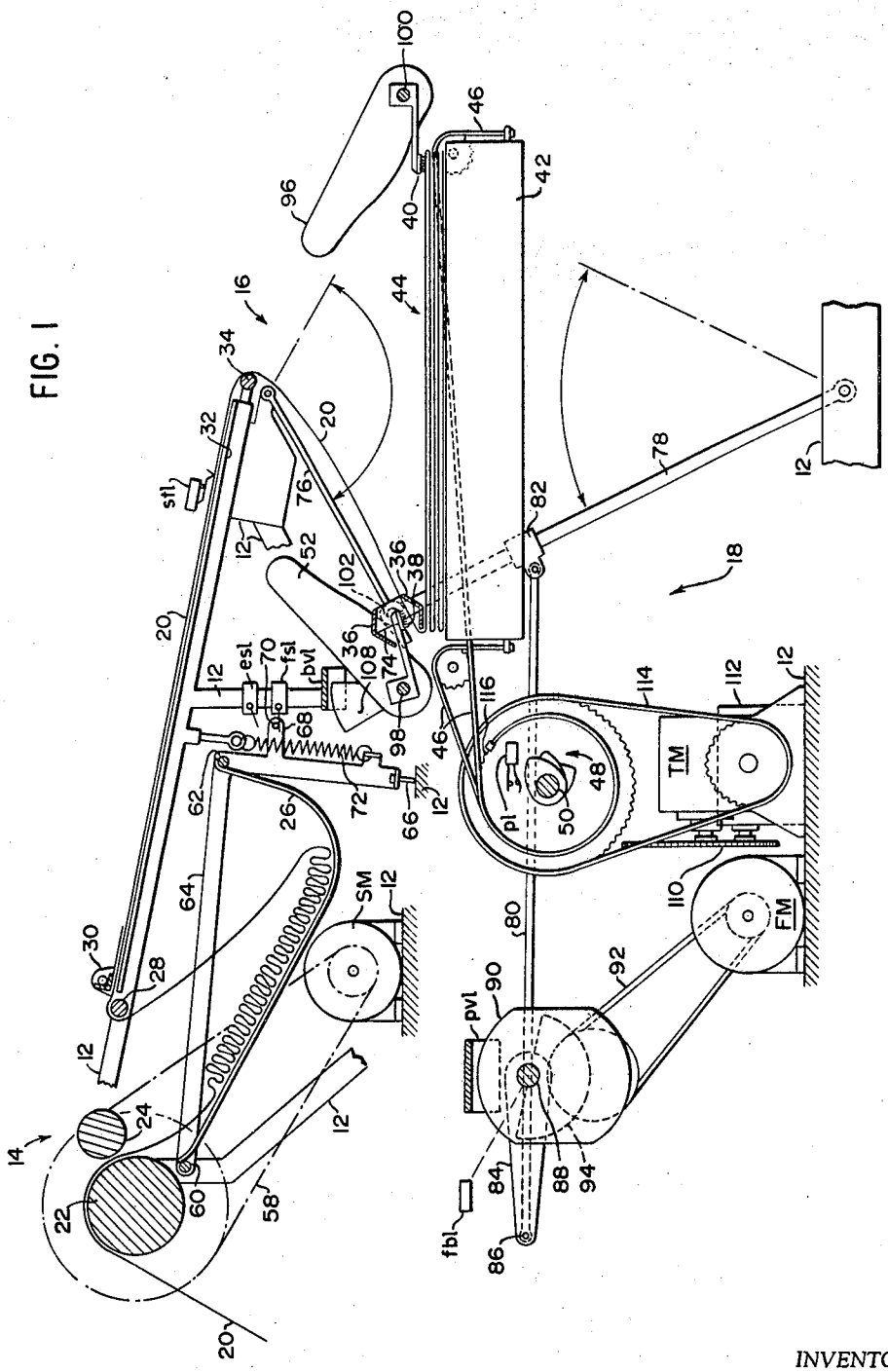
Feb. 17, 1970 R. L. DAVIDSON 3,495,819

FOLDING MACHINE

Filed July 7, 1967 3 Sheets-Sheet 1

FIG. 1



INVENTOR.
RALPH L. DAVIDSON
BY Fenway, Jenney & Hildreth
ATTORNEYS

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FOLDING MACHINE

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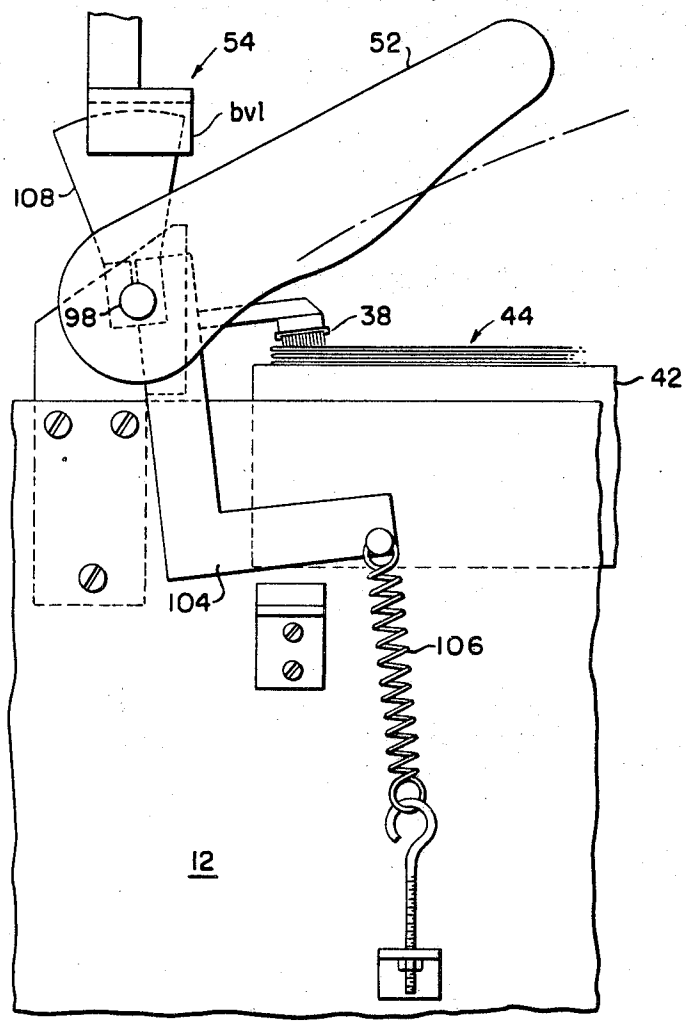


FIG. 2

INVENTOR.
RALPH L. DAVIDSON
BY Kenway, Jeaney & Hiedrich
ATTORNEYS

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FOLDING MACHINE

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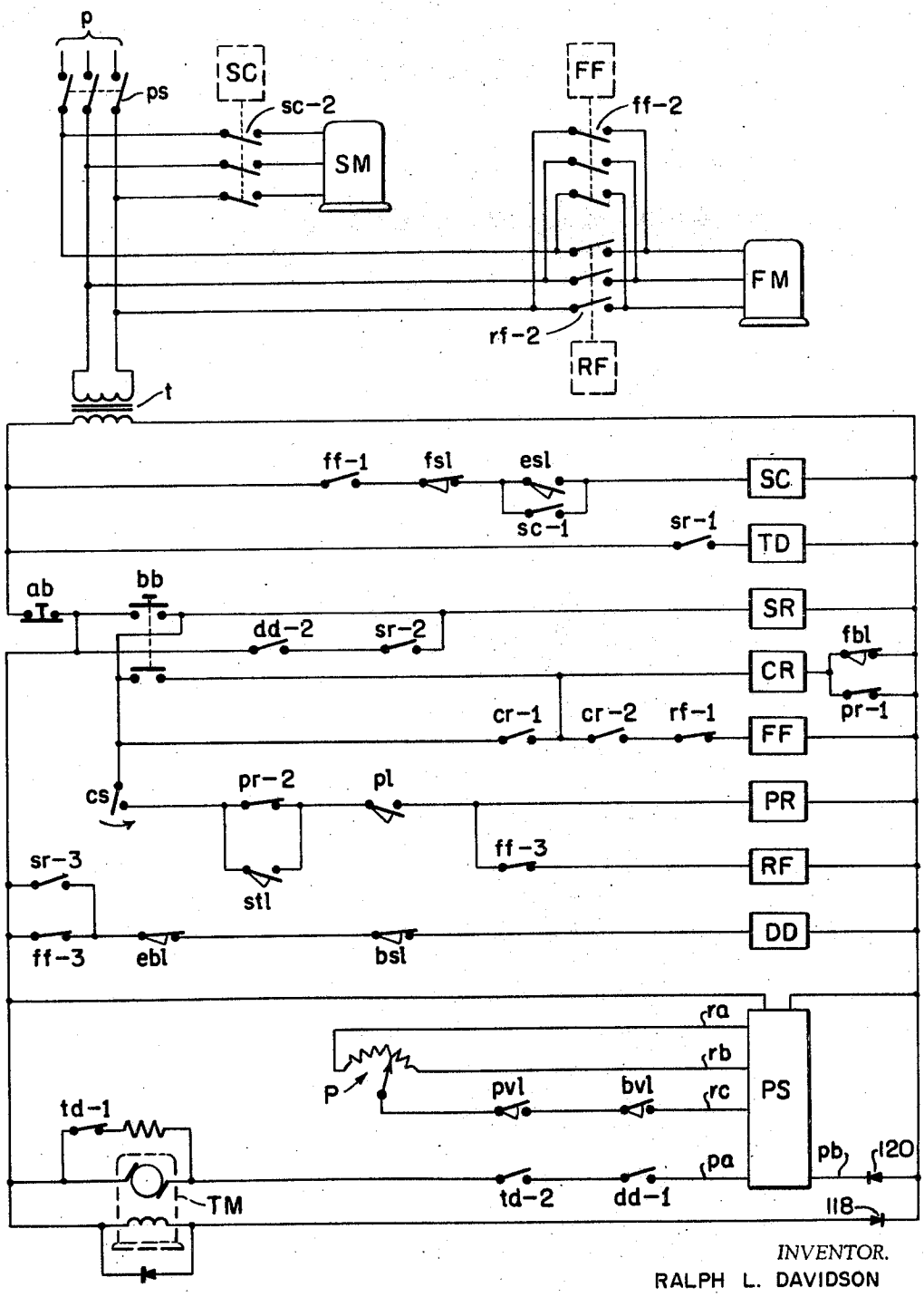


FIG. 3

INVENTOR.
RALPH L. DAVIDSON
BY Kenway, Jenney & Hildreth
ATTORNEYS

United States Patent Office 3,495,819 Patented Feb. 17, 1970

3,495,819

FOLDING MACHINE

Ralph L. Davidson, Worcester, Mass., assignor to Curtis & Marble Machine Co., Worcester, Mass., a corporation of Massachusetts

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Int. Cl. B65h 45/20
U.S. Cl. 270—79 4 Claims

ABSTRACT OF THE DISCLOSURE

A textile folding machine has an intermittently and automatically loaded scray from which a web is delivered in folded layers to a table. The web is conveyed by folding blades alternately to and between a pair of alternately oscillated jaw members that form and engage the folds. The table is lowered in relation to the jaw members in jogs under the control of a vane operated limit switch responsive to the angular deflection of a jaw member by the folds. The switch is associated with a blanking circuit operable to prevent jogging by reason of jaw movement during oscillation.

Background of the invention

The field of the invention generally comprises folders for textiles, and it more particularly relates to a folder oscillating or reciprocating between jaws to produce zigzag folds in a web of material. The folder is associated, at the supply end, with a scray automatically loaded in response to the weight of material therein, and at the delivery end, with a table lowered automatically in such manner as to maintain the level of the top fold of the material at or near the level of the jaws.

Prior art machies generally have tables lowered in relation to the folding devices. Certain prior art machines also have the tables oscillating about horizontal axes in relation to fixed jaw parts to form and engage the folds laid down by the folder. These machines all have as an objective the provision of a fixed folding level in the machine, that is, a substantially constant level at the top of the pile of fabric. The table is lowered in a series of jogs to accommodate the increasing depth of the folded material. The machines differ widely, however, in the structures and characteristics of the jogging table drive controls. In addition, they differ in the means employed to maintain control of the clamping pressure on the jaw or gripper devices as the depth of the folded pile increases. In some cases, as in Patent No. 2,845,265, issued July 29, 1958 to R. S. Gamble et al., pneumatic means are employed, and in other cases the means are manually operated.

In still other prior art machines having a jaw part reciprocal about a fixed pivotal axis, it is apparent that while the table is stationary the pressure of the jaw on the pile progressively increases with each added fold. Also, the jaw is deflected increasingly by the folds when in its rest or nonoscillating and fold-engaging position. However, little if any attention has been given to the potential utility of means responsive to the jaw position at rest as an aid in controlling the jogging means or the working limits on the jaw pressure. It is noted that the movable jaw parts are oscillated or reciprocated to an extreme open position to receive each and every new fold, this extreme position being far beyond the rest position in which the jogging controls should preferably be operated. It is normally desired to lay down a substantial number of folds between successive jogs of the table, which requires control means that are not operative for each and every fold, but only at substantially less frequent intervals.

In consequence, jogging or table drive means of varying reliability and complexity have been associated with other variables such as the weight or height of the folded pile, employing such variables to initiate the jogging table movements.

Summary

The devices hitherto employed for controlling the accumulation of material in the scray and for jogging the table have not proven entirely satisfactory. It is an object of this invention to provide a largely mechanical and automatic electrical system of simple and reliable form that offers more precise adjustment and insures smooth and continuous performance of the machine with a variety of weights of textiles.

This invention attains the foregoing object by means automatically responsive to the weight of material at the scray or feed end, and responsive to the rest position of the movable jaw parts at the table or delivery end. More specifically, the peculiar advantages of a vane-operated limit switch or analogous devices are utilized to this end, in conjunction with a blanking circuit enabling the vane switch to operate the table drive only when it is in the rest position as defined above.

Other features of the invention will be seen by reference to the following description of a preferred embodiment, and include certain improvements in the combinations of the parts and in their respective modes of operation.

Brief description of the drawing

FIG. 1 is a side elevation of a machine embodying the invention.

FIG. 2 is a detail elevation of the table drive control jaw and related parts, shown in a rest position in which a jogging movement is initiated.

FIG. 3 is a schematic circuit diagram of the parts controlling certain operations of the machine.

Description of the preferred embodiment

Referring to FIG. 1, the preferred embodiment of the folding machine is shown supported within a rigid steel main frame **12**, preferably made up of channel irons, angle irons and beams of suitable cross section welded, riveted or bolted together in a conventional manner, for example as shown in said patent to Gamble et al. For convenience in the following description, the machine supported on this frame may be considered as divided into three operative sections: a scray section **14**, a folding section **16** and a table drive section **18**. A web **20** of cloth to be folded is drawn into the machine intermittently from a supply roll, basket or other suitable supply means. It passes between a draft roll **22** and a nip roll **24** into a metal scray pan **26**, where it accumulates until the total weight in the pan reaches a predetermined value as described below. The web passes over a bar **28**, under a conventional tension control device **30**, over a slide **32**, and over a bar **34** where it enters the folding section **16**.

In the folding section the web passes between a pair of oscillating, longitudinal angular metal folding blades **36** that draw it alternately to and between a pair of oscillating jaws **38** and **40**. These jaws and the blades **36** extend the full width of the web **20**. By the coaction of the jaws and the blades, the fabric is laid up on a table **42** in a pile **44** of fabric containing zigzag folds defining panels of precisely measured length, for example one yard, one meter or any desired folding dimension.

At periodic intervals the table **42** which is suspended upon chains **46**, is lowered in jogs to accommodate the increasing height of the pile **44**. As explained further below, the machine automatically stops after a "program" producing a pile of preselected height. The machine also has safety limit means under the control of a number of

cams **48** mounted on the drive shaft **50** for the cables **46**.

The table drive job controls, hereinafter described in greater detail, are associated with the table drive control jaw **38**, and include an oscillating cam **52** and a vane-operated limit switch *bvl* having a part pivotal with the jaw **38** and providing an indication of its rest position upon the pile **44** after completion of each fold by the jaw **38**. This control is further associated with a blanking device including a vane-operated limit switch *pvl* that prevents the oscillating movement of the jaw from producing undesired operations of the table drive means.

Referring more specifically to the scray section **14**, the draft roll **22** is driven by a scray motor SM by means of a V-belt **58**. The motor SM is energized intermittently under the control of the circuit shown in the upper part of FIG. 3, as further described below.

As in conventional machines, the draft roll **22** has a fixed pivotal axis in the frame **12** and the nip roll **24** has a spring support causing it to bear continuously upon and in rolling engagement with the roll **22**. Thus the web **20** is drawn at a continuous speed into the scray pan **26** while the motor SM is running.

The pan **26** is supported on cross bars **60** and **62** extending between pivotal L-shaped scray frame members **64**. The bar **60** is secured in the frame **12** and the scray frame members **64** pivot about the axis of this bar, thus pivoting the scray pan **26**. One end of each of the members **64** is bent and threaded to receive a stop screw **66** that defines a lower stop or limit position of the scray pan by contact with the main frame **12**.

An extension arm **68** bearing a pin **70** extends from one of the frame members **64**, the pin **70** being in position for alternate operation of an empty scray limit switch *esl* and a full scray limit switch *fsl*, these switches being supported upon the main frame **12**. By the means hereinafter more fully described in connection with the circuit of FIG. 3, these switches turn the motor SM on and off as required to keep the weight of fabric within the scray pan **26** within predetermined limits.

A tension spring **72** is secured at one end to a lateral extension of the members **64**, and at the other end to the frame **12**. When the scray pan **26** is empty, the spring **72** raises the frame members **64** and the scray pan sufficiently to cause the pin **70** to actuate the limit switch *esl*, turning on the motor SM. The motor runs continuously until such time as the weight of the fabric overcomes the tension of the spring **72** sufficiently to allow the pin **70** to actuate the limit switch *fsl*. This turns off the motor SM which then remains off until sufficient fabric is removed from the scray pan to permit the spring **72** to elevate the frame members **64** to the position where the limit switch *esl* is again actuated.

The web is withdrawn from the scrap pan by the folding blades **36**, passing beneath a seam trip limit switch *stl* associated with controls hereinafter described for normally stopping the machine with a seam at or near the top of the pile **44**. The blades **36** are very similar in action to the like-numbered blade in the said patent to Gamble et al. They are fastened together in mutually parallel, spaced relationship at their ends by brackets **74** that are slidable on a pair of rods **76** pivotal at their upper ends in the main frame **12**. The brackets **74** are also pivotal on a pair of arms **78** that are in turn pivotal at their lower ends on the main frame **12**. Thus oscillation of the arms **78**, which are respectively located on the sides of the machine, causes the blades **36** to reciprocate between two extreme positions, of which one extreme position is illustrated in FIG. 1. This oscillatory movement is imparted by a rod **80** pivoted on a bracket **82** fixed to each arm **78**. A crank **84** is secured at **86** to the rod **80** and is pivotal about a shaft **88**, the shaft being driven by a gear train **90**, a V-belt **92** which drives the gear train, and a folder blade motor FM. During the normal operation of the machine the motor FM rotates at constant speed.

A half-circular shaped metal vane **94** is secured to the shaft **88** and rotates through a slot in the vane-operated limit switch *pvl*. This switch is associated with the blanking circuit in the table drive controls in a manner hereinafter described.

The mechanism described above oscillates the jaws **38** and **40** by means of the cam **52** and an identical cam **96**, respectively pinned to shafts **98** and **100**, to which the jaws **38** and **40** are also respectively pinned. The shafts **98** and **100** have bearings fixed to the frame **12**. The cams **52** and **96** are engaged by cylindrical sleeves **102** on the brackets **74**, and are each alternately pushed from a rest position in which the corresponding jaw bears upon the pile **44** to an upper limiting position illustrated by the cam **52** in FIG. 1. In the latter position, the jaw **38** has an end situated between the folder blades **36**. The jaws **38** and **40** are resiliently urged toward the rest position, as shown in FIG. 2. The shaft **98** has a bracket **104** pinned to it, and the bracket **104** is attached to one end of a tension spring **106** secured at its other end to the main frame **12**. The jaw **40** has an identical spring, not shown. As the folding blades **36** move from the position shown in FIG. 1 toward the front of the machine, the jaw **38** engages the fold and retains it, while the blades **36** withdraw a further portion of the web from the scray pan **26** and repeat the folding operation in cooperation with the jaw **40**.

A metal vane **108** is secured to the shaft **98**, this vane being located in position to pass through a slot in the vane-operated limit switch *bvl* similar in construction to the switch *pvl* previously described. As shown in the lower portion of FIG. 3, these two switches are in series connection and are used for control of the table drive. Each of these switches includes a permanent magnet having a flux path including an air gap across the slot with which the vane is associated. The parts are so constructed that the switch has one position when a sufficiently large portion of the vane is within the slot, and another position when a smaller portion of the vane is within the slot. Details of the device are not given, as it is commercially available. FIG. 2 illustrates the position of the vane **108** at which the change of switch position occurs. In this position, the vane **108** has been sufficiently rotated out of the slot in the switch *bvl* by the pile **44** to reduce the magnetic flux to a point where the contacts move from a normally open position, as shown in FIG. 3, to a closed position. For a shorter pile **44**, the vane **108** has a larger portion within the slot in the switch, whereby the magnetic flux remains at a sufficiently high level to prevent closure of the contacts.

The foregoing construction has the advantage that the change in the switch position, which operates the table drive as hereinafter further described, is a function of the position of the vane and therefore of the jaw **38**, and is not a function of the tension on the jaw. Thus the spring **106** can be adjusted for higher or lower tension to compress the folds more or less firmly, but the table drive will continue to operate when the jaw reaches the identical position shown in FIG. 2. This is useful for folding a variety of textiles of varying thickness surface texture, weight and hand.

As shown in FIG. 3, the scray motor SM and the folder blade motor FM are three-phase alternating current operated motors. The table drive, on the other hand, is driven by a direct current table drive motor TM. As shown in FIG. 3, this motor has a continuously excited single wave rectified field winding, although in practice it is preferred to vary the current in this field so as to provide a normal slower speed for jogging table drive movement and a faster speed for doffing after a pile **44** has been completed and for return of the table to its upper limit position. The controls associated with these latter operations have been omitted from the drawing for the sake of simplicity.

The armature of the motor TM receives pulses of

direct current from a pulse source PS, as further described below in connection with the circuit diagram. The motor TM is connected through a chain drive **110** to a worm gear speed reducer **112** driving a chain **114**. The speed reducer provides a reduction of 60:1, whereby the motor may serve as a brake on the table motion and the weight of the pile **44** cannot reverse the motion of the table drive mechanism.

The chain **114** rotates the shaft **50** which carries sprockets **116** over which the chains **46** are received and also carries a number of control cams **48**. These cams operate an extreme bottom limit switch *ebl* (FIG. 3) when the table **42** is in its lowest position within the main frame **12**, a bottom safety limit switch *bsl* when when the table is in a position slightly above the extreme bottom position, and a program limit switch *pl* which is actuated when the table **42** is in a position corresponding to a pile **44** of the desired height. This position is adjustable by rotation of the corresponding cam **48**.

In addition to the illustrated cam-operated limit switches, there are other limit switches associated with the top limit positions of the table, which are used to limit the upward or reverse movement of the table drive after doffing, but these parts have been omitted from the drawing as immaterial to the present invention.

FIG. 3 schematically shows circuits for operation of the scray drive motor SM, the folder blade motor FM and the table drive motor TM. For simplicity, only certain parts of the entire circuit are shown. The parts omitted from the drawing are conventional and include the usual fuses, overload devices, electrical jog controls and remote controls. Also omitted from the drawing, as stated above, are the usual controls for doffing a completed pile **44** of fabric and for returning the empty table to the top position, including associated means for speeding up the table drive motor during this return movement.

In the drawing, relays are designated by capital letters, their corresponding contacts having the same letters in lower case, and being shown in the positions corresponding to the unenergized state of the relays. Limit switches are shown in their unactuated positions. The switch *pvl* is shown in its position retained throughout the oscillation of the jaw **38** during engagement of the blades **36** with the cam **52**. The switch *bvl* is shown in its position corresponding to jaw positions lower than that of FIG. 2.

The machine is provided with three-phase alternating current power connected from lines *p* through a power switch *ps*. The motors SM and FM are three-phase motors, and the remainder of the circuit is supplied through a transformer *t* by reduction of the voltage in a single phase.

Operation of the machine is started by depressing a momentary start push button *bb* which energizes a start relay SR. A table drive relay TD is thereby energized through make contacts *sr*–**1** of the relay SR. While the button *bb* is depressed a down drive relay DD is also energized through make contacts *sr*–**3** of the relay SR, provided that neither the extreme bottom limit switch *ebl* nor the bottom safety limit switch *bsl* is actuated. Upon release of the push button *bb* the relay SR holds on its make contacts *sr*–**2** and make contacts *dd*–**2** of the relay DD.

The energized relays TD and DD prepare a circuit to the armature of the direct current table drive motor TM from the pulse source PS. This source is sold by General Electric Company under the name "Statotrol Drive" and is operated by alternating current, delivering pulsed direct current to the motor armature. It includes reference voltage connections *ra, rb* and *rc* and pulse output connections *pa* and *pb*. The unit includes an internal circuit (not shown) to supply a constant reference voltage between the connections *ra* and *rb*. The connection *rc* comprises a pulse trigger circuit associated with the vane operated limit switches *pvl* and *bvl*, and is connected to the brush of a potentiometer P having its end terminals across the connections *ra* and *rb*.

The field winding of the motor TM, as stated above, is separately excited through a rectifier **118** providing half-wave rectified current. As further described below, the armature of the motor TM is intermittently energized under the control of the trigger circuit which, when closed by the limit switches *pvl* and *bvl*, causes passage of a half-wave rectified voltage impulse through a rectifier **120**, internal circuits of the pulse source PS and make contacts *dd*–**1** and *td*–**2** of the relays DD and TD, respectively, these relays being already energized as described above.

The responsive downward movement or jog of the table **42** results from the acceleration of the armature and its subsequent deceleration and coasting to a stop. The total resultant vertical jogging movement is determined by mechanical inertial factors and also by the voltage applied to the trigger connection *rc*. This is controlled by adjustment of the potentiometer P which changes the voltage on the trigger connection *rc* so as to produce greater movements for thicker textiles and smaller movements for thinner textiles.

The table drive motor TM is stationary when a folding operation is started, and does not receive an impulse until the vane operated limit switches *pvl* and *bvl* are simultaneously closed. The switch *pvl* is closed only during a half-cycle interval when the jaw **38** is at rest on the pile **44** of fabric, that is, when the folder blades **36** are out of contact with the cam **52**. It acts as a blanking device to prevent operation of the motor during oscillation of the jaw by the folder blades. The switch *bvl* is closed only when the vane **108** is removed from the magnetic circuit of the switch to at least the extent shown in FIG. 2.

The same depression of the start push button *bb*, described above, also initiates operation of a control circuit associated with the scray drive and folder motors SM and FM, respectively. A relay CR is energized through break contacts *pr*–**1** of a relay PR, and holds through contacts *cr*–**1**. This causes energization of a forward folding relay FF through make contacts *cr*–**2** and break contacts *rf*–**1** of a reverse folding relay RF. The relay FF performs two functions, namely, energization of the folder motor FM by closure of contacts *ff*–**2**, and preparation of the circuit of a scray drive relay SC by closure of make contacts *ff*–**1**.

The scray drive may now operate on an independent intermittent basis. Assuming that the scray pan is initially empty, the empty scray limit switch *esl* is actuated and the relay SC is energized, closing its contacts *sc*–**2** to energize the scray drive motor SM, and holding on make contacts *sc*–**1**. The scray motor continues to run until the scray pan moves down under the weight of the fabric and against the tension of the spring **106** through a sufficient displacement to actuate the full scray limit switch *fsl*, deenergizing the relay SC and thereby deenergizing the motor SM. When sufficient cloth is thereafter removed by the folder to permit the switch *fsl* to close again, the relay SC will remain unenergized until the switch *esl* is again actuated.

Means are provided to terminate the folding operation after the table has been lowered sufficiently to actuate the program limit switch *pl*, corresponding to a pile of the desired height. More specifically, the folder motor FM is abruptly stopped at the next movement after the switch *pl* is closed when a seam across the web is sensed by the seam trip limit switch *stl* and the folder blade has reached its forward limit of movement (the right-hand limit as viewed in FIG. 1). This permits the web to be severed at this seam preparatory to doffing, and causes the folder to commence the next pile with a rearward movement. This feature is desirable as a safety measure.

The foregoing operations are controlled with the aid of a centrifugal switch *cs* on the drive shaft of the motor

FM. This switch is closed whenever this drive shaft is rotating forwardly, and opens when the shaft is substantially at a standstill. The termination operation in detail is as follows.

At the first moment when the program limit switch *pl* and the seam trip limit switch *stl* are both actuated, a program relay PR is energized, holding on its make contacts *pr*–**2**. This opens break contacts *pr*–**1** in the circuit of the relay CR, and this relay is deenergized at the next instant thereafter when the folder blades **36** have reached their forward limit (the right-hand limit in FIG. 1), opening a folder blade limit switch *fbl* operatively associated with the shaft **88**. This in turn deenergizes the relay FF by opening the contacts *cr*–**2**, thereby opening the contacts *ff*–**2** to the motor FM and closing contacts *ff*–**3** to energize the reverse folding relay RF. The contacts *rf*–**2** then close to produce a reverse phase connection to the motor FM. The motor then receives current for a brief interval until the reverse torque that it develops reduces the forward speed of the shaft to zero and causes the centrifugal contacts *cs* to open.

The machine is then ready for doffing. As previously stated, the circuit used for this function is not included in the drawing as it forms no part of the present invention. In operation, this circuit includes the usual means to deenergize the relay DD, which deenergizes the relay SR by opening the contacts *dd*–**2** in its holding circuit. The table drive controlling relays are then all deenergized and the circuit is restored in its initial condition.

It will be recognized that various modifications in the machine may be carried out in accord with generally recognized practices, and without departing from the teaching of this invention. For example, with respect to the described means for oscillating the jaws **36**, various other means may be employed to open the jaws and to allow them to close to a rest position on the pile **44**. Similarly, the particular forms of limit switches and the circuits that they operate may be varied to the extent permitted by the teachings hereof.

I claim:

1. In a folding machine for a web of material, the combination of

a table having a surface to receive the material,

a reciprocating folder for conveying the web to the surface in layers by feeding it alternately to and between a pair of mutually spaced jaw positions,

means for driving the folder,

jaw means in each said position supported for pivotal movement and comprising a jaw adapted to engage the folds, means resiliently urging the jaw against the folds and a cam pivotally secured to the jaw and adapted for engagement and oscillation by the folder at the extremities of its reciprocating movement, at least one of said jaw means further having one part of a vane-operated switch device pivotally secured to the jaw, said switch device having contacts, another part of said switch device being supported in fixed position, said switch device parts including a magnet and a vane movable within the magnetic field thereof and adapted to operate said contacts as a function of the position of the vane within said field,

motor driven means for intermittent downward movement of the table in relation to the jaw positions, and

an electrical circuit connecting said contacts and motor and adapted to transmit a pulse of electrical energy to the motor in response to operation of said contacts.

2. The combination according to claim **1**, in which the pulse is adjustable to jog the table downwardly a predetermined distance upon operation of the contacts.

3. The combination according to claim **1**, including blanking means operable by said driving means to interrupt said circuit when a cam is engaged by the folder.

4. The combination according to claim **1**, in which the folder includes a pivoted guide member and a pair of parallel folder blades slidably mounted on the guide member and retaining the web.

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LAWRENCE CHARLES, Primary Examiner