Aug. 5, 1969 E. PFÄFFLE 3,459,074

METHOD AND APPARATUS FOR THE PERFORATION OF EDGES OF PAPER STACKS

Filed Sept. 30, 1966 2 Sheets-Sheet 1

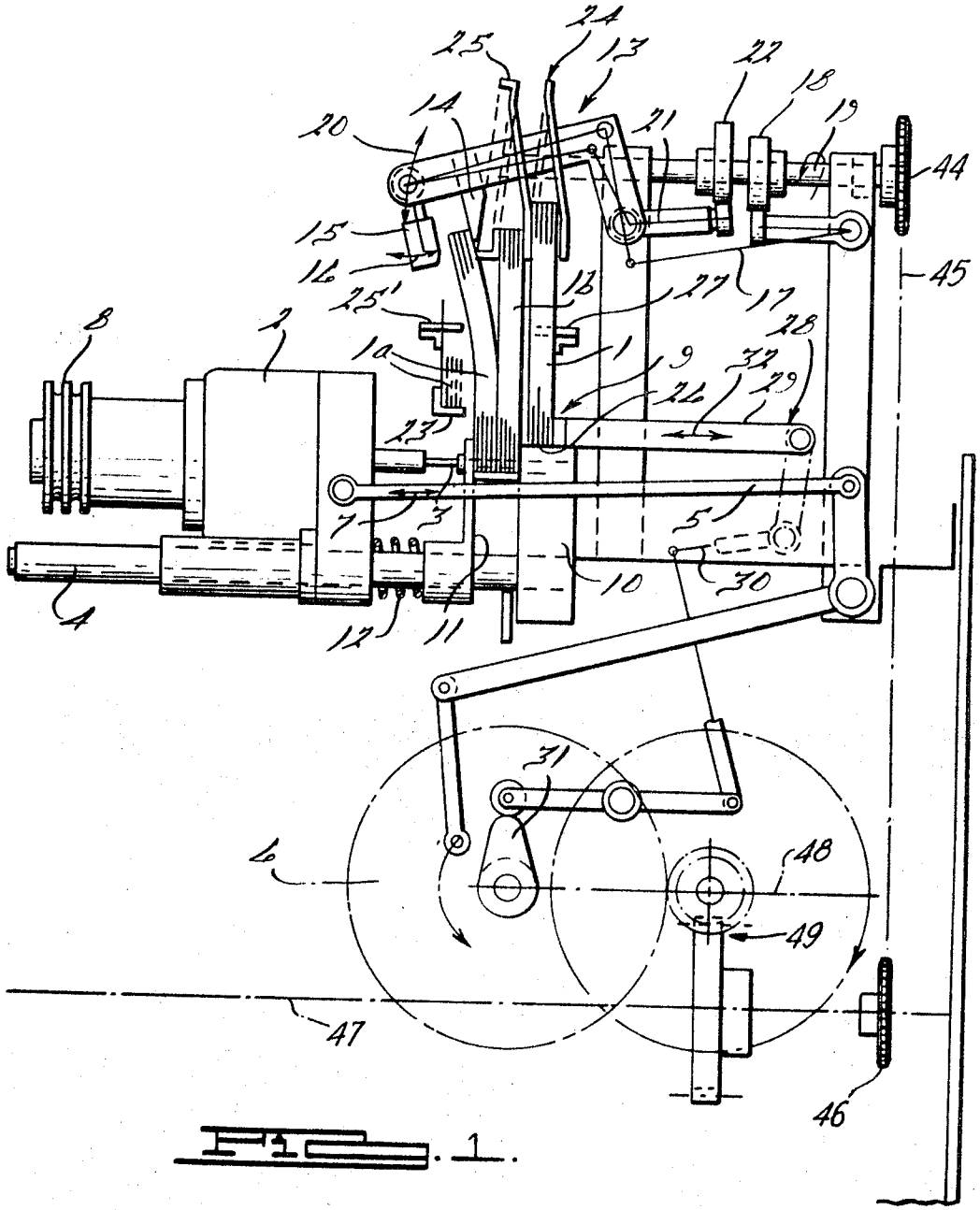

Fig. 1.

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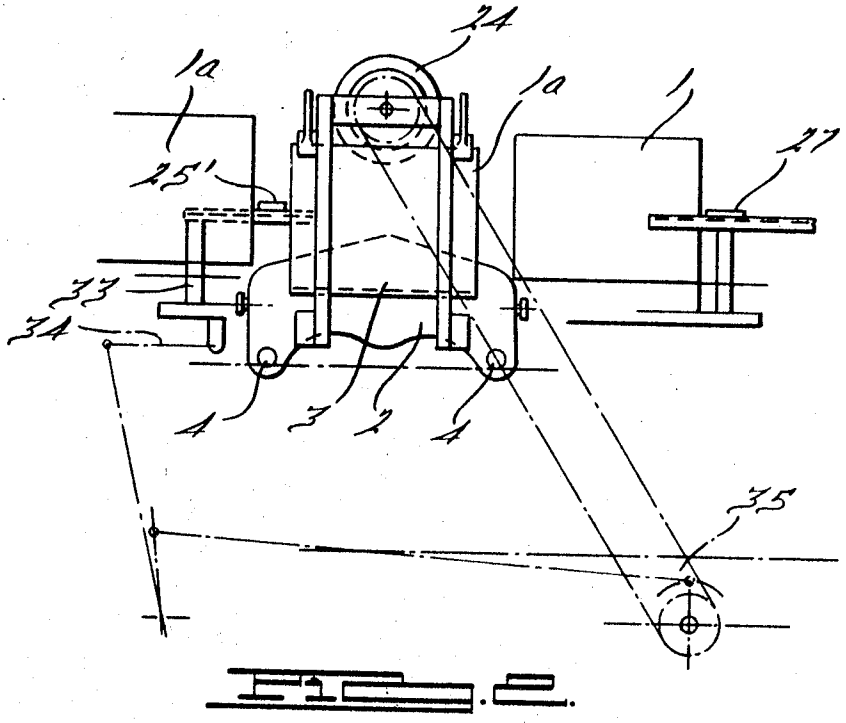

Fig. 2.

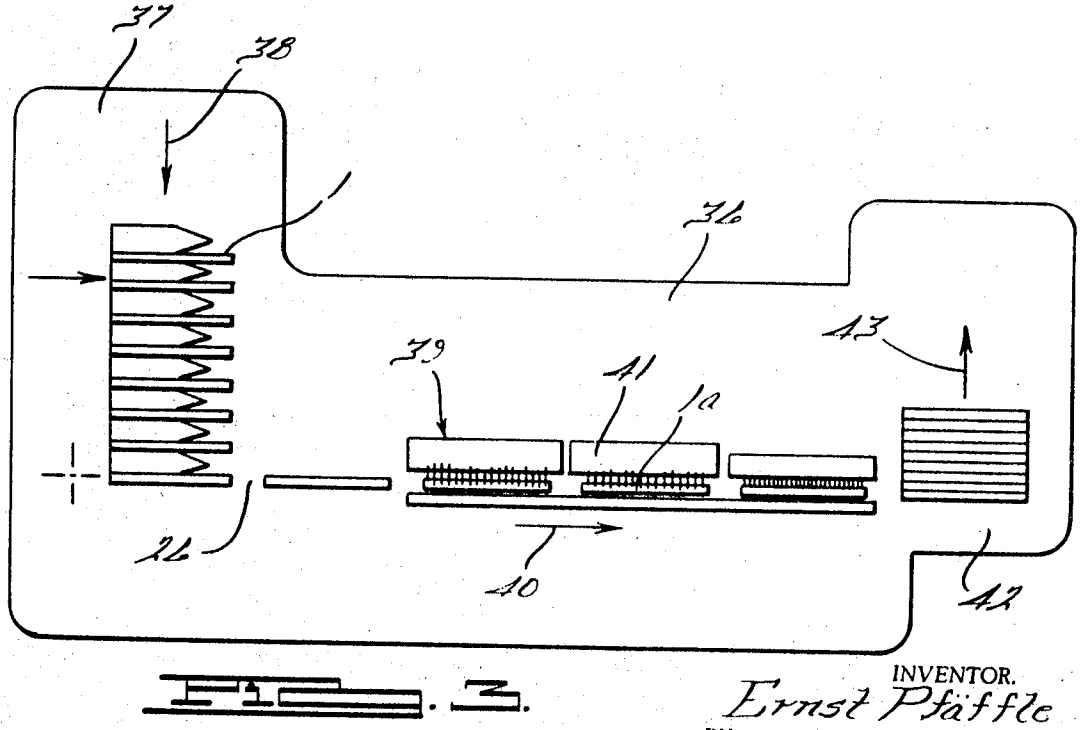

Fig. 3.

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METHOD AND APPARATUS FOR THE PERFORATION OF EDGES OF PAPER STACKS

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U.S. Cl. 77—22 13 Claims

ABSTRACT OF THE DISCLOSURE

Vertical paper stacks are dropped into a drill position on an elongated base wide enough to support two stacks. The lower edges of the stacks are clamped and drills enter the first stack which is backed up by the second stack. The first stack is then lifted, advanced and removed transversely to the direction of advance, while the next stack to be used as a drill backing is advanced and permitted to drop onto the base.

The invention relates to a method for perforating edges or margins of paper stacks by drilling, with the paper stacks clamped during drilling and placed opposite the drills on a drill backing which is renewed for each stack.

The invention further relates to an apparatus for accomplishing this method, in which the clamping device for holding the paper stacks and opening and closing in a working cycle is provided with a drill backing continually replaced in the working cycle and is arranged to feed as well as remove the stacks by pulling or pushing conveying means working in conjunction with slideways to guide the stacks.

It is known to use drills for perforating edges of paper stacks. If the holes are very close together, such as in paper stacks intended for use in manufacturing of ring books, edge perforation is often done by a two-stage drilling if the close spacing of the holes does not permit a simultaneous drilling of all edge holes because of either limited paper strength or the design limitations imposed on the closeness of arrangement of the various drills.

No matter in which way the edge perforation is done according to known methods and in known apparatuses, there is a very considerable disadvantage which greatly affects their results. If no countermeasures are taken, then at the drill exit side of the paper stack there is either an incomplete perforation of the last sheets of paper in the stack or a burr is formed, because the small resistance of the last sheets of paper to the feed pressure of the individual drill causes a tearing and not a drilling. A satisfactory edge perforation which includes the last sheet of the paper stack at the drill exit side is possible only if suitable countermeasures are provided to cause the feed pressure of the drill in the region of the last sheets of the paper stack to be taken by something other than the individual sheets. For this purpose, so-called drill backings of cardboard are used in previously known methods and apparatuses. The drill backings are placed behind the various stacks to be drilled. The drill backings must necessarily be changed and replaced after each drilling or edge perforating, so that firm and smooth support surfaces will be available for the new edge perforations.

It is obvious that the continual introduction and removal or displacement of the cardboard drill backings result in an increased use of material and also in increased expenditure of time and effort, thus making the manufacture of perforated and especially edge-perforated papers more expensive. To save material, effort is made to use cardboard drill backings which are as thin as possible. This is possible if behind the drill backings are placed suitably strong supports, made of metal, for example, to take the drill feed pressures so that the drill backings need merely transfer the drill feed pressures and in thickness need only be suitable for the thickness or height of the conical drillpoint, to insure that the latter will make a clean breakthrough from the last sheet of the paper stack in all cases. While a very close tolerance on thickness of the drill backings helps to reduce the material cost for the drill backings, it leads to increased labor outlay for the replacement at regular intervals of the various drills by sharpened or reground drills. If the drill backings are to have very close tolerances, then the drills must be made with very high accuracy, that is, with maximum errors of $\frac{2}{10}$ or $\frac{3}{10}$ mm., with points straight and parallel to the stack surface and drill backing surface. An exact setting such as this is not only difficult but also time-consuming. It means that the material saving from close design of thickness of the drill backings does not improve economy, because the downtime for adjusting the drilling apparatus increases as the tolerance of drill backing thickness narrows.

It has already been proposed that in edge perforation the stack be drilled from two sides rather than one, and be drilled about halfway through the stack from each side. In this type of edge perforation, too, it is difficult to insure satisfactory cutting away of the drilled-out material from the paper stack, when the latter is drilled in the part of the stack consisting of only a few sheets. The effect of drill feed pressure will make inevitable a tearing of the paper in this type of drilling, too.

The purpose of the invention is to avoid the described disadvantages of the previously known methods and apparatuses and to create a simple and particularly economical method and a simply constructed and reliably operating apparatus with which satisfactory and economical edge perforating can be done by drilling.

To solve this problem, a method of the above-mentioned type is described by the invention, such that during the drilling in each case two paper stacks are arranged and clamped one behind the other with a separation maintained between stacks in the drill feed direction, whereby the rear stack in terms of the drilling device serves as a drill backing and, after the finish of drilling and removal of the front stack, is moved to the place of the front stack, while a new stack is supplied as drill backing and is clamped together with the stack which is now located on the side facing the drill.

In the invention, the known difficulties are satisfactorily avoided, and this is accomplished in a very economical way. There are no difficulties in clamping two stacks simultaneously and removing the first stack when the latter has been completely drilled through, then slid-

ing the second clamped stack, used as a drill backing for edge perforation of the first stack, in place of the completely perforated one, followed by bringing a newly supplied stack as a new drill backing behind the second stack, clamping the two together, and perforating them by drilling. Because the thickness of a paper stack is many times as great as that of drill backings of cardboard, it is entirely immaterial whether individual drills differ from one another in length by several millimeters or not; that is, a laborious, time-consuming adjustment of the free drill length does not have to be made, so that even when blunted drills are exchanged for reground new ones, the down times are very brief.

A very substantial advantage of the new method is that no expendable material is needed for edge perforation. The second paper stack held in each case and into which the various drills penetrate slightly before the first stack is completely and satifactorily perforated and can be removed serves as drill backing. Thus considerable expense in material procurement, previously caused by the use of drill backings of cardboard, is saved and the economy of manufacture of edge-perforated papers is significantly improved. In addition, labor and effort are saved in the accomplishment of edge perforation, because the hitherto necessary introduction of drill backings and the movement of them after each drilling action are no longer necessary. There is no significant increase in equipment requirements for an apparatus to accomplish the new method, because in comparison with the previous labor effort, the new method needs no significant additional labor effort.

An apparatus of the type mentioned, suitable for accomplishment of the new method and built in extremely simple fashion, is characterized according to the invention by acceptance by the clamping device of two stacks arranged one behind the other, with the clamping device having a feed device working cyclically against the drill feed direction and moved by a rotating cam through a linkage connection, while above the clamp device at the height of the stack upper edges are arranged a stack separating device and gripper; the gripper is journalled so that it can swivel vertically and is connected through a linkage connection with a rotating cam controlling its height movement in the working cycle. The gripper has a movable gripping jaw which is driven through an additional linkage connection by a cam which rotates and controls the opening and closing of the gripper in the work cycle.

It can be seen from the above that in addition to the devices previously common, only the separating device, the gripper device, and the pushing device are necessary to place the successive paper stacks in the clamping device of the drilling apparatus in a manner suitable for the method or to remove them after the perforating is finished, with a stack in the clamping device serving as drill backing in each case. If this expenditure is compared with the expenditure in known drilling apparatuses, in which instead of the separating and gripping device and the pushing device, insertion devices for the drill backing and feed or adjustment devices for the drill backing movement and withdrawal after use are necessary, then it is easy to see that the cost of equipment is not increased in comparison with known methods by the new construction of the apparatus. The new construction, because it handles only paper stacks and because automatic operation by cam control is possible, permits a rapid, automatic working cycle and thus an economical manufacture of edge-perforated paper sheets.

The invention provides, in a suitable design of the new apparatus, for the use of a multiple drill head mounted on guide rails and connected with a rotating crank-device by a lever rod to transmit the feed motion and feed force.

An especially simple and suitably designed embodiment of the new device is characterized, according to the invention, by the mounting on the guide rails for the drill head of a drill jig which is supported by compression springs or the like on the drill head and simultaneously constitutes the movable jaw of the clamping device.

A further simplification of the apparatus is achieved, according to the invention, by the construction of the fixed jaw of the clamping device as drill support and, with its upper edge, as slideway for feed as well as slideway for the paper stack moved by the pusher device.

As a further characteristic of the invention it is provided that the separating device is designed as a rotating worm, with axis of rotation approximately in the drilling direction, and with widened flanks or a steeper pitch at the end toward the gripper.

A preferred design of the new apparatus is characterized by provision of grippers arranged as feed and removal devices transverse to the paper stacks and above the slideways, and which are connected with a crank-drive device through a lever rod and execute alternating feed strokes in the work cycle.

If the edge perforations are very close together there are considerable difficulties in known methods and apparatus when drilling must be done successively in two stages, because the loss in drill backings, the time loss in adjusting the necessary two drill heads with their drills and the expense in feeding, moving, and removing the drill backings become especially large.

With an additional design of the apparatus, the invention makes possible economical edge perforation when the holes are very close together, if two drilling devices with clamping, separating gripping, and pusher devices are arranged behind one another in the movement direction, with the drills of both apparatuses staggered on the edge of the stack in relation to each other. An example of embodiment of the new drilling apparatus, suitable for accomplishment of the new method, is shown in the figures.

Other objects, features and advantages of the present invention will become apparent from the subsequent description and appended claims, taken in conjunction with the acompanying drawings, in which:

FIGURE 1 shows a greatly simplified side view of the drill head and the clamping device of the new apparatus with auxiliary equipment;

FIGURE 2 shows a front view of those parts of the new apparatus shown in FIGURE 1; and

FIGURE 3 shows a plan view of the entire apparatus.

In the apparatus shown in the figures, a drill head **2**, provided with a plurality of closely spaced drills **3**, is used for edge perforating of paper stacks **1**. The drill head **2** is slidably displaceable in the direction of the drills **3** on rodlike guide rails **4**, with a lever rod **5** forming a drive connection between drill head **2** and a crank disk **6** and in this manner moving drill head **2** back and forth on guide rails **4** in the direction of arrows **7**. This movement in the direction of arrows **7** produces the feed, feed pressure and return stroke of the drilling apparatus. A belt pulley **8** which is connected to suitable drive means in manner not shown, is provided on the drill head to drive the individual drills **3**.

A clamping device **9** is arranged on the rails **4**. It consists of a fixed support **10** and a movable clamp jaw **11**. The latter is formed by a drill jig, which is mounted slidably on the guide rails **4** and supported on the front side of drill head **2** by one or more compression springs **12**. In the course of the feed and return movements of the drill head **2** the movable clamp jaw of clamping device **9** or the drill jig is drawn away from the paper stacks and thus the clamping device is opened, or moved in a direction toward the paper stacks and thus closed and the paper stack clamped, when the drill head **2** is moved in the corresponding manner by lever rod **5**.

It can be seen from the figures that clamping device **9** is provided to hold two paper stacks **1**. The paper stack **1α** facing the drill is the one in which edge perfora-

tions are finished, while paper stack 1*b*, behind paper stack 1*a* and also clamped, serves as a drill backing during perforation of stack 1*a*. When drills 3 have entered the first sheets of stack 1*b*, so that stack 1*a* is satisfactorily perforated, then the previously mentioned opening of clamping device 9 occurs, and stack 1*a* is removed from clamping device 9.

To remove the perforated paper stack 1*a* from clamping device 9, a gripper 13 is mounted in swiveling fashion above the clamping device. Gripper 13 has a fixed gripper jaw 14 and a movable gripper jaw 15. Movable gripper jaw 15 can be swivelled on gripper 13 in the direction of arrows 16 and is connected so that it can be driven by a cam 18 on a shaft 19 through a lingage connection shown schematically at 17. When the machine runs, shaft 19 turns and with it cam 18, so that the movable gripper jaw 15 moves in the working cycle of the machine, and the gripper thus is opened and closed in the cycle of the machine.

Gripper 13 executes a further swivelling movement in the direction of arrows 20. To achieve this movement there is mounted on gripper 13 a linkage connection shown schematically at 21 which drives gripper 13 from a cam 22 which is also mounted on shaft 19 and rotates with it. When shaft 19 rotates, gripper 13 executes vertical swivelling movements, in the direction of arrows 20, completed during the cycle of the working machine. The vertical swivelling movements are coordinated with the gripper movement, so that stack 1*a* to be removed from the clamping device 9 is engaged by the gripper jaws. held, and lifted out of the clamping device by the subsequent upward swivelling movement. The coordination is accomplished as follows: Shaft 19 carries a sprocket 44 which drives a chain 45. The chain drives a sprocket 46 on a shaft 47 which drives a shaft 48 for crank disk 6 through gears indicated generally at 49. Gripper 13 opens on a slideway 23, mounted above, and stack 1*a* is placed on this slideway so that it can be transported away. To insure that gripper 13 holds only one and in particular the perforated material stack 1*a*, care is taken during the clamping of material stacks 1*a* and 1*b* in the clamping device that the stack separation is maintained. This is done by a separating device 24, which is designed as a rotating screw fastened to shaft 19. The screw is provided with widened flanks 25 at the end nearest the gripper to effect the deflection of the upper end of stack 1*a* shown in FIGURE 1, and thus to facilitate pickup by gripper 13. Stack 1*a*, lifted to slideway 23 by the gripper, is taken there and transported away by suitable drag or pusher mechanisms (not shown in detail), in which followers 25′ running transversely to the length of slideway 23 act on successive paper stacks 1*a*.

The space freed in the clamping device by removal of stack 1*a* must be occupied by a new paper stack. Paper stack 1 is advanced by conveyor elements or followers 27 on a slideway 26 which extends to the upper edge of drill support 10 which simultaneously forms the fixed jaw of the clamping device 9. FIGURE 1 shows that a paper stack 1, which needs only to be pushed in the direction of drill feed to enter the clamping device, is ready on the fixed jaw of clamping device 9. This movement actuates a pusher device 28, consisting of a ram 29 which is driven by a rotating cam 31 through a linkage connection 30. The rotating cam causes ram 29 to move in the direction of arrows 32 in the cycle of the machine. This means that paper stacks 1 standing on fixed jaw 10 are pushed into the clamping device in the drill feed direction, and are there carried by their own weight into the suitable or intended height, and at the same time move stack 1*b*, already in the clamping device, so that stack 1*b* occupies the front position of removed stack 1*a*. Clamping device 9 then closes, perforating is accomplished, and the working process described here is repeated.

FIGURE 2 shows another detail of the new apparatus. It can be seen that follower 25′ for removal of perforated paper stacks 1*a* taken from gripper 13 of clamping device 9 is driven by a rotating crank disk 35 through lever 30 and a linkage connection 34 and thus executes in the working rhythm of the apparatus pushing movements which serve to remove stack 1*a*. These movements can also be used, if lever connection 33 is suitably designed, to move stack 1 if follower 27 is connected mechanically with follower 25′.

The individual parts of the apparatus essential to functioning are shown in clearly recognizable form in FIGURES 1 and 2. The entire apparatus is shown in plan in FIGURE 3. A housing 36, which forms a tablelike working surface, is equipped at one end with a receiver device 37 in which paper stacks 1 are placed by hand or by mechanically driven, automatically operating devices. These stacks 1 are moved in the direction of arrow 38 and finally reach the previously mentioned slideway 26. On this slideway they pass an initial drilling station 39 which is constructed as shown in FIGURES 1 and 2. After leaving drilling station 39, paper stacks 1*a* move on in the direction of arrow 40 and reach a second drilling station 41. This second drilling station is also constructed as shown in FIGURES 1 and 2 and is as described above. The use of two successive drilling stations 39, 41 serves to provide paper stack 1 with a very closely spaced edge perforation. For this purpose the drills of drill heads 2 in drilling apparatuses 39, 41 are staggered with respect to the edge of the paper stack, so that double drilling gives an edge perforation with the desired small hole interval. After leaving the second drilling station or drilling apparatus 41, paper stacks 1*a* arrive at a collecting table 42 and are transported thereon in the direction of arrow 43. If the construction of the described apparatus is changed, then more than two drilling apparatuses can be provided to achieve, for example, a very closely spaced edge perforation, or the drills can be set at different heights, so that they produce a zig-zag edge perforation. Additional devices can be provided on the table of housing 36 subsequent to the two drilling apparatuses 39, 41 and serving to introduce book or holding spirals into the paper stacks, so that after passing the various devices complete ring-backed books, blocks, or the like, can be removed at discharge point 42. It is not necessary to discuss in detail the various designs of such additionally necessary devices which make possible this production of finished products, because such devices are known and in addition are not a subject of the invention.

While it will be apparent that the preferred embodiment of the invention disclosed is well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

I claim:

1. In a method for simultaneously drilling a series of edge perforations in paper stacks, the steps of arranging two aligned vertical paper stacks one behind the other and clamping them at their lower edge, a first of the stacks being in a drilling position and the second stack being in a drill backing position, simultaneously drilling a series of perforations adjacent said lower edge of said first stack, continuing said drilling until said first stack is entirely penetrated and the drills engage the second stack, whereby said second stack serves as a drill backing to permit complete formation of the perforations in said first stack, simultaneously withdrawing the drills from said first stack, unclamping said stacks, lifting and advancing said first stack from its drilling position, removing said first stack transversely to the direction of advance, advancing said second stack from said drill backing position to said drilling position, moving a third stack behind said second stack by transverse movement on a level above said second stack, advancing said third stack toward said second stack so that it drops behind and is

aligned with said second stack, clamping said second and third stacks at their lower edge, simultaneously drilling a series of perforations adjacent the lower edge of said second stack until the drills entirely penetrate the second stack and engage the third stack, whereby the third stack acts as a drill backing for the second stack to permit complete formation of the perforations in the second stack, withdrawing the drills from said second stack, unclamping said second and third stacks, lifting and advancing the second stack from said drilling position, removing said second stack transversely to the direction of advance, advancing said third stack into the drilling position, continuing to place successive stacks behind the stacks at the drilling position to serve as drill backings, and then advancing the stacks which have served as drill backings successively into drilling position.

2. In a device for drilling edge perforations in successive paper stacks, a multiple drill head carrying a plurality of drills for perforating paper stacks, a fixed jaw extending transversely to said drills and spaced from the ends thereof, means between said fixed jaw and said drills for supporting two paper stacks in position for drilling, one behind the other in the direction of the drill feed whereby one stack will be in a drilling position and the other stack in a drill backing position, said means comprising an elongated base extending transverse to said drills on which the lower edges of said stacks rest, said drills being adjacent said lower edges, means for simultaneously advancing said drills toward said supporting means sufficiently to drill through the stack in said drilling position and engage the stack in said drill backing position, means for simultaneously withdrawing said drills, means for lifting the stack in said drilling position from the drilling position and advancing said stack away from the drilling position, means supporting a third stack above and behind said drill backing position, and means for advancing the stack in said drill backing position to said drilling position and advancing the stack adjacent said drill backing position toward said drill backing position so that it drops by gravity into said drill backing position.

3. The combination according to claim 2, said means for advancing the stack adjacent said drill backing position toward said drill backing position comprising a pusher device actuatable in a direction counter to the direction of drill feed movement, and cam-and-linkage means for actuating said pusher device.

4. In a device for drilling edge perforations in successive paper stacks, a multiple drill head carrying a plurality of drills for perforating paper stacks, a fixed jaw extending transversely to said drills and spaced from the ends thereof, means between said fixed jaw and said drills for supporting two paper stacks in position for drilling, one behind the other in the direction of the drill feed whereby one stack will be in a drilling position and the other stack in a drill backing position, means for simultaneously advancing said drills toward said supporting means sufficiently to drill through the stack in said drilling position and engage the stack in said drill backing position, means for simultaneously withdrawing said drills, means for removing the stack in said drilling position from the drilling position, means supporting a third stack adjacent said drill backing position, and means for advancing the stack in said drill backing position to said drilling position and advancing the stack adjacent said drill backing position to said drill backing position, said means for advancing the stack in said drill backing position toward said drilling position and the means for advacing the stack adjacent said drill backing position toward the drill backing position comprising a rotatable screw adjacent those edges of said stacks which are remote from the edges being drilled, the end of said screw nearer said drills being provided with widened flanks, whereby rotation of said screw will cause deflection of a stack in said drilling position away from the stack in said drill backing position.

5. The combination according to claim 4, said means for removing the stack in said drilling position comprising a gripper mounted adjacent said screw, said gripper being movable between an advanced position and a retracted position, gripper jaws on said gripper for gripping said deflected stack when in said advanced position, first cam-and-linkage means for moving said gripper between its said positions, and second cam-and-linkage means for moving said gripper jaws between open and closed positions.

6. The combination according to claim 2, further provided with at least one guide rail supporting said multiple drill head, and crank-and-lever rod means for moving said drill head between its advanced and retracted positions.

7. The combination according to claim 6, further provided with a drill jig slidably supported on said guide rail between said drill head and said stack supporting means, and spring means between said drill jig and drill head, the drill jig constituting a movable jaw engageable with the stack in said drilling and drill backing position when said drill head is advanced to clamp said two stacks in position for drilling.

8. The combination according to claim 2, said fixed jaw having an upper surface which constitutes said means for supporting said stack adjacent the drill backing position, the means for supporting the stacks in drilling and drill backing positions constituting a platform at a lower level than said last-mentioned surface.

9. The combination according to claim 5, further provided with reciprocable supply means movable transversely to said drills for moving stacks into said position adjacent the drill backing position, a slideway adjacent said drilling station, said gripper jaws being adapted to release a pack onto said slideway, and removal means reciprocable transversely to said drills for sliding stacks along said slideway.

10. The combination according to claim 9, further provided with a second drilling device having all the elements of said first-mentioned drilling device, the reciprocable supply means of said second drill device being aligned with the removal means of said first apparatus, whereby the two devices may successively drill two staggered sets of holes in each stack.

11. In a device for drilling edge perforations in successive paper stacks or the like, a housing having a working surface comprising a table having a receiving leg, a drilling station leg extending transversely from one end of said receiving leg, and a collecting leg extending from one end of said drilling station leg, whereby said three legs have a substantially U-shaped pattern, a receiver device on said receiving leg for moving successive vertically disposed stacks of paper toward said drilling station leg, said successive stacks being arranged in a row along said receiving leg during such movement with the planes of the stacks being parallel to said drilling station leg, a slideway extending along said drilling station leg, means for moving successive paper stacks while still in vertical position along said slideway, whereby the successive stacks will be behind each other and in the same plane, first and second drilling stations spaced along said drilling station leg for drilling staggered sets of edge perforations in successive stacks, and means on said collecting leg for transporting successive drilled stacks therealong while still in vertical position and in planes parallel to said drilling station leg.

12. In a method for simultaneously drilling a series of edge perforations in a paper stack or the like, the steps of holding said stack vertically so that all the sheets of said stack rest on a common horizontal base, clamping together the sheets along the lower edge of said stack, and simultaneously drilling a series of perforations along said lower edge while maintaining the lower edge in its clamped position.

13. In a device for simultaneously drilling a series of

edge perforations in a paper stack or the like, an elongated horizontal base for supporting the lower edges of a vertically disposed stack of paper sheets, clamping members on opposite sides of said base, said members being relatively movable toward each other transverse to the length of said base to clamp said sheets along the lower edge of said stack, a drill head having a plurality of horizontally extending drills transverse to the extent of said base, guide rail means transverse to the extent of said base for supporting said drill head for horizontal movement, and apertured portions in one of said clamping members through which said drills extend.

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