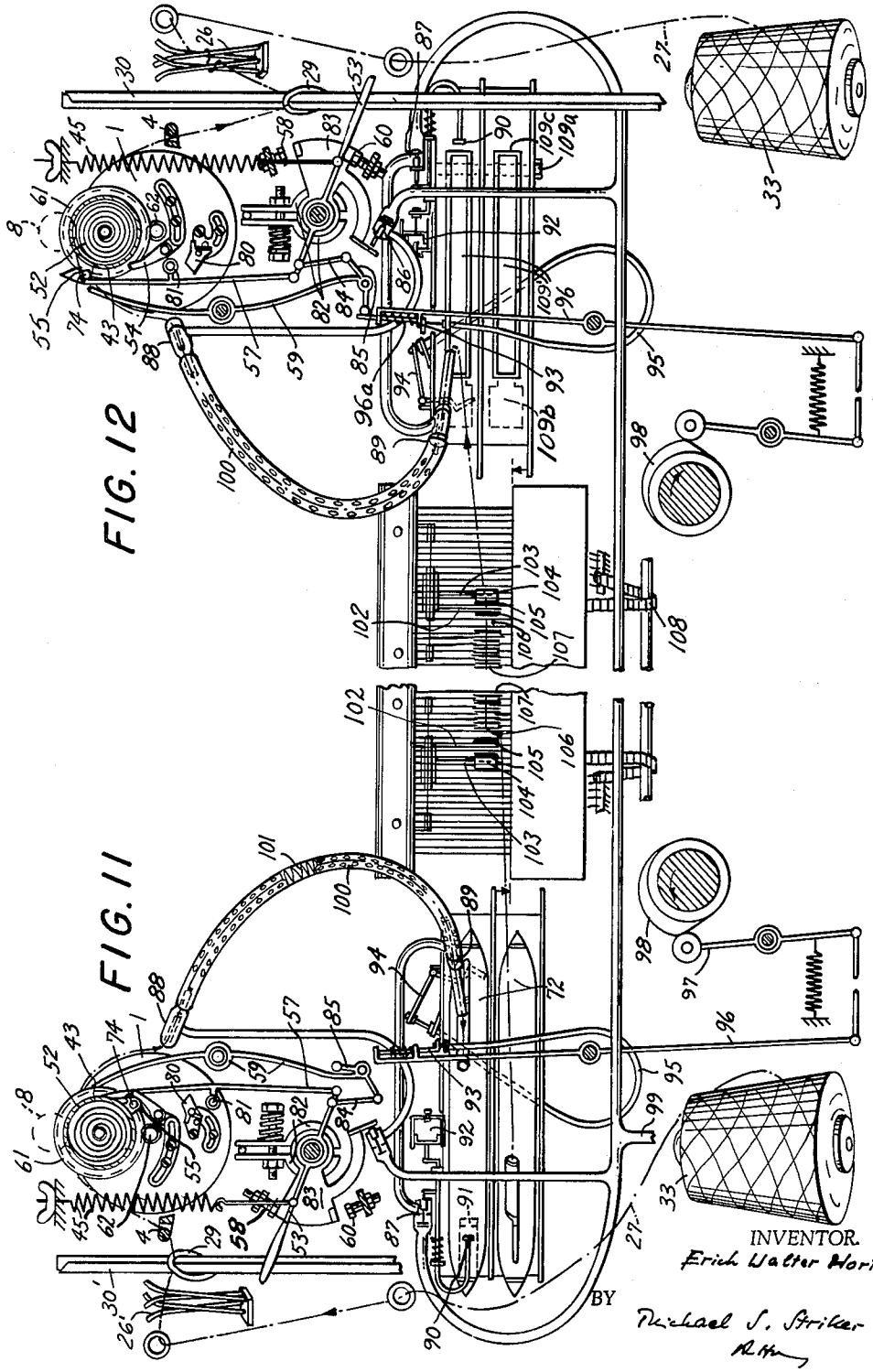


FIG. 12

FIG. 11

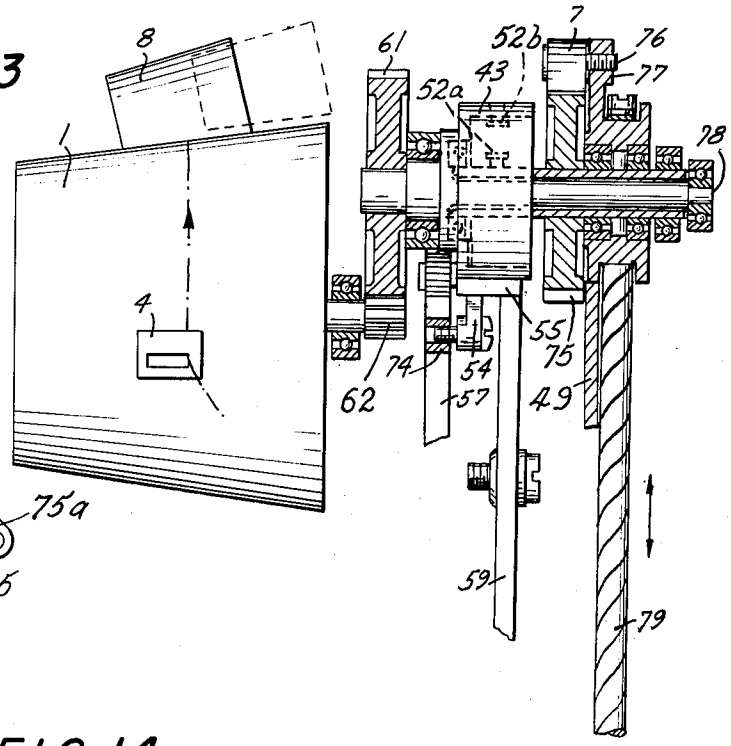
INVENTOR.
Erich Walter Hortmann
BY
Michael S. Striker
Atty

June 21, 1966 E. W. HORTMANN 3,256,914

WEAVING METHOD AND PNEUMATIC LOOM

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FIG. 13



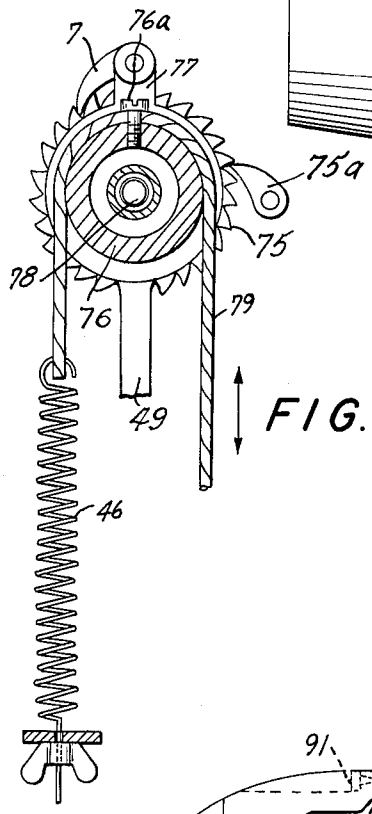
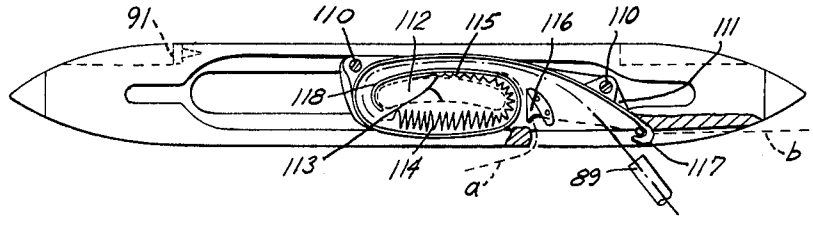


FIG. 14

FIG. 15



INVENTOR.
Erich Walter Hortmann

BY

Richard J. Stricker

United States Patent Office 3,256,914 Patented June 21, 1966

3,256,914

WEAVING METHOD AND PNEUMATIC LOOM

Erich Walter Hortmann, Schotten, Germany, assignor to Albert Hortmann, Schotten, Germany

Filed Dec. 24, 1962, Ser. No. 250,200
Claims priority, application Germany, Dec. 22, 1961, H 44,469
9 Claims. (Cl. 139—125)

The present invention relates to a weaving method, and to a pneumatic loom for carrying out the method of the invention.

Pneumatic looms are known in which a weft thread is drawn from a spindle package and blown by a stream of air through a warp shed. Suction is applied to the other side of the thread, but it is difficult to transport the weft through the shed without occasional disturbances. In shuttleless pneumatic looms of this type, the weft is cut off at the edge of the shed, so that no selvedges are formed.

It is one object of the invention to overcome disadvantages of known pneumatic looms, and of methods for operating pneumatic looms, and to provide a method for operating a pneumatic loom in a reliable and efficient manner.

Another object of the present invention is to provide a pneumatic loom of simple construction which produces a woven fabric provided with selvedges.

Another object of the invention is to provide a pneumatic loom in which a shuttle carries a measured length of weft thread.

Another object of the present invention is to provide a pneumatic loom with a dispensing device dispensing measured lengths of weft thread corresponding to the width of the woven fabric.

Another object of the present invention is to dispense a measured length of weft thread corresponding to twice the width of the fabric so that a shuttle transporting the measured length of weft thread through two sheds, lays two wefts.

With these objects in view, a weaving method according to the present invention comprises the steps of dispensing a measured length of weft thread from a supply of weft thread located on one side of a warp shed; blowing at least a part of the measured length of the weft thread into a hollow shuttle; moving the shuttle from one side of the shed to the other side of the shed while holding the weft thread on one side of the shed so that a portion of the measured length forms a weft in the shed; and cutting the weft thread on said one side.

The dispensed and measured length of weft thread corresponds to twice the width of the warp shed, and the shuttle is moved in return movement through another shed so that the part of the weft located in the shuttle is drawn out of the shuttle and forms another weft in another shed.

A double length of weft thread may be blown into the shuttle, and drawn out during travel of the shuttle in opposite directions through two sheds.

The weft thread is inserted into the shuttle by means of a nozzle which is spaced from the edge of the fabric, so that a piece of weft thread extends between the nozzle and the cutting means after the weft thread has been cut. Preferably, the cut off end piece of the weft thread is retracted to the nozzle so that the nozzle is ready for insertion of another measured length of weft thread into a shuttle.

The dispensing operation which is effected by a dispensing device may still be carried out while the shuttle travels the first time through a shed.

The dispensing of the measured length of weft thread, and the insertion into the shuttle is preferably carried out at the same time.

In a modified embodiment of the invention, the measured length of weft thread is first blown into a storage means, and then blown from the storage means into the shuttle. In this embodiment, the dispensing device is preferably mounted on the frame of the shuttle, and connected with a nozzle by a flexible hose. In another embodiment, the dispensing device is mounted on the slay of the loom.

The start of the dispensing operation, and the start of the blowing of the weft thread by the nozzle, is controlled by a sensing means which detremine the arrival of an empty shuttle in the region of the nozzle.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The inveniton itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a fragmentary perspective view illustrating a loom according to one embodiment of the invention as seen from one side;

FIG. 2 is a fragmentary sectional view illustrating a shuttle;

FIG. 3 is a perspective view illustrating the shuttle;

FIG. 4 is a fragmentary perspective view illustrating the dispensing device as seen from the other side of the loom;

FIG. 5 is a side elevation illustrating the dispensing device in an operational position at the end of a dispensing operation;

FIG. 6 is a side elevation corresponding to FIG. 5, but illustrating another operational position of the dispensing device at the end of an operation withdrawing a part of the weft thread;

FIG. 7 is a perspective view, partially in section, illustrating a detail of a weft inserting nozzle;

FIG. 8 is a sectional view illustrating a modified shuttle;

FIG. 9 is a plan view of the shuttle illustrated in FIG. 8;

FIG.10 is a perspective view, partially in section illustrating the insertion of a weft thread into the shuttle;

FIG. 11 is a schematic side elevation illustrating one side of a loom according to a modified embodiment in the operational position directly after the beat of the reed;

FIG. 12 is a schematic side elevation illustrating the loom of FIG. 11 as viewed from the other side, and in the same operational position;

FIG. 13 is a front view of the dispensing device used in the embodiment of FIGS. 11 and 12;

FIG. 14 is a fragmentary, partially sectional view, illustrating a mechanism for winding up the spring-loaded dispensing device of FIG. 13; and

FIG. 15 is a plan view illustrating another embodiment of a shuttle according to the present invention.

The drawings illustrate a basically conventional loom with two shuttle boxes on either side, which is adapted according to the present invention to operate with two shuttles of which one has its starting position in the upper left shuttle box, and the other has its starting position in the right upper shuttle box, the two shuttles traveling alternately to the lower right and to the lower left shuttle box, respectively, to change the weft color according to a 1:1 or 2:2 program. In accordance with the invention, the shuttles do not carry bobbins, but each shuttle is supplied with a measured length of weft thread sufficient for two picks, and consequently corresponding to twice the width of the woven fabric. At least a part of the weft required for the second pick is inserted into each shuttle while the same is on one side of the loom, while the length of weft required for the first pick, may be dragged by the shuttle, or supplied during the travel of the shuttle through the first shed. However, if the shuttles stay sufficiently long on one side of the loom, as will be the case during

a 2:2 weaving operation, the entire length of weft thread necessary for two picks will be deposited in the shuttle.

It is also possible to charge the shuttle with part of the weft thread, start the travel of the shuttle to the other side of the shed, and to supply the rest of the necessary length of weft thread during the travel of the shuttle through the first shed.

At the moment in which a shuttle arrives in its initial position, a measured length of weft thread is blown into the shuttle by a nozzle. For example, as shown in FIG. 7, a weft thread **27** passes through a nozzle **5** mounted on a support and guide plate **67** and supplied with air under pressure from a tubular connection **3**, **65**. As shown in FIG. 10, the nozzle **5** blows the weft thread into an opening **41** on the side of a hollow shuttle.

A dispensing device is provided for drawing the weft thread from a spindle package **33** or **34** connected by a thread **35**, and for dispensing a measured length of weft thread to the nozzle. When the weft has been inserted, it is cut off at the edge of the fabric by a cutting means **51**, and the dispensing device is operated to pull back the dispensed thread a distance corresponding to the distance between the nozzle **5**, see FIG. 1, and the cutting means **51**, shown in FIG. 4, so that the end of the thread is located at the nozzle, and can be properly inserted into a shuttle during a following inserting operation.

FIGS. 1, 4, 5 and 7 illustrate one embodiment of the invention in which the nozzle **5** is mounted on the upper shuttle box, and in which the dispensing device with the measuring drum **1** is mounted on the slay by means of a base plate **64**. The pressure air is supplied to nozzle **5** by bellows **21** in a timed relation to the shuttle operation so that air is supplied to nozzle **5** at the moment in which a weft thread has been dispensed and is to be inserted or blown into the shuttle.

As best seen in FIGS. 1, 4, 5 and 6, the dispensing device includes a turnable drum **1**, which is conical for adjustment of the dispensed length of the thread, and which has a rubber cover **2**. An adjustable thread guide **6**, a pressure roller **8**, a guide means **66** for the thread, adjustable on a holder **44**, and a thread guide **4** are provided as also shown in FIG. 12.

A spring motor drives the dispensing device and includes a spring housing **43** with a main spring **52** which is intermittently wound up. A winding lever **49** is secured to a pulley **76** mounted freely turnable on shaft **78** and having a bracket **77** carrying a ratchet pawl **7**, as best seen in FIGS. 13 and 14. During reciprocation of the slay, lever **49** runs against roller **50** on the breast beam of the loom and is angularly displaced in clockwise direction, as viewed in FIG. 14. A band **79** is secured to pulley **76** by a screw **76***a* and also to a wind-up spring **46** so that the same is tensioned during the clockwise stroke of lever **49**. A ratchet **75** is secured to shaft **78** to which main spring **52** is attached, and prevented from turning in clockise direction by a locking pawl **75***a*. When lever **49** separates from roller **50**, spring **46** turns lever **49** in counterclockwise direction so that pawl **7** turns ratchet **75** with shaft **78** and main spring **52** to wind up the main spring, unless the latter is tensioned so highly that the force of wind up spring **46** is insufficient to turn shaft **78**, in which event lever **49** remains in its wound up position, until the main spring has run down.

Main spring **52** is secured to a journal shaft at **52***a*, and to spring housing **43** at **52***b*.

The spring housing **43** is turned by main spring **52** a single revolution during each operation, and is connected by gear means **61** and **62** with the measuring drum **1** so that the same performs the number of revolutions necessary for dispensing a certain length of weft thread. The dispensing device has control means, as follows:

A stop **55** is provided on the spring housing **43** and includes a stop roll **74** cooperating with a stop hook **57** as shown in FIGS. 5, 6 and 13. Stop hook **57** is pivotally connected with one arm of a double-armed lever **53** whose other end is attached to the catch and return spring **45**. Stops **58** and **60** limit the movement of the double-armed lever **53**, the upper stop **58** determining the terminal stop position of stop hook **57** for each dispensing operation, while the lower stop **60** determines the position of stop hook **57** before stopping a dispensing movement.

FIG. 6 illustrates a dispensing device and its control means in an intermediate position which is at the same time the starting position before the beginning of a dispensing operation. Stop hook **57** holds stop roll **74** and spring housing **43** against the action of main spring **52**. When release rod **56** is operated in the direction of the arrow, stop hook **57** releases stop roll **74** so that double-armed lever **53** with stop hook **57** are turned by spring **45** to engage stop **60** while spring housing **43** is driven by main spring **52** to cause a rapid rotation of measuring drum **1** through gears **61** and **62**. Return stop arm **54** is pushed aside by roll **74**.

After a little less than one revolution of the spring housing, stop hook **57** is again engaged by roll **74** and is taken along due to the inertia of the measuring drum which is braked, until engages stop **58** of double-armed lever **53** whereby the spring housing and thereby the measuring drum **1** are stopped, while arresting lever **59** snaps under stop **55**, due to spring **59***a*, as shown in FIG. 5. In this position, the return spring **45** is tensioned, and a measured length of weft thread has been dispensed, including a piece of weft thread extending from nozzle **5** to the edge of the fabric.

When the weft has been beaten into the fell of the fabric, the weft thread is cut off at the edge of the fabric and at the outermost warp thread by cutting device **51**, shown in FIG. 4. A guide thread **71**, which is controlled by a loom part, guides the weft thread to the cutting device **51**.

When the slay performs its return movement arresting lever **59** is pulled off stop **55** by a release hook **48** displaced by a small roll **47** on the breast roll, so that return spring **45** turns the dispensing device and drum **1** against the action of the main spring **52** in the opposite direction until stop **55** abuts the spring-loaded return stop arm **54**. Due to this opposite rotation, measuring drum **1** draws the cut off end of the dispensed weft thread from cutting means **51** and the edge of the fabric back to the nozzle outlet. At the same time, release hook **48** is raised out of the region of roll **47** so that the dispensing device is again in its initial position shown in FIG. 6.

The distance which the weft thread is retracted toward the nozzle, can be adjusted by adjustment of the return stop arm **54** toward or away from stop **55**.

As long as the weft thread has not been retracted, the dispensing device is locked by a stop screw **73** shown in FIG. 5 against which the stop hook **57** abuts to prevent an undesired release of the dispensing device at this moment.

The start of a dispensing operation by the forward rotation of the drum **1**, takes place simultaneously with the operation of the bellows **21** which is tensioned by a spring **16** acting on a member **17** pivoted at **19**. In the initial position, compression of the bellows **21** is prevented since a locking lever **13** engages roll **18** on member **17**.

In the embodiment of FIG. 1, the entire device is mounted on the slay, and reciprocates with the same. An actuating hook member **14** is turnably mounted on pivoted member **17**, and cooperates with a bolt **15** mounted on the frame of the loom so that the bellows **21** is again expanded when the slay moves forward and member **14** is hooked to bolt **15** and prevents movement of member **17** with the slay. The outlet means **22** of bellows **21** is connected by a hose **3** and a sleeve **65** with nozzle **5**, as shown in FIGS. 1 and 7. The guide sheet **66** controls and guides together with plate **67** the weft **27** to prevent entanglement in the event that the weft thread is supplied too rapidly.

A starting impulse is given by a shuttle **72** arriving at the shuttle box and displacing a tongue **109** on which a forked part **12***b* on one end portion of a sensing lever **12** rests so that lever **12** is angularly displaced about pivot **12***a* of a universal joint. An adjustable abutment member **10** is provided which shifts a hook member **9** to start the dispensing device through a lever and the release rod **56** as described with reference to FIGS. 5 and 6, when shifted by the displaced tongue **109**. The other end of the turned sensing lever **12** raises through lever **20**, link **23**, lever **25** and link **24** the actuating hook member **14** of the bellows to release bolt **15** so that pivoted member **17** is released, and the bellows **21** blow air into nozzle **5**. The end of lever **12** also engages the vertical arm of the bellcrank lever **13** and turns the same about pivot **13***a* so that the horizontal locking arm of lever **13** is raised out of the path of roller **18**.

Since sensing lever **12** moves up and down with the shuttle boxes, it is mounted in a universal joint, and has part-circular end portions.

A handle **11** is provided for turning the pivoted forked part **12***b* of sensing lever **12** to an inoperative position which permits the manual insertion of a shuttle into the upper shuttle box without actuation of the dispensing device and air pressure supplying means **21**. The operation is started after insertion of the shuttle into the shuttle box, by turning the end portion of sensing lever **12** back to its sensing position embracing tongue **109**.

When the dispensing device is stopped, it is necessary to maintain the weft thread in tensioned position, and to prevent the feeding of an additional length of thread due to inertia. The portion of the weft thread between the supply spindle package **33** and the dispensing drum **1** is loaded by a ring-shaped weight **29**. This weight is also operative to take up slack when the measuring drum **1** performs a turning movement for withdrawing the weft thread. A U-shaped member **28** is mounted on the frame portion **31** and supports two rods **30** extending at a very small angle to each other. Ring **29** surrounds rods **30**, and slides along the same due to the action of gravity. The weft thread **27** from spindle packages **33** or **34**, passes through an eye of a holder **32**, over the thread brake **26**, between rods **30** and through ring **29** to the dispensing device so that the weft thread is guided in a direction transverse to the direction of oscillation of the slay which results in the least influence of the reciprocating slay on the thread letoff from the spindle package **33** or **34**.

Referring now to the loom illustrated in FIGS. 11 to 15, a dispensing device is provided on the left side and on the right side of the loom, and the dispensing devices are mounted on the frame. Since the shuttle boxes oscillate with the reciprocating slay, a flexible hose **100** connects the stationary dispensing devices with the nozzle **89** which is mounted on the shuttle box. The weft thread dispensed from the dispensing device is stored temporarily in hose **100** which thus constitutes a storage device for the thread. An axiliary nozzle **88** is arranged at the dispensing device, and blows the weft thread into the hose **100** which is provided with perforations permitting the air to escape, while the weft thread is transported to the main nozzle **89**, and from there inserted into the empty shuttle arriving at the shuttle box. The part of the weft thread which is still in the hose when the shuttle travels through the shed, is pulled out of the hose by the shuttle.

FIG. 11 shows a stored thread portion **101** in hose **100**. Nozzle **88** inserts an additional thread portion into the hose until the measuring drum stops, while nozzle **89**, which started to blow 1¾ turns of the main shaft later, has started to blow the weft thread into the shuttle, and at the same time pulls the weft thread out of the hose so that the amount of thread stored in the hose decreases although additional thread is supplied from the dispensing device. Consequently, during the pick, the entire stored weft thread is drawn out from the hose, unless the measuring drum stops before that. Nozzles **88**, **89** are constructed as shown for nozzle **5** in FIG. 7 and have inner thread-guiding parts and outer annular air passages communicating with an air supply pipe **99**.

In the embodiment shown in FIGS. 11 to 15, the measuring of the weft thread is not started at the beginning of the insertion of the weft thread into the shuttle, but already when the cut off end of the weft thread is withdrawn, and directly after the beat of the first picked weft of the length of weft thread previously measured and dispensed.

For this purpose, the stop hook **57** carries a roll **81** which urges through a member **80** the stop hook **57** away from roll **74** when the thread is pulled back, so that directly after abutment of stop **55** on the return stop arm **54**, the dispensing operation is started. Consequently, the rearward movement of the dispensing drum **1**, which has just started in the position of FIG. 12, will immediately be followed by the next dispensing and measuring operation.

The dispensing device illustrated in FIGS. 11, 12 and 13 operates in substantially the same manner as the dispensing device described with reference to FIGS. 4, 5, 6, 13 and 14. The wind-up spring **46** is tensioned by a band **79** guided over a pulley **76**, see FIGS. 13 and 14, which may be pulled in downward direction by an arm, not shown, mounted in the region of the turning axis of the slay when the slay moves forward. During the return movement of the slay, the arm is released so that spring **46** turns the belt pulley **76** with bracket **77** and pawl **7** which shifts ratchet wheel **75** to wind-up the main spring **52** which is hooked at one end into the hollow shaft **78** of ratchet wheel **75**.

The retraction of the weft thread from the cutting device to the nozzle, which starts the next dispensing operation, is controlled by a cam **98** from the crankshaft. Cam **98** acts through levers **97** and **96** on the small lever **85**. However, the upper end of lever **96** reaches lever **85** only after the shuttle has left its initial position. As long as a shuttle is in shuttle box, it urges the tongue **109'** outwardly to a position in which the tongue extension **109***b* blocks sensing lever **94**, as shown in FIG. 11, and does not permit spring **96***a*, which engages a flange on pin **93**, to move pin **93** to an operative position, since sensing lever **94** is connected by a Bowden cable to stop pin **93**. When the shuttle box is empty, tongue **109'** can move inwardly when spring **96***a* moves pin **93** to the operative position shown in FIG. 12.

Tongues **109'** are mounted in windows **109***c* of the shuttle boxes for pivotal movement on a pivot pin **109***a*. The small lever **85** which is pivotally connected to arresting lever **59**, is connected by link **84** through double-armed lever **53** with stop hook **57** so that it can assume an operative position only if the preceding dispensing operation has been completed.

The position of the elements in FIG. 12 corresponds to the moment in which the arresting lever **59** has been pushed away from the stop **55** of the spring housing **43** so that the return spring **45** starts to turn the device in rearward direction through double-armed lever **53** and hook member **57**.

The position of FIG. 11 shows the last part of the operation of the dispensing device, shortly before stop roll **74** has moved into the region of the stop hook **57**. Lever **85** is in an inoperative position, and the shuttle is still in the initial position so that the abutment pin **93** is retracted, so that no operation can be started in this position. Consequently, the operation can only be started when the preceding operation has been fully completed, and the shuttle with the measured length of dispensed weft thread has moved out of the starting position.

The pressure air is taken through a hose **99** from a source of compressed air having a pressure of between 0.01 and 0.1 atm. Suitable valves are provided in hose **99**, and a pump may produce the compressed air.

The control of the valve **86** for the nozzle **88** is effected by a control portion **83** cooperating with the double-armed lever **53** which opens valve **86** at the start of the rotation of the measuring drum. When the measuring drum stops, valve **86** is closed. Member **83** includes a brake part **82** which brakes double-armed lever **83** in its end positions shortly before engagement with stops **58** and **60**.

Valve **87** for nozzle **89** is opened by a sensing portion **90** engaged by portion **91** of the shuttle when the same arrives at the shuttle box and is stopped. A spring closes valve **87**, in an action which is delayed by small pneumatic cylinder and piston means **92**, so that the time during which insertion of the weft thread into the shuttle takes place can be adjusted.

The force of the nozzle may be increased, if the pressure air is supplied in a vibrating or pulsating condition, which may be obtained by a suitable vibrating valve. The shock waves in the air act in the nozzle like the pistons of a cylinder which drive air out of a tube and produce suction between the pressure waves so that a greater force is exerted on the thread.

The thread brake before the ring weight **29**, and its guides **30'**, is constructed as a V-shaped grid-like structure which, together with ring **29** compensates differences in tension of the thread which may be caused by empty or full spindle packages. In accordance with the tension of the thread, ring **29** pulls the thread more or less down between the crossing fingers of the thread brake **26'**, and when the thread is greatly tensioned at the beginning of the dispensing operation, it is raised above the thread brake so that the same is not effective.

When the measuring drum stops, the ring weight **29** pulls an excess of the weft thread into the weft brake **26'** so that no additional thread can be drawn from the spindle package during the return movement of the measuring drum when the ring weight **29** drops lower.

The cutting devices which are necessary at both edges of the fabric for cutting the weft threads, each comprise a cutting knife **102**, and a pressure member **103** which are mounted on a common shaft directly behind the upper edge of the reed, and on the slay. The cutting devices are advanced to an operative position only when the reed performs the beating operation, which is accomplished by a suitable small chain **108** whose length can be adjusted. The presser member **103** presses the thread against a leather abutment **104** which is mounted on the fabric holder so that the knife **102** cuts the thread held between pressure member **103** and fabric edge in a groove **104** of the fabric holder, or tears the thread.

The weft threads connected to the shuttle carrying thread for the return pick, are guided downward by a guide thread **106**, appearing as a dot in the drawing, and consequently guided away from the knife **102** and the pressure member **103**. The guide thread **106** is raised and lowered by a suitable shaft, not shown, or by the motion of the shuttle box. A weft thread **107** is shown which has just been beaten up and woven into the fabric, while a shed just opens.

FIGS. 2, 3, 8, 9, 10 and 15 illustrate embodiments of shuttles which are advantageously used in the loom of the present invention for carrying out the method of the present invention. The shuttle shown in FIG. 3 has an insert with a channel **40** whose inner front wall is constructed as a brush for the thread, while the opposite wall is smooth and curved in such a manner that the weft thread, when blown into the shuttle, slides along the smooth surface due to the action of the centrifugal force without engaging the brush surface. On the other hand, when the weft thread is drawn out during the travel of the shuttle, it is smoothed by engagement with the brush wall. The bottom of the channel **40** is particularly at one end higher than the bottom of the shuttle **38**, which is constructed as a sieve or grid, so that portion **37** of the thread storage chamber is located directly below the end of the inlet channel end, whereby an ejection of the thread due to the shock of the shuttle arriving in the shuttle box is prevented. The inlet channel is covered by downwardly bent cover of plexiglass. A shuttle eye **39** guides the thread. A sieve **36**, or a grid, closes the thread storage chamber on top. On the left and right side of the inlet opening **41**, thread brushes **42** are provided.

FIG. 9 shows a modified shuttle in which sufficient space is provided for the weft thread, so that layers of the thread slip due to the shock of the stop shuttle in such a manner that the pulled out thread is alternately drawn into the two thread brake slots **68** to which slanted guide edges **69** lead located on opposite sides of the inlet opening **41** in the front double wall **70**. FIG. 8 is a section of the shuttle shown in FIG. 9, clearly showing the sieve-like or grid-like bottom **38**. FIG. 10 illustrates the cross section of the shuttle of FIG. 9.

FIG. 15 illustrates a shuttle capable of receiving the inserted thread in such a manner that the thread cannot become entangled, and is easily pulled out without forming any loops.

This is accomplished by an inlet channel having the form of a flat tapered elongated spiral and having a narrow portion **115** partly surrounding an air permeable sieve-like wall **113** which extends around an elongated outlet **112**. The leading thread end is lightly clamped in the narrow portion when blown in, and is pulled out again after the portion of the thread located in the wider chamber **114** has been pulled out in smooth and straight condition.

The inlet channel with the thread storage chamber **114** is closed by a plexiglass cover **111** which is attached by screws **110**. The upper air outlet opening **112** is opened in the plexiglass cover. Behind the inlet opening of the shuttle, and on the inner side of the wider portion of the inlet channel, a self-threading thread guide **116** is provided into which the thread is always safely threaded during the first pick, and where the thread is braked and stretched when pulled out during the second pick due to the portion thereof curving about the thread guide **116** and the wall **118**. A self-threading thread guide eye **117** assures that even the outermost end of the thread runs out in smooth and stretched condition during the second pick. The dotted line (a) indicates the path of the thread leaving the shuttle during the first pick, and the line (b) illustrates the path of the thread during the second pick.

Looms according to the present invention can be operated with comparatively small and flat shuttles, and can consequently be equipped with shorter shaft motions, slay motions and shuttle box motions, which permits the operation of the loom at a number of picks which cannot be attained by conventional looms.

When the loom of FIG. 11 and FIG. 12 is operated at the maximum number of revolutions, during the 3.5 revolutions of the crankshaft which are available for the dispensing operation, the dispensing operation can still be carried out in a manner which will not fray or damage the weft thread, or wear out the dispensing device.

The pneumatic insertion of the weft thread into the shuttle can be very rapidly accomplished without any wear on the weft thread, particularly since the stored thread portion in hose **100** is always laid in tight loops and curves in the vicinity of nozzle **89** so that even highly twisted yarns have no space to untwist and to become entangled.

Furthermore, only a little more than half of the measured length of weft thread has to be inserted into the shuttle, since the part of the weft thread which has not been inserted into the shuttle, is blown out of and through the storage hose **100** until the weft thread extends in stretched condition through nozzle **89** and hose **100** to the measuring drum, which has been stopped in the

meantime to determine the measured length of the dispensed thread portion.

When the measured weft length is placed in the shed during the travel of the shuttle, the weft thread is not worn or unduly tensioned, since only a very small tension under uniform conditions is applied to the weft, without the great differences in the tension and weight which are unavoidable when shuttles are operated in conventional looms. Due to the fact that the condition of shuttle travel remain always the same, the loom can be operated at higher speed.

The weft inserting method of the present invention permits the weaving with threads having two different colors, for example a black and a gray weft can be alternately inserted, or two gray wefts may follow two black wefts. It is also possible to alternate one gray, one black with two gray and two black wefts. It is also possible to weave into the fabric an extra thread of a particular bright color in which event on either side of the loom a third shuttle box is provided for one or two other shuttles.

A four color weave of the basic fabric is accomplished by providing on either side of the loom two dispensing devices with corresponding nozzles for the weft insertion.

Since a weft thread is inserted through two sheds, portions of alternating wefts are located alternately on the edges of the fabric, so that a sufficiently strong selvedge is formed.

An apparatus according to the present invention forms a complete unit which can be mounted on a conventional loom with shuttle boxes without any exchange of parts. For example, in the embodiment of FIGS. 11 and 12, only two hoses, a belt, a Bowden cable, and a light rod to the control cam have to be provided.

If a loom is built in accordance with the present invention, standard parts of conventional looms can be used during the manufacture. However, it is advantageous to construct the loom in such a manner that very flat and comparatively small shuttles can be used, since the shuttle transports only a length of weft as required for two picks. Corresponding shorter slay and shuttle box movements can be provided. Looms which do not perform more than 150 cycles per minute, do not require the premeasuring and the storing in the hose **100**, and consequently one nozzle can be eliminated, and only the nozzle **88** is required from which a non-perforated hose leads to the shuttle box in which the shuttle blow line terminates. In this embodiment, the thread end can be drawn deeply into the hose. When the thread is blown into the shuttle, the preceding thread end has already a higher speed when entering the narrowed portion of the shuttle channel, which facilitates an improved reinsertion.

In order to make use of this advantage also in the construction of FIGS. 11 and 12, where the thread is stored in the hose, the nozzle pipe of nozzle **89** is preferably made longer than the tubular end portion of nozzle **88**, in which event the return stop arm **54** of the dispensing device can be omitted, since it is not necessary to control the rearward movement of the drum in such an exact manner.

The dispensing device may also be constructed to be driven by an electric motor instead of by a spring motor, in which event the shaft **78** serves only as a control shaft which effects the connection and disconnection of the drive motor, whereas the return rotation is accomplished by the return spring which is tensioned as explained above. The control of the dispensing device may also be carried out by electromagnetic means.

The thread guide of the dispensing device may be oscillated by a cam provided on the spring housing, not shown, so that the thread moves in axial direction along the surface of the measuring drum to prevent the formation of a groove in the surface coating of the measuring drum.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of weft inserting arrangements differing from the types described above.

While the invention has been illustrated and described as embodied in a weaving method according to which the shuttle carries only a predetermined length of the weft thread, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A weaving method comprising the steps of dispensing from a supply of weft thread located on ane side of a warp shed a measured length of weft thread corresponding to twice the width of the warp shed; blowing the measured length into a storage means to store the same, and then blowing at least a part of the stored measured length of the weft thread into a hollow shuttle; moving the shuttle from said one side of the shed to the other side of the shed while holding said weft thread on said one side of the shed so that the portion of said measured length still stored in said storage means forms a pick in said shed; cutting said weft thread on said one side; and moving the shuttle through a warp shed from said other side to said one side so that said part of said measured length is drawn out of the shuttle and forms another pick in another shed.

2. A pneumatic loom comprising a dispensing device for dispensing a measured length of weft thread, when actuated including an intermittently rotating measuring drum, and thread supply means for supplying thread to said drum so that a thread is wound up on said drum and a measured length of thread is dispensed during turning movement of said drum; a hollow shuttle; pressure nozzle means for blowing at least part of the measured length into said shuttle, said shuttle having a tapered perforated channel for holding the end of the thread; means for guiding the measured length of thread from said drum to said nozzle means; means for supporting said dispensing device, said nozzle means, and the shuttle on one side of the loom and of warp sheds formed on the loom; and means for sensing an empty shuttle at said one side of the loom, and operatively connected to said dispensing device to actuate the same when sensing an empty shuttle.

3. A pneumatic loom comprising a dispensing device for dispensing a measured length of weft thread, when actuated including a rotary measuring drum, and means for supplying a thread to said drum; a hollow shuttle; pressure nozzle means for blowing part of the measured length into said shuttle; cutting means for cutting a thread carried by said shuttle during a pick and spaced a predetermined distance from said nozzle means; control means for first turning said drum in one direction for dispensing a measured length of the thread to said nozzle and shuttle, and for then turning said drum in the opposite direction for winding back a part of said thread having a length substantially equal to said distance so that the thread end is located at said nozzle pressure air supply means for supplying air under pressure to said nozzle means; means for supporting said dispensing device, said nozzle means, and the shuttle on one side of the loom and of warp sheds formed on the loom; and means for sensing an empty shuttle at said one side of the loom, and operatively connected to said control means of said dispensing device, and operatively connected to said

pressure air supply means to actuate the same when sensing an empty shuttle.

4. A pneumatic loom comprising a dispensing device for dispensing a measured length of weft thread, when actuated including a rotary measuring drum, and means for supplying a thread to said drum; a hollow shuttle; pressure nozzle means for blowing at least part of the measured length into said shuttle; cutting means for cutting a thread carried by said shuttle during a pick and spaced a predetermined distance from said nozzle means; control means for first turning said drum in one direction for dispensing a measured length of the thread to said nozzle and shuttle, and for then turning said drum in the opposite direction for winding back a part of said thread having a length substantially equal to said distance so that the thread end is located at said nozzle; a reciprocating slay; bellow means operated by said reciprocating slay; conduit means including valve means connecting said bellow means with said nozzle means for supplying air under pressure to said nozzle means; means for supporting said dispensing device, said nozzle means, and the shuttle on one side of the loom and of warp sheds formed on the loom; and means for sensing an empty shuttle at said one side of the loom, and operatively connected to said control means of said dispensing device, and operatively connected to said valve means, and operatively connected to said bellow means to actuate the same when sensing an empty shuttle.

5. A pneumatic loom comprising a dispensing device for dispensing a measured length of weft thread, when actuated including a rotary measuring drum, and means for supplying a thread to said drum; a hollow shuttle; pressure nozzle means for blowing at least part of the measured length into said shuttle; cutting means for cutting a thread carried by said shuttle during a pick and spaced a predetermined distance from said nozzle means; control means for first turning said drum in one direction for dispensing a measured length of the thread to said nozzle and shuttle, and for then turning said drum in the opposite direction for winding back a part of said thread having a length substantially equal to said distance so that the thread end is located at said nozzle; frame means for supporting said dispensing device on one side of the loom; reciprocating slay means for supporting said nozzle means and the shuttle on said one side of the loom and of warp sheds formed on the loom; hose means connecting said dispensing device with said nozzle means for guiding and storing a part of the measured length of thread; and means for sensing an empty shuttle at said one side of the loom and operatively connected to said control means of said dispensing device to actuate the same when sensing an empty shuttle.

6. A pneumatic loom comprising a dispensing device for dispensing a measured length of weft thread, when actuated including an intermittently rotating measuring drum, and thread supply means for supplying thread to said drum so that a thread is wound up on said drum and a measured length of thread is dispensed during turning movement of said drum; a hollow shuttle; pressure nozzle means for blowing at least part of the measured length into said shuttle; means for guiding the measured length of thread from said drum to said nozzle means; frame means for supporting said dispensing device on one side of the loom; reciprocating slay means for supporting said nozzle means and the shuttle on said one side of the loom and of warp sheds formed on the loom; hose means connecting said dispensing device with said nozzle means for guiding and storing the measured length of thread; other nozzle means for blowing the weft thread into said hose means; and means for sensing an empty shuttle at said one side of the loom and operatively connected to said dispensing device to actuate the same when sensing an empty shuttle.

7. A pneumatic loom as set forth in claim 3 wherein said dispensing device includes a spring-motor; said measuring drum being driven by said motor, said motor including a spring housing mounted for turning movement; and said control means having a stop, a stop hook cooperating with said stop, a return stop arm cooperating with said stop, a spring-loaded double-armed lever pivotally connected with said stop hook, and means for moving said stop hook away from said stop.

8. A pneumatic loom comprising a dispensing device for dispensing a measured length of weft thread, when actuated, said dispensing device including a rotary measuring drum, means for turning said drum in one direction to dispense a measured length of weft thread corresponding to two picks and an additional piece of weft thread extending between said nozzle means and the edge of the fabric; cutting means for cutting the weft thread at the edge of the fabric; means for effecting turning of said drum in the opposite direction to draw said additional piece of weft from said cutting means to said nozzle; a shuttle pressure nozzle means for blowing at least part of the measured length into said shuttle; means for guiding the measured length of thread from said drum to said nozzle means; means for supporting said dispensing device, said nozzle means, and the shuttle on one side of the loom and of warp sheds formed on the loom; and means for sensing an empty shuttle at said one side of the loom and operatively connected to said dispensing device to actuate the same when sensing an empty shuttle.

9. A shuttle having a channel in the form of an elongated spiral adapted to hold a length of weft thread, said channel gradually tapering from a wider outer portion to a narrower inner portion, and being partly formed by air-permeable walls permitting escape of air when a weft thread is blown into said channel whereby the thread is wedged in said gradually tapering channel.

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DONALD W. PARKER, *Primary Examiner.*

RUSSELL C. MADER, *Examiner.*

J. KEE CHI, *Assistant Examiner.*