March 16, 1965 R. DEZOPPY 3,173,680

DEVICES FOR AUTOMATICALLY ASSEMBLING SHEETS OF PAPER

Filed March 19, 1962 6 Sheets-Sheet 1

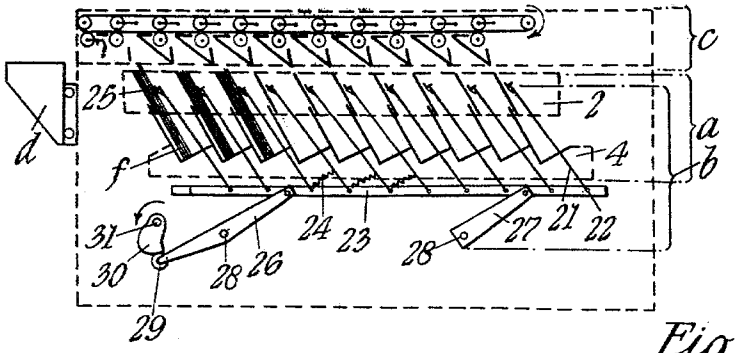

Fig. 1.

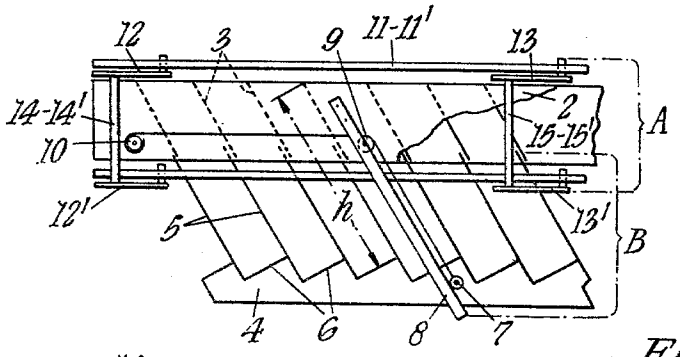

Fig. 2.

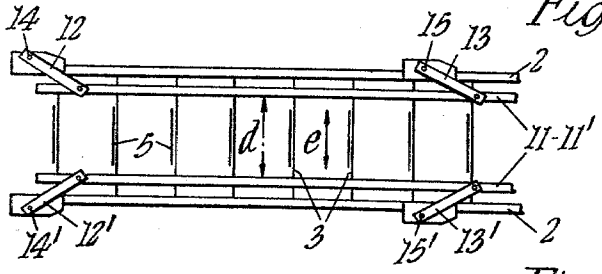

Fig. 3.

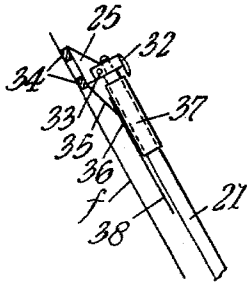

Fig. 4.

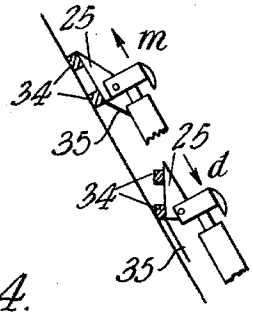

Fig. 5.

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DEVICES FOR AUTOMATICALLY ASSEMBLING SHEETS OF PAPER

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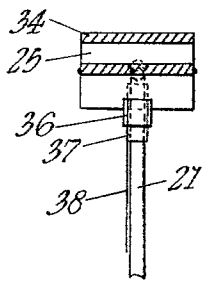

Fig. 6.

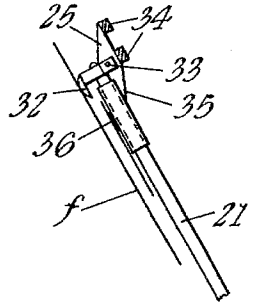

Fig. 7.

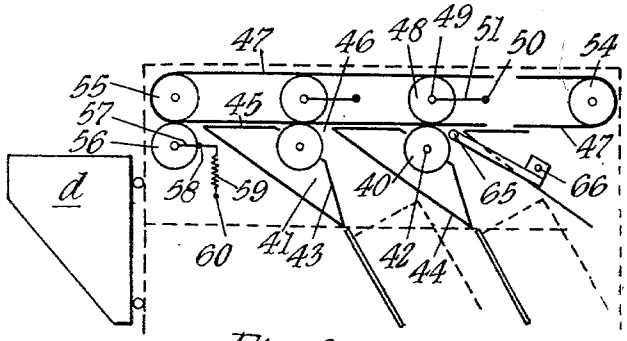

Fig. 8.

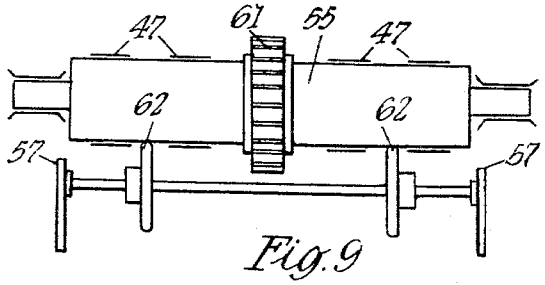

Fig. 9

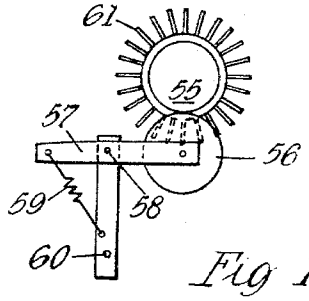

Fig. 10.

DEVICES FOR AUTOMATICALLY ASSEMBLING SHEETS OF PAPER

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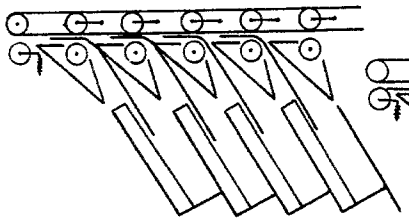

Fig. 11.

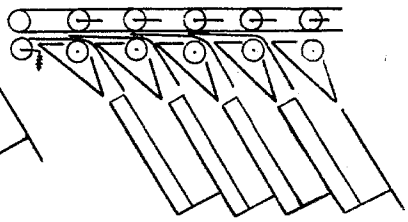

Fig. 12.

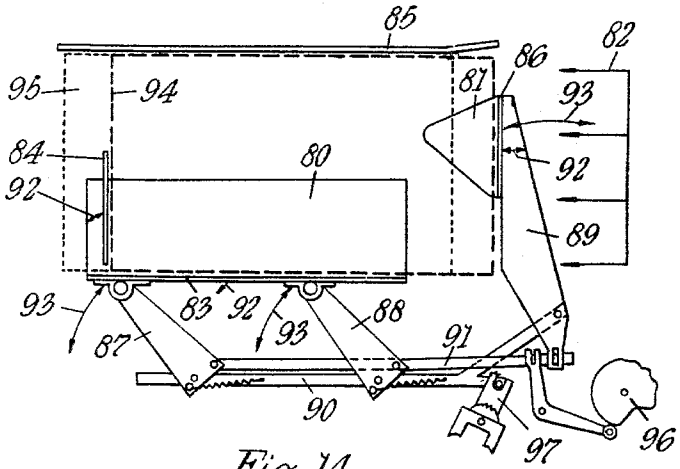

Fig. 14.

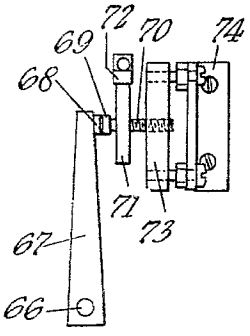

Fig. 13.

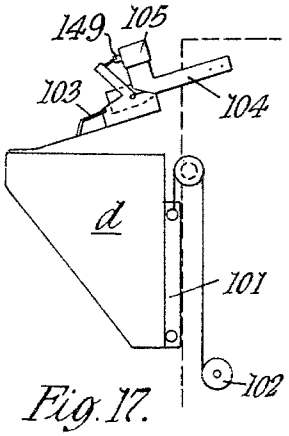

Fig. 17.

DEVICES FOR AUTOMATICALLY ASSEMBLING SHEETS OF PAPER

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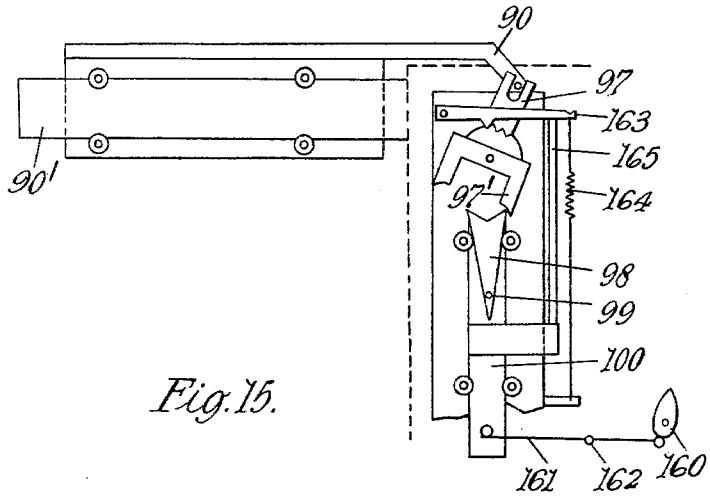

Fig. 15.

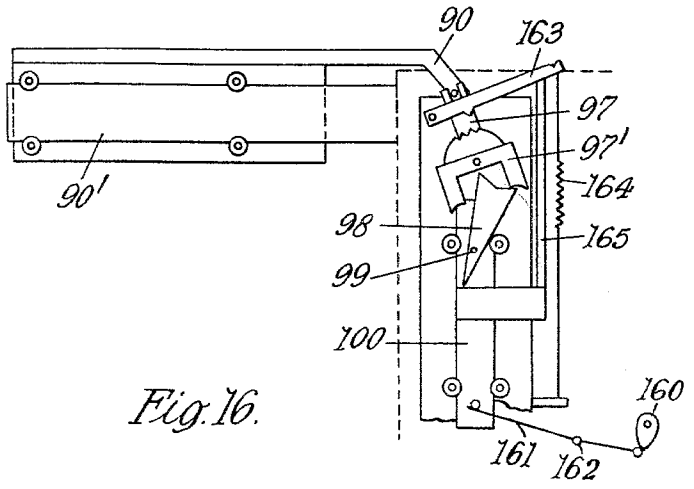

Fig. 16.

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DEVICES FOR AUTOMATICALLY ASSEMBLING SHEETS OF PAPER
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Fig. 18

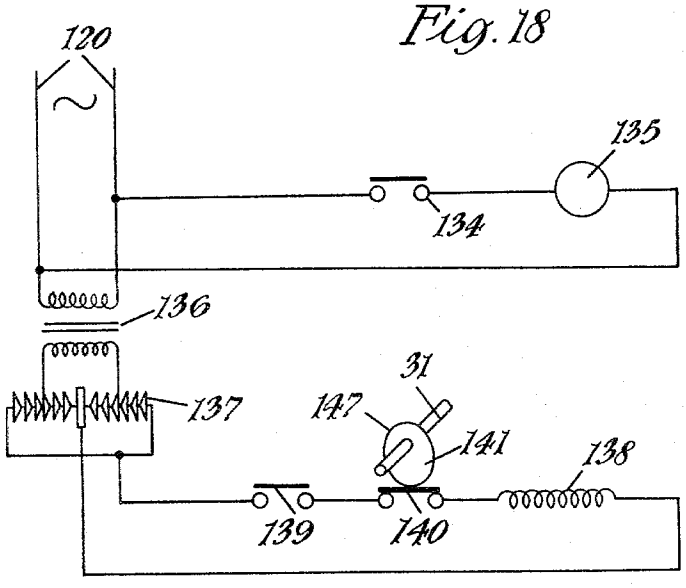
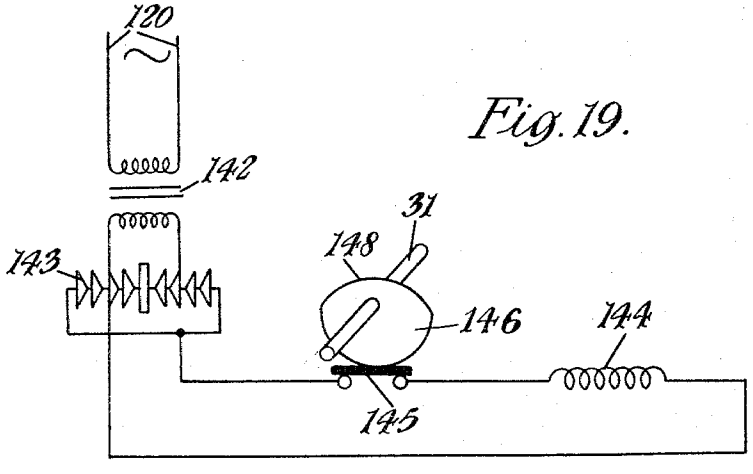


Fig. 19.



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DEVICES FOR AUTOMATICALLY ASSEMBLING SHEETS OF PAPER
Filed March 19, 1962 6 Sheets-Sheet 6

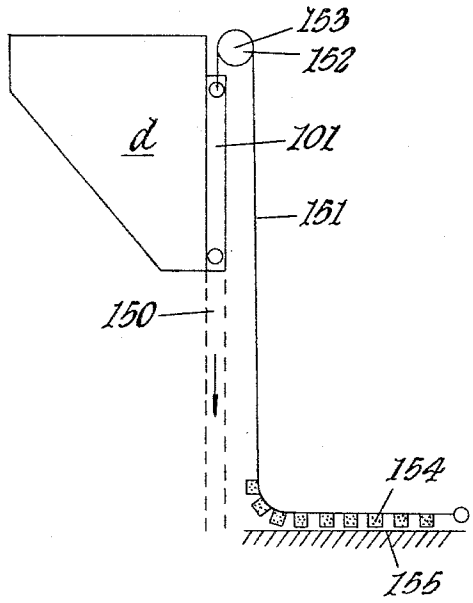

Fig. 20.

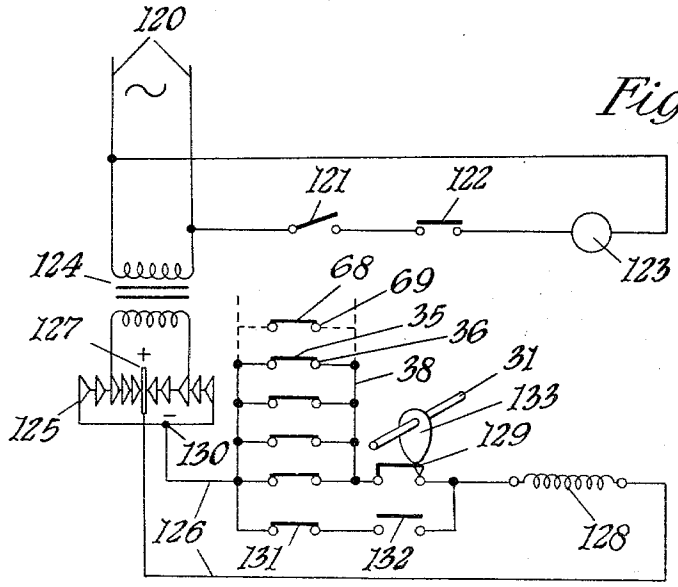

Fig. 21.

United States Patent Office 3,173,680 Patented Mar. 16, 1965

3,173,680

DEVICES FOR AUTOMATICALLY ASSEMBLING SHEETS OF PAPER

Robert Dezoppy, Rue Triolet 96, Angleur, Belgium

Filed Mar. 19, 1962, Ser. No. 180,549
Claims priority, application Belgium, Mar. 23, 1961, 601,747
12 Claims. (Cl. 270—58)

This invention relates to a device for automatically assembling sheets of paper.

In the general art of printing (the latter word being used in its widest sense), it is generally necessary to produce prints or booklets, that is to say groups of different sheets placed in a definite order, more often in their order of numbering. At the outlet of the printing machine, there are obtained parcels of each of the printed sheets needed to compose the booklet, for example, a parcel of sheets No. 1, a parcel of sheets No. 2, and so on. The operation of assembling into booklets consists in taking each time one sheet from each of the parcels and putting these sheets together in the order desired, for example in the order of numbering.

Carrying out this operation by hand is slow and expensive. It necessitates the employment of a considerable number of staff, who are liable to make mistakes in the manipulation of the sheets. Moreover, the space required for arranging the parcels of sheets before assembly becomes very large when the number of sheets per booklet reaches a certain value.

Several methods and devices have already been proposed with the object of mechanising and rendering automatic this operation of assembling the sheets into booklets, but the machines adapted to carry these methods into effect and utilise these devices have the disadvantage of being very expensive, especially when they are not used intensively.

In particular, the present applicant has devised a method enabling the above-mentioned automatic assembly to be carried out. In this method, after arranging the sheets to be assembled in parcels (in the present text, the word "parcel" signifies a group of identical sheets as it leaves the printing machine; to obtain a print or booklet, there are therefore available as many parcels as there are different pages in the booklet), a sheet is simultaneously taken from each of the parcels, which are placed in the order in which the assembly is to be carried out. These sheets are then introduced into a driving device so that the sheet from the first parcel is partially covered by the sheet from the second parcel, the sheet from the second parcel is partially covered by the sheet from the third parcel, and so on. There is thus formed a train of sheets which is carried along by a suitable device until it reaches a stop against which the sheets are successively brought to a standstill, covering one another completely, thus constituting a booklet containing one sheet from each parcel in the same order as that of the parcels.

The present invention relates to a machine capable of advantageously carrying into effect the process described above.

The accompanying drawings will facilitate understanding of the details of the machine according to the invention and its functioning. They are given by way of non-limiting example. In the drawings:

FIGURE 1 shows diagrammatically a longitudinal section through the machine.

FIGURES 2 and 3, show diagrammatically the constructional features of the magazine containing the parcels.

FIGURES 4, 5, 6 and 7, show diagrammatically some details of an elevating device.

FIGURES 8, 9, 10, 11, 12 and 13, show diagrammatically the structure of various parts of the assembling device.

FIGURES 14, 15, 16 and 17, show diagrammatically the structure of the receiving device.

FIGURES 18 and 19 show diagrammatically circuits used in connection with the machine.

FIGURE 20 is a diagrammatic showing of counterweighting of the receiving device.

FIGURE 21 shows diagrammatically a circuitry for use with the machine.

In all the figures, the same references, numerals or letter represents the same parts.

FIGURE 1 shows the principal parts constituting the machine, which are: the magazine given the reference *a* and comprising pigeon-holes in which are housed respectively the parcels each consisting of sheets of the same kind; the elevating device given the reference *b* and comprising fingers carrying friction devices adapted to take one by one the sheets housed in the various pigeon-holes, to raise them and engage them in the assembling device; the assembling device given a reference *c*, which receives the various sheets, superposes them in the order of succession of the pigeon-holes and conveys them to the receiving device; the receiving device *d* which receives and groups the successive booklets of sheets superposed in the order provided by the assembling device.

These four parts are fixed to the frame of the machine.

The magazine (reference *a* in FIGURE 1) consists essentially of a group of pigeon-holes slightly inclined to the vertical, arranged parallel with one another, and in each of which the parcels sheets are placed, a different one in each pigeon-hole, in the order the said sheets are to follow in the assembled booklet. The magazine therefore necessarily comprises at least as many pigeon-holes as there are different sheets in each booklet. The inclination of the pigeon-holes in relation to the vertical is made small enough for the adherence between the top sheet and the parcel beneath it to be low, so that the said sheet may be easily separated from the parcel, but sufficient to avoid collapsing of the parcel in the pigeon-hole such collapsing being particularly likely in the case of very thin sheets. Generally an inclination of between 15° and 45°, but preferably of the order of 30°, satisfies this double condition. According to the invention, the pigeon-holes are so conceived that their dimensions may be easily modified in order to be able to adapt them in each case to the particular format of the sheets to be assembled. To this end, the pigeon-holes are formed in height of two telescopic parts, which makes it possible to raise or lower the level of the bottom of the pigeon holes, whilst horizontal, longitudinal bars may be drawn closer to or away from the longitudinal axis of the magazine so as to adapt the effective width of the pigeon-holes to the width of the sheets to be accommodated therein.

If one refers to FIGURE 2, which is a diagrammatic view in elevation and partially in section of the magazine, and to FIGURE 3, which is a plan view thereof, one can see that the said magazine consists of two superposed parts. The upper part A which is fixed, is formed from two side bars 2 fixed to the frame, not shown, of the machine, which side bars are connected by inclined and equi-distant plates 3 which constitute the upper part of the inclined wall of the pigeon-holes. The lower part B which may be raised or lowered at will is constituted by two side members 4 on which are fixed the lower parts of the pigeon-holes. These consist of inclined parts 5 parallel with and adjacent to the plates 3 and bottom 6 serving to support the bottom end of the parcels of sheets. The two lower side members carry rollers 7 which are guided by rails 8 parallel with the plates 3 and fixed to the side bars 2. Only one of these rollers is shown. Cables fixed to the pivots of the rollers 7 pass over fixed

pulleys **9** and thence onto a rotating drum **10** on which they are wound up. It is evident that by turning the drum **10** in the appropriate direction, the lower part of the pigeon-holes may be raised or lowered at will by imparting to them a movement of translation parallel with the guides **8** and thus also with the plates **3**, which makes it possible to modify the effective height *h* of the pigeon-holes according to the dimensions of the sheets to be accommodated therein.

According to the invention, the effective width of the pigeon-holes is adjusted by a very simple device. On each side of the pigeon-holes near the side bars **2** are arranged symmetrically at the top and bottom of the fixed part A longitudinal bars **11** and **11'** carried by identical rods, such as **12–13**, **12'–13'** which can pivot about pivots such as **14–15** and **14'–15'** carried by the side bars **2**. One of the groups of pivots, for example the pivots **14** and **14'**, may be set in rotation by any suitable mechanism which makes them turn through equal angles but in opposite direction. By this means, the pair of bars **11** and the pair of bars **11'** are, as desired, brought closer together or away from one another parallel with themselves, whilst remaining symmetrical with respect to the longitudinal median plane of the group of pigeon-holes, so as to adapt the distance between the bars to the width of the sheets to be accommodated in the pigeon-holes. By modifying, as has just been described, the dimensions *h* and *d*, the effective length and width of the pigeon-holes can easily be adapted to the format of the sheets to be accommodated therein.

It should be noted that in order to permit the inclined walls **5** to pass between the bars **11–11'** and **11–1'** in all cases, the width *e* of the said walls must not be greater than the minimum value of the space *d* between the said bars.

According to the invention, the elevating device which serves to feed the assembling device with sheets previously deposited in the magazine, is characterised in that the taking of the sheets from each pigeon-hole and the engaging thereof in the assembling device is effected automatically by means of friction devices actuated mechanically. To this end, skids mounted on fingers engaged in the pigeon-holes (one per pigeon-hole) through openings formed in the bottoms of the pigeon-holes and animated with an alternating rising and descending movement, rest on the sheets which they carry along by adherence, when they are carrying out their upward stroke, so as to introduce the said sheets into the assembling device, whilst in their return stroke, the said skids slide with much less friction over the sheets, which at this moment are already gripped by the gripping mechanisms provided in the assembling device.

By this means, on each operating cycle of the elevating device, one sheet is taken from each of the parcels and engaged in the assembling device, which then superposes in the desired order all the sheets constituting one booklet. One referring to the diagrammatic FIGURES 1, 4, 5, 6 and 7, one will easily understand the structure and functioning of an elevating device according to the invention.

FIGURE 1, which shows the whole elevating device diagrammatically, shows the fingers **21** articulated by pivots **22** to a bar **23**, which fingers are engaged in the successive pigeon-holes where, owing to their weight assisted if desired by springs such as **24**, they apply to the parcels of sheets *f*, the skids **25** mounted at the upper end of the fingers.

The bar **23** is supported by two cranks **26** and **27** articulated to fixed pivots **28**. One of the cranks (the crank **26** for example) carries on its extension a roller **29** in contact with a cam **30** animated with a continuous rotating movement about a pivot **31**. By this means, the bar is alternately raised and lowered according to an appropriate law of motion determined by the form of the cam.

At each end of each finger **21** is mounted a shoe **32** which can turn freely about the geometrical axis of the finger **21**. On this shoe is articulated by the pivot **33** a skid **25** which carries strips **34** or studs of a material, such as foam rubber, having a high coefficient of friction with respect to the paper. For manipulating sheets of glossy paper, these strips could be replaced by fine metal points. A tail member **35** limits the pivoting of the skid **25** downwards. FIGURE 5 shows how the skid is applied to the sheet during the upward stroke of the finger (arrow *m*) and how it is disengaged by spontaneous pivoting about its axis, when the skid is displaced with respect to the sheet in the opposite direction of the movement of the latter (arrow *d*); this is a situation as soon as the sheet introduced into the assembling device is carried along by the gripping mechanism to be described hereinafter at an upwardly speed greater than that of the skid.

According to the invention, this pivoting of the skid at the moment the sheet is gripped by the gripping mechanism, is utilised to reveal the accidental non-engagement of a sheet in the assembling device. To this effect, when the skid entrains a sheet, the tail member **35** of metal bears on a contact stud **36** fixed to an insulating collar **37** carried by the finger **21**. This contact is contacted electrically by an insulated wire **38** to one pole of an electric source, the other pole being connected to the earth of the machine, with which are electrically connected all the fingers **21**, shoes **32**, skids **25** and tail members **35**. All the conductors **38** connected in parallel. A general switch incorporated in a common branch of the source circuit is closed, by a cam not shown mounted on the shaft **31**. The moment the fingers complete their rising strike, that is, the moment the sheets are being gripped by the gripping mechanisms, the skids pivot in the direction of arrow *d* in FIGURE 5 and break the contact between the tail members and the studs **36**. If, at this moment, all the skids do in fact carry out their pivoting movement, which will happen if each skid is actuated by its sheet engaging in the assembling device, the electric circuit is interrupted at all the studs **36** and the current does not pass into the circuit in spite of the closing of the general switch. But if, by accident, one of the fingers has not entrained its sheet or has not engaged it in the assembling device, the corresponding skid will not swing back at the end of its rising stroke, its tail member will remain in contact with its stud and the current will pass into the circuit at the time of closing the general switch. This current can then actuate a relay, which will cause the stoppage of the machine, and the emission of a sound or visual signal.

It is, however, indispensable to prevent the fingers corresponding to each pigeon-hole not being used to intervene in this safety process. To this end the contact between the tail member and the contact stud of all skids out of use must be permanently eliminated. This can easily be done by causing the corresponding shoes **32** to rotate a half turn, as shown in FIGURE 7.

In order to facilitate the rising of the sheets under the action of the skids, it may be desirable in certain cases to blow air into the sheets. But in order to avoid the introduction of charges of static electricity into the paper, it is important that the quantity of air should be as small as possible and limited to the first sheets of the parcel.

This result can be achieved by articulating beneath each parcel a tube of suitable diameter connected to a common supply by a flexible pipe. Each of the said tubes is connected to a finger which at a certain moment in the cycle of the machine rests on the parcel, this determining the position of the tube with respect to the thickness of the parcel. At this moment a suitable quantity of air is blown between the first sheets of the parcel.

During the rest of the cycle, the blowing is stopped and a control rod common to all the tubes removes them

from their respective parcels, in order to allow a fresh rising of sheets.

The assembling device, the function of which is to superpose in the desired order the sheets taken from the pigeon-holes by the elevating device and convey the trains of sheets thus formed towards the receiving device, is arranged above the magazine and fixed to the frame of the machine, in such a manner that it can easily be swung back to give free access to the pigeon-holes. It comprises gripping mechanisms, the number of which is equal to the number of pigeon-holes, placed respectively above each of the pigeon-holes and consisting of two superposed rollers between which pass one or more endless belts animated with a continuous longitudinal translation motion. The rollers arranged transversely turn freely about their axes. The spindles of the lower rollers are fixed and are carried by the lateral side bars of the assembling device. The spindles of the upper rollers are each carried by two arms capable of oscillating about fixed pivots carried by the longitudinal side bars. Owing to this arangement, the upper rollers weigh on the belts and press them on to the lower rollers and, during functioning on to the sheets introduced between the lower rollers and the belts. There is thus created an adherence between the belts and the sheets, so that the sheets engaged between the lower rollers and the belts are entrained in the movement of the latter. Below the belts and between the rollers are arranged fixed traverses adapted on the one hand to guide the sheets, raised by the elevating device, so as to engage them between the belts and the corresponding lower roller, and on the other hand to support the sheets between successive rollers. To this end, the traverses fixed to the longitudinal side bars have the form of triangular prisms having their horizontal generatrices perpendicular to the side bars. The upper faces of the traverses are horizontal and situated a little below horizontal plane defined by the upper generatrices of the lower rollers. The two other faces of each traverse are inclined to the vertical by angles such that the gap left between two successive traverses takes the form of a wedge converging upwards and the bisecting plane of which, substantially parallel with the plane of the sheet-carrying plates, penetrates the mitre formed by the belts and the corresponding lower roller whilst passing into the immediate vicinity of the said roller. The group of horizontal faces of the traverses constitutes a horizontal table intersected, to the right (as looking at the drawings) of each lower roller by a narrow slot parallel with the roller and through which the sheet raised by the finger of the elevating device passes in order to come into contact, by its upper edge, with the moving belts, which curve it, bring it into the mitre and engage it between the belts and the corresponding roller. At this moment the sheet is strongly gripped and entrained, by adherence to the belts, in the movement of longitudinal progression of the latter.

In this movement the sheets are supported by the horizontal carrying table constituted by the upper faces of the traverses.

The superposing of successive sheets is carried out automatically, each sheet of train of sheets coming from the right taking up a position, as it approaches a new roller, between the belts entraining it and the sheet passing over the said roller.

The endless belts pass over two transverse rollers mounted at the ends of the horizontal carrying table, one of the rollers being set in rotation by mechanical means. The left-hand roller is situated in the vicinity of the receiving device. It is associated with a roller situated below it adapted to press the sheets against the belts so as to ensure their propulsion and discharge into the receiving device.

On abutting against stop plates arranged in the receiving device the sheets from each train slide on top of one another until they completely cover one another and thus constitute a print or booklet ready for stitching.

Another advantageous feature of the invention consists in associating with each gripping mechanism a safety device adapted to detect the accidental incorporation in one booklet of two identical sheets.

Other features will become apparent from an examination of FIGURES 1, 8, 9, 10, 11, 12 and 13, which show diagrammatically and by way of non-limiting example one embodiment of an assembling device according to the invention.

FIGURE 8, is a vertical section along a longitudinal plane of the machine. FIGURES 9 to 11 show constructional and operational details. In these figures, references **54** and **55** designate the two rollers which support and actuate the endless belts **47** adapted to propel the sheets towards the receiving device *d*. These belts are made of a material adhering well to paper, for example rubberized fabric. Reference **40** designates the lower rollers of the gripping mechanisms, which turn freely about fixed spindles **42** carried by the side members of the assembling device. The pressure rollers **48** turn freely about spindles **49** carried by oscillating levers **51** themselves articulated to fixed pivots **50**.

The reference **41** designates the braced prisms, the horizontal face of which forms a supporting table for the trains of sheets travelling towards the receiving device. The convergent faces **43** and **44** form between two adjacent braces an empty space in the form of an upwardly converging wedge, which guides the sheet elevated by the elevating device towards its engagement in the mitre **46** comprised between the roller **40** and the belts **47**.

The reference **56** designates the pressure roller adapted to press the train of sheets against the belts in alignment with the left-hand roller **55**. The right-hand roller **54** is set in rotation by a suitable drive, not shown, and communicates a continuous movement of translation to the belts **47**. The bearings supporting the spindle of the roller **55** are mounted on slides so as to make it possible to adjust the tension of the belts. The roller **56** turns freely about the spindle carried by the levers **57** articulated by a fixed pivot **58** and the ends of which are acted on by springs **59** connected to fixed pins **60**.

In an alternative embodiment shown in FIGURES 9 and 10, the roller **55** carries in its centre a wheel **61**. This wheel **61** is provided on its periphery with rigid blades which bear on the parcel of sheets passing between the parcel of belts and the pressure roller **56** so as to curve the sheets and propel them towards the receiving device. The roller **56** is then reduced to a shaft carrying two small rollers **62** which raise the parcel of sheets and bring into contact with the roller **55**. This curving of the sheets has as its object to impart a certain rigidity of form thereto, so as to facilitate their correct placing on the pile of booklets contained in the receiving device.

A particularly advantageous alternative when the booklets are relatively thick, consists in making the spindle of the roller **56** fixed but, on the other hand, making the spindle of the roller **55** movable in an upward direction, suitable springs tending to lower it continually so as to press it on to the train of sheets.

FIGURE 11 shows diagrammatically the beginning of the engagement of the sheets from each pigeon-hole in the corresponding gripping mechanism, whilst FIGURE 12 shows the superposition of the entrained sheets at the beginning of the assembling stage.

The safety device associated with each of the gripping mechanisms is adapted to detect the simultaneous engagement of two sheets in the mitre **46** and consists of a feeler, the details of which can be seen in FIGURES 8 and 13. For the sake of simplicity of the drawings only one feeler has been shown in FIGURE 8. It comprises a small roller **65** carried by a lever keyed on a shaft **66** capable of oscillating in a fixed support carried by the side members of the assembling device, beyond one of

which the said shaft **66** is extended. On this extension of the shaft **66** is keyed another amplifying lever **67**, carrying at its end a stud **68** capable of coming into contact with a stud **69**, the position of which is adjustable by means of a micrometric screw **70**, operated by a graduated drum **71** and provided with a stop brake **72**. The said screw engages in a nut **73** carried by a support **74** insulated electrically from the frame of the machine.

The shaft **66** and the support **74** are connected, respectively, to the poles of a source of electricity via a circuit, in which is inserted a relay, which controls a suitable warning device and a switch for stopping the machine.

When the studs **68** and **69** are not in contact, the current does not pass into the relay circuit and the machine can function normally. However, as soon as the stud **68** comes into contact with the stud **69**, the relay is excited, the warning device functions and the machine stops. It will be understood that if the position of the stud **69** is adjusted by acting on the screw **70**, so that contact between the studs **68** and **69** is established when two sheets come between the roller **40** and the feeler roller **65**, but the two studs **68** and **69** remain separated when a single sheet is engaged between the roller **40** and the feeler roller **65**, the safety device will come into operation each time two sheets come at the same time to the entrance to the gripping mechanism. In this case, the sound or light signal gives warning of the incident; the machine stops and the operator can intervene immediately.

According to the invention, the receiving device adapted to receive the prints supplied by the said assembling device and to effect stacking thereof is characterized in that it is lowered as the prints or booklets accumulate therein, so that the height of the stack is kept constantly between two levels chosen arbitrarily, so that the depositing of each new booklet on the stack already formed can be effected in good condition.

To this end, the receiving device, as shown diagrammatically in FIGURE 17, comprises a compartment in which are deposited in succession the booklets leaving the assembling device, which compartment, arranged in front of the outlet face of the assembling device is fixed to a support **101** movable vertically, the displacements of which are controlled by a reversible motor **102**, controlled by relays actuated by a feeler **103** suspended on a support **104** fixed to the frame of the machine and resting on the upper part of the stack of booklets. The raising of this feeler beyond a predetermined level causes the closing of a micro-switch, not shown, which sets off the action of the relay, which puts the motor in rotation in the direction of lowering of the support until the upper face of the pile is lowered to the level selected as normal. In this position, the feeler closes a micro-switch which actuates the relay for stopping the motor. If the top of the pile is lowered below the normal level, the feeler actuates a third micro-switch, which sets off the action of a relay which puts the motor in rotation in the direction of rising of the support until the upper face of the pile has returned to the normal level. At this moment the feeler actuates the switch which causes the motor to stop.

According to an advantageous embodiment, the feeler only functions during the idle periods separating the arrival in the receiving device of two successive booklets. Outside these periods, the feeler is raised by an electromagnet **105** controlled by a cam mounted on the shaft **31**, so that its rotation is synchronized with that of the cam **30**, which actuates the elevating device. The same cam which controls the electro-magnet of the feeler, puts out of circuit, when the feeler is raised and out of action, the micro-switches controlling the movement of the motor displacing the receiving device.

To facilitate the action of the motor, it is advisable to balance in weight the movable parts of the receiving device. As the weight of the movable unit increases as the booklets pile up in the receiving device, the balance in counter weight must increase as the receiving device is lowered. According to the invention, a simple solution to this problem is obtained by effecting the balancing by means of a constant counter weight associated with a variable weight consisting, for example, of strings of lead beads suspended on the receiving device and the lower ends of which rest on a fixed support, the weight per centimeter of length of the series of strings being equal to the weight of a pile of sheets of one centimeter thickness.

By this means the weight applied to the receiving device by the series of the strings of beads decreases as the receiving device descends, owing to the fact that an ever increasing fraction of the said strings comes to rest on the support and thus ceases to act on the receiving device. To sum up, the series of strings acts on the receiving device in the same manner that in aeronautics, the guide rope acts on the vertical equilibrium of the balloon.

Finally, the receiving device may advantageously be provided with a stacking device adapted to complete the correct superposition of the sheets constituting each booklet and which staggers with respect to one another the booklets deposited successively in the compartment, with a view to facilitating their removal. FIGURES 14, 15 and 16 show diagrammatically some features of a stacking device according to the invention.

According to the invention, the stacking device comprises horizontal shelves **80** and **81** arranged in the same plane situated slightly below the level of the trains of sheets leaving the assembling device. The shelf **80** is rectangular and has its large side arranged parallel with the direction of arrival of the sheets in the compartment as indicated by the arrows **82**. Its large side **83** outside the compartment is raised at right angles so as to constitute a flange, the height of which is approximately equal to that of the booklets to be manipulated. At its end remote from the assembling device, the said shelf carries, perpendicularly to the direction of arrival of the sheets, an angle iron **84**, the raised face of which serves as a stop against which the sheets coming from the assembling device come to bear. The position of this angle iron on the shelf is adjustable at will according to the format of the booklets. The longitudinal outer edge of the said shelf turned up at right angles serves to hold the sheets of the booklet laterally. The lateral wall **85** of the compartment, parallel with the direction of arrival of the sheets and situated opposite the said turned up edge **83** may be brought closer to or away from the shelf so as to form between it and the edge **83** a space slightly greater than the width of the sheets. The second shelf **81** of much smaller dimensions is constituted by an angle iron, the raised edge **86** of which is directed perpendicularly to the direction of the sheets. The lateral wall **85** of the compartment, the angle iron **84** and the two edges **83** and **86** of the shelves thus constitute the four sides of a flat tray having substantially the format of the booklets. The shelves are carried by levers **87**, **88** and **89** articulated to a carriage **90** sliding on a support **90'** fixed to the frame and receive under the action of a cam **96** which actuates a rod **91** a reciprocating movement of small amplitude indicated by the arrow **92**, which movement is adapted to complete the correct superposition of the sheets of the booklets and apply the latter against the lateral wall **85** of the receiving compartment.

When all the sheets constituting one booklet have been put in place, the cam controlling the shelves causes the sudden withdrawal of the latter from below the booklet as indicated by the arrows **93** and the booklet **94** is deposited on the pile already formed. After the depositing of each booklet and whilst the shelves are withdrawn, the carriage carrying them is displaced longitudinally either to left or right, so that the following booklet **95** will be staggered longitudinally with respect to the booklet **94** which has been deposited.

The cam then returns the shelves to the working position.

The displacement of the carriage may be produced by a cam of suitable form rotating in synchronism with the cam **96** actuating the blades. According to an advantageous embodiment, the movement of displacement of the carriage alternately to left and right and then left and so on, is produced by an oscillating anchor having three branches, one of which actuates the carriage **90**, whilst the two others are acted on alternately by a push rod **98** articulated to a pivot **99** carried by a slide **100** actuated by a cam **160** acting on a lever **161** articulated on a pivot **162**, which push rod causes the anchor to swing once in one direction and once in the other. The anchor is locked in each of its end positions or in a middle position by a pawl **163** which engages in one or other of three corresponding notches in the branch connected to the carriage, which pawl is set off by a spring **164** but is disengaged at the appropriate moment by a finger **165** carried by the slide. FIGURE 15 shows the slide **100** in its lowermost position and the anchor swung towards the right, in which position the carriage **90** is at the end of its travel towards the right. FIGURE 16 shows the push rod **98** which, raised by the slide **100**, engages the branch **97'** of the anchor and causes swinging of the anchor and displacement of the carriage to the left. To render this movement possible, the finger or feeler **165** has raised the pawl and unlocked the anchor.

When it is desired to avoid the alternating displacement of the carriage, the anchor is locked by the pawl in its middle position, in which position the push rod, in its upward movement, does not come into contact with either of the two branches of the anchor.

As can be seen from FIGURE 18, which is given by way of illustration only, the apparatus is connected with alternating electrical mains **120** to which there are connected two circuits. The first circuit comprises a series of contact relays **134** and the motor **135** for moving the table. The second circuit is coupled to the main **120** through the transformer **136** and the rectifier **137**. The direct current from this rectifier passes through a relay **138**, a relay contact **140** controlled by a cam **141** mounted on the shaft **31** and a switch **139** operated by the sensing device **103** (FIG. 17). The contact **134** opens when the direct current passes through the relay **138**.

The circuit is connected with the circuit shown in FIGURE 19 for the control of the sensing device **103** (FIG. 17). As shown in this figure, the circuit is connected with mains **120** from which current passes through a transformer **142** and a rectifier **143**. The D.C. circuit connected with the rectifier **143** is closed by a relay **144** controlling the sensing device **103** and a microswitch **145** controlled by a cam **146** mounted on the shaft **31**.

The circuit functions as follows:

The two cams **141** and **146** have their profiles **147** and **148** turned to close their microswitches alternately. When the sheets of a complete booklet have arrived and been piled on the base of the receiving device or on a preceding booklet, the cam **146** moved by the shaft **31** opens the contact **145** (that is, at this moment the cam **146** is in the position opposite to the position shown). The current ceases to pass through the relay **144** which maintains the sensing device **103** in a raised position due to the armature **149** (FIGURE 17) moving into the relay **114**. (The armature **149** and the relay **144** constitute the electromagnet means **105** (FIGURE 17).) The arm **103** is lowered and stops in the position in which it is resting on the stacked booklets.

During this time the microswitch **139** (controlled by the sensing device **103**) remains closed, and the cam **141** maintains the contact **140** in a closed position and the current passes to the relay **138** which, in its turn, maintains the contact **134** closed thus putting in circuit the drive motor for causing downward movement of the table. If the upper level of the booklets attains a value which has previously been set as a minimum, the microswitch **139** is opened by the same movement of the sensing device, and the current to the relay **139** is interrupted. Consequently, the contact **134** opens and the motor **135** stops. During the remainder of the cycle, owing to the rotation of the shaft **31**, the cam **141** opens the contact **140** which stops the motor **135**, the cam **146** closes the contact **145**, thus causing the coil **144** to be energized and the sensing device **103** to be raised which, as it moves upwards, closes the switch **139**. Then the cycle begins again.

The electrical circuit of FIGURE 21, given by way of example only, comprises two circuits connecting two alternating current mains **120**. The first circuit comprises in series a general switch **121**, relay contacts **122** and motor **123** for driving the machine.

The second circuit is coupled to the mains **120** through a transformer **124** and a rectifier **125**. The circuit comprises successively, starting with the positive terminal **127**, a relay **128**, a general switch **129**, all the contacts **35** and **36** (arranged in parallel) of the fingers **21**, and a negative terminal **131**. A secondary circuit comprises the push button **131** which is normally closed, a relay contact **132** arranged in parallel with the general switch **129** and the contacts **36**. The contact **122** is open when the current passes through the relay **128** while at this moment the contact **132** is closed.

The device functions as follows:

After having closed the general switch **121**, the motor **123** begins to turns since the contact **122** is closed. At this moment all the boxes contain sheets, the fingers **21** are put in their lower position and the contacts **35–36** are closed.

The rotation of the motor **123** rotates the shaft **31** on which there are set the cams **30** (see FIG. 1) and the cam **133**. The cam **30** raises the fingers **21**. At the moment when the first sheets are taken up by the gripping mechanism at the end of the upward movement, the rotation of the slides **25** (FIG. 5) opens all the contacts **36** while the cam **133** closes the contact **129**. If there happen to be no more sheets, the corresponding slide is not returned at the end of its upward movement and a contact **35–36** remains closed and the current passes through the relay **128**. The contact **122** opens, stopping the motor **123**. while the contact **132** closes and ensures that the relay **128** continues to be supplied with current. The operator can thus feed the box which is lacking a sheet. After this he operates by hand the push button **131** which stops the passage of direct current to the relay **128**. The contact **132** opens and the contact **122** closes and the motor **123** begins to turn again.

The device described above also serves for detecting instantaneously the entrainment by any slide of two sheets instead of one.

If reference is made to FIGURES 8 and 13, it can be seen that, coming from any one of the boxes the sheet or sheets entrained by a slide **25** pass between a lower roller **40** and an auxiliary roller **65** resting on the sheets. This latter roller is carried by a lever turning about the fixed shaft **66**. The thickness of the paper passing between the roller **40** and the roller **65** sets the distance between the two parts. This distance is amplified by a lever **67** (FIGURE 13) fixed in turn to the shaft **66**, and the lever carries an electrical contact **68** at one end.

When, due to the rotation of the lever **67**, the contact **68** comes to rest on a second contact **69**, an alarm circuit is closed and the operator is warned and the machine stops. It suffices to regulate the distance **68** to **69** by means of a micrometer screw **70** so that the circuit **68–69** remains open as long as not more than one sheet passes between the rollers **40** and **65**.

In practice there are as many pairs of contacts **68** and **69** as there are boxes, and each of the pairs of contacts are connected in parallel with the contacts **35** and **36** described above. The principle of operation remains the same. Any closing of any one of the contacts **68** and

69 causes the passage of current through the relay 128, closes 132, opens 122 and stops the motor 123.

The circuit used in the device of FIGURE 20 is similar to that of FIGURE 17. The sheet receiver *d* is fixed to a support 101 which can slide vertically in a slide 150. The assembly made up of the receiving device and the support is supported by a cord or cable 151 wound on a pulley 152 mounted on a shaft 153 fixed on the frame of the machine. The other end of the cable 151 is provided with a chain of weights 154 which can lie on a fixed surface 155.

As the receiving device *d* is charged with sheets, the motor 102 (FIGURE 17) rotates to allow the device *d* to slide in the slide 150. During this movement downward, the cord 151 lifts upwards a certain number of weights 154 in such a fashion that at any given moment there is an equilibrium between the support 101, the receiving device and the sheets, on the one hand, and the weights 154 which have been raised clear of the plate by the cord 151, on the other hand.

Owing to this arrangement the power required from the motor 102 is reduced to a minimum.

It is clear that numerous modifications may be made in the details of the construction of the machine, whilst maintaining the general principles of construction and operation which characterize the present invention.

I claim:

1. In a machine for the automatic assembly of sheets of paper, said machine including a frame, the combination of: a magazine comprising adjacent pigeon holes equal in number to the number of sheets to be assembled in one booklet, each pigeon hole being adapted to receive a parcel of sheets of a single page of the booklet in the order they are to follow in the booklet, said pigeon holes being inclined with respect to the vertical by an angle comprised between 15° and 45°, said pigeon holes being divided in height into two telescopic parts, the upper parts of which are fixed to the frame while the lower parts, connected by side bars, can be raised or lowered as a unit with respect to said upper parts to adapt the effective height of the pigeon holes to the size of the sheets to be assembled, said magazine also comprising movable horizontal bars arranged symmetrically with respect to the longitudinal mean vertical plane of the magazine, which bars constitute the lateral walls of the pigeon holes, which horizontal bars are symmetrically movable towards or away from said mean vertical plane so as to adapt the effective width of the pigeon holes to the size of the sheets to be assembled; an elevating device adapted to move sheets one by one from each pigeon hole in order to present them simultaneously to the assembling device, said elevating device comprising as many fingers as there are pigeon holes, one end of each finger resting on the upper sheet in each pigeon hole, each finger being attached by its other end to a horizontal longitudinal member, lever means to move said horizontal longitudinal member periodically upwards and downwards, means being attached to said member and rotating about an axis fixed in relation to the frame and perpendicular to the longitudinal vertical and symmetrical plane of the machine, a rotating cam for actuating one of said levers, the profile of said cam causing upward and downward movement of said longitudinal member so the motion is transferred to said fingers, the axis of the cam being fixed with respect to the frame, the fingers being provided with tilting skids which are adapted to move the upper sheet upwards during the upward movement of the fingers, an assembling device which superimposes the sheets in the desired order and conveys them to the receiving device, said assembling device comprising a gripping mechanism arranged above each pigeon hole of the magazine which grips the sheet raised by the elevating device and propels it towards a receiving device, said assembling device being formed substantially of two rollers turning freely about transverse spindles and between which the under strand of endless belts pass, said belts being driven to produce a continuous longitudinal movement, the spindle of the lower roller being fixed adjacent the upper end of a corresponding pigeon hole while the spindle of the corresponding upper roller is carried by two levers articulated to a fixed pivot, so that the upper roller can oscillate downwards so as to weigh on belts and apply them firmly to the lower roller or on to the sheets engaged between the lower roller and the belt; and a receiving device in which the succession of booklets thus constituted are stacked, said receiving device consisting of a vertically movable compartment comprising a bottom plate to receive the booklets to be stacked, an end wall plate against which the booklets are stacked as they leave the assembling device, and vertical slipping guides securing the bottom of said compartment to the outlet face of the frame so said compartment is lowered as booklets are added to the compartment, so as to maintain the top of the pile of booklets between two preselected levels.

2. The machine of claim 1, in which said elevating device includes a common bar extending parallel to the assembling device and including means to reciprocate said common bar in a direction toward and away from the pigeon holes, each said finger being pivotally connected to said common bar and extending upwardly into a corresponding pigeon hole, said fingers being inclined to the vertical so that their ends may be biased against sheets of paper in the pigeon hole.

3. The machine of claim 2, in which each said finger is provided at its upper part with a horizontal pivot on which said tiltable skid is mounted, said skid carrying strips of a material having a high adherence to the paper and provided with a tail member, the end of which rests on the body of the finger so as to limit the tilting of the skid to the desired value.

4. The machine of claim 1, including means to automatically lower said receiving device, said means including a reversible motor, an electric circuit including relays to operate said motor, and a feeler positioned to contact booklets in the receiving device, said feeler being adapted to operate switches to control said relays.

5. A machine as claimed in claim 4, in which said feeler consists of an oscillating arm resting at one end on the pile of booklets and at its other end on a fixed pivot.

6. A machine as claimed in claim 4, in which electromagnet means are provided to raise said feeler during the periods of introduction of one train of sheets into the receiving device coming from the assembling device.

7. The machine of claim 4, in which counterbalance means are provided to compensate for the increasing weight of said receiving device and its burden as booklets are delivered to it, said counterbalance means comprising a plurality of masses carried by said receiving device mounted above a support, said masses being positioned to successively contact said support as said receiving device moves downwardly under an increasing load of booklets.

8. A machine as claimed in claim 1, including a safety device consisting of a metal stud, an insulating collar to carry said stud fitted over each said finger, an electric circuit comprising a source of current, a branch connected to one pole of the source, a general switch controlled by the cam which actuates the member moving said means to move the fingers, and a relay which controls the machine and gives a warning signal when it is excited, and branches connecting the fingers in parallel, each of these branches being constituted by a conductor connected to the general branch and to said metal stud, said studs being in contact with the free end of the tail member of the corresponding skid when the latter is tilted downwards as the skid propels its sheet upwards, in which situation the electric circuit is closed by the tail member, the skid, the body of the finger and the metal mass of the machine, the said mass being connected to the second pole of the source,

the profile of the cam closing the general switch only during the end of the upward stroke of the fingers when the skids are tilted by gripping of the sheets by the assembling device.

9. The machine of claim 1, in which two rotating rollers placed one at the outlet of the assembling device and the other at its opposite end are provided to tension said belts, one of the rollers being set in rotation mechanically while the other is loose on its spindle and may be displaced parallel with the belts in order to adjust their tension, and the roller situated at the outlet of the assembling device carries a wheel provided with blades having a diameter greater than that of the parts on which the belts are wound, said blades being rigid and adapted to press on the sheets, thus curving them and propelling them towards the receiving device.

10. A machine as claimed in claim 1, including a safety device consisting of a lever constituting a feeler, a small roller at the end of said lever which rests on the lower roller of the gripping mechanism, a shaft carried by a fixed support to which shaft said lever is keyed, an amplifying arm keyed to said shaft provided at its end with a stud, a fixed stud carried by a micrometric screw mounted opposite to said arm, said micrometric stud making it possible to adjust the position of said stud so as to regulate with precision the space separating the two studs, said studs being connected respectively to the terminals of an electric source, the electric circuit thus constituted being normally open but adapted to be closed by the swinging of the feeler when two or more sheets are engaged at the same time between the roller and the small roller of the feeler.

11. A machine as claimed in claim 1, in which each booklet is placed on a staggered device before being directly stacked on the bottom plate or on the booklets already on the bottom plate, which comprises a highly polished horizontal plate and four vertical walls, the height of said walls being substantially greater than the thickness of a booklet, the four walls being arranged to form a rectangular box the horizontal dimensions of which are greater than those of a booklet, a lever fixed at one end to one of the walls and pivoting around a vertical axis fixed to the frame, the other end acting with an alternating movement imparted thereto whereby said walls are reciprocated horizontally, a cam rotating synchronously with the assembling device to actuate said lever, two horizontal levers pivotally connected with the plate adapted to be rapidly rotated about a vertical axis by said cam to subject said horizontal plate to a rapid horizontal movement away from the booklet and this movement, due to the polish of the plate and the rapidity of its movement and to the inertia of the booklet, allows the booklet to remain in place and fall on the other booklets.

12. The machine of claim 1, in which a safety device is provided for each said gripping mechanism, said safety device comprising a feeler element bearing against the successive sheets as they are fed from the pigeon hole to the corresponding gripping mechanism, said feeler device being cooperatively connected to means to energize an electric circuit for operation of a warning device or the like, whereby upon the feeler element being displaced by more than one sheet at a time the warning device is operated.

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