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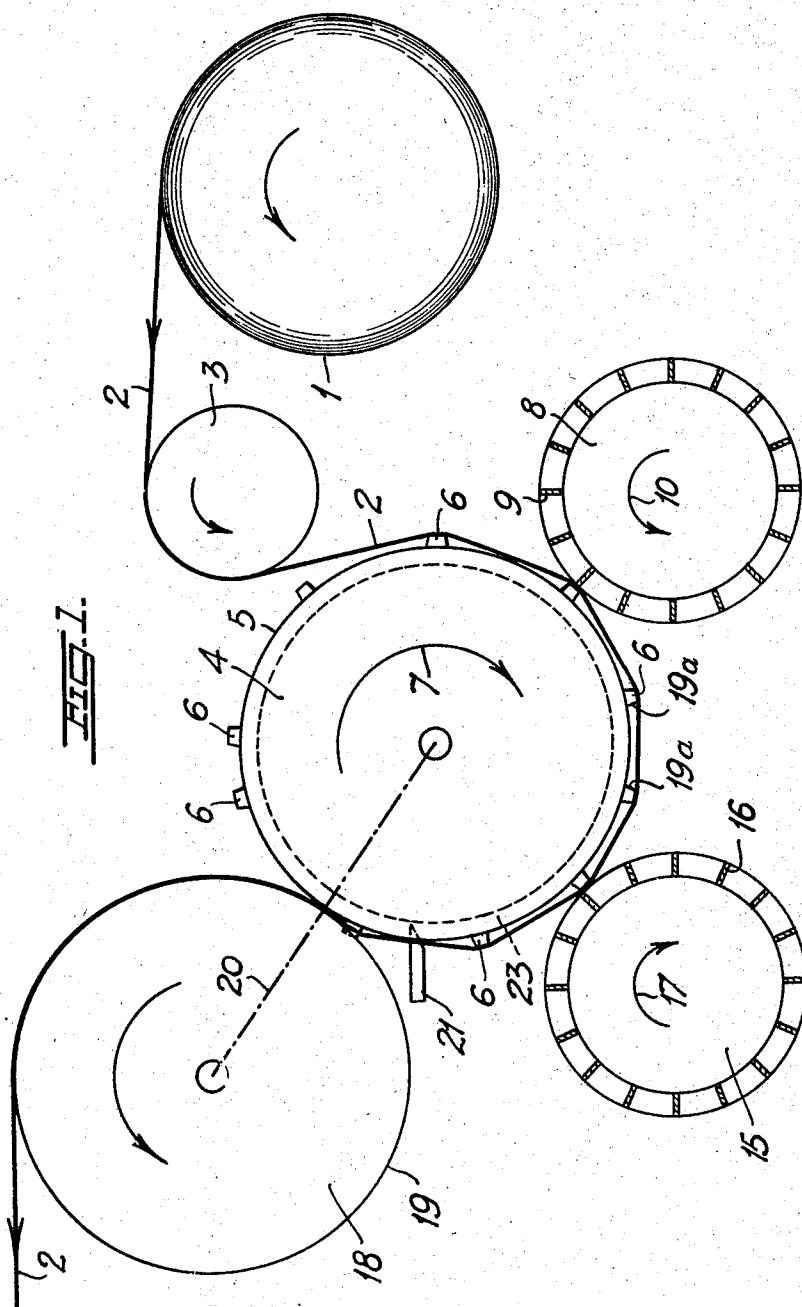
G. S. HELLBERG

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METHOD AND MEANS FOR THE PERFORATION OF PAPER AND THE LIKE

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3 Sheets-Sheet 1



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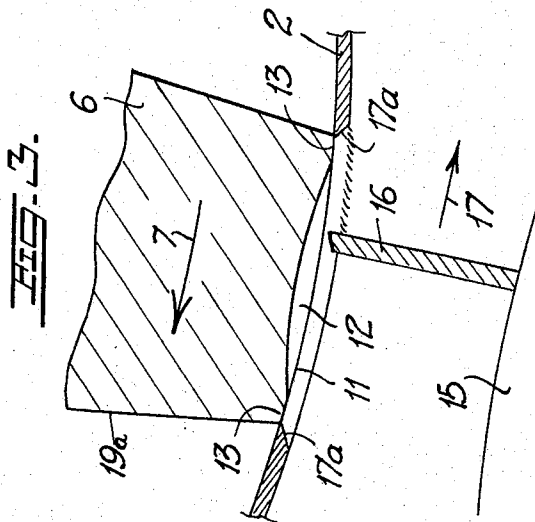
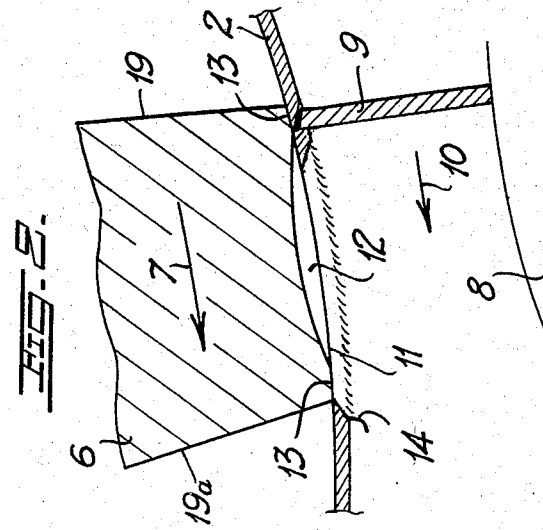
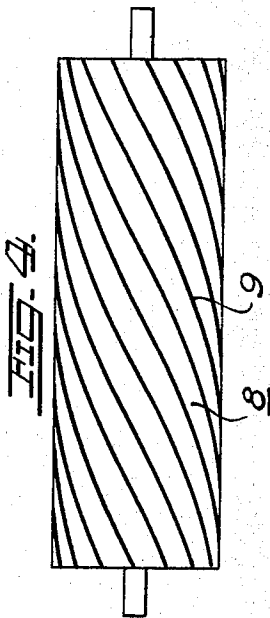
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METHOD AND MEANS FOR THE PERFORATION OF PAPER AND THE LIKE

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METHOD AND MEANS FOR THE PERFORATION OF PAPER AND THE LIKE

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13 Claims. (Cl. 90-11)

In the modern bookkeeping and punch-card machine technics it is important that hole perforations and folding perforations be accurate as to form and position, so that holes corresponding to each other are brought opposite one another, when the paper sheets are folded or piled on top of each other for the simultaneous production of a plurality of carbon copies. According to the usual perforating method the perforations are produced by punching out the corresponding portions of the paper by means of hole punches. It is also known to produce tear-off perforations by making incisions in the paper by means of knives, in which case no material is worked out of the paper. The punching method involves, in addition to fabrication difficulties, also certain difficulties as regards the possibility of producing smooth hole edges. Moreover, it has proved difficult according to the punching method to produce folding perforations that are exactly perpendicular to the borders of the finished paper sheets. Such imperfections in the finished paper sheets or bundles thereof frequently cause shut-downs in the use of book-keeping machines and the like.

The present invention has for its object to overcome the above-mentioned drawbacks. The invention is substantially distinguished by the fact that the paper is brought into contact with a patrix, the relief-like portions of which have end surfaces corresponding to the shape of the perforation holes, whereupon the portions of the paper bearing on said end surfaces are worked off by means of one or more chip removing tools, while the paper and the patrix are moving together relatively to the tools. The patrix preferably takes the form of a rotating roll, the paper web being entrained round the roll in a position bearing on its relief-like portions and being worked upon by means of one or more stationary arranged rotating tools preferably consisting of cutters or rotating knives with the cutting edges disposed obliquely to the axis of rotation. The working off of the paper material may also be effected by a scraping or grinding action, for instance by means of a grinding roll. Generally, any tool may be used by means of which paper material may be removed in the form of chips or the like. The patrix roll and the tool should preferably rotate in opposite directions, so that the paper and the cutting edges acting upon the same move in the same direction; the tool then rotating at a speed which is a multiplicity of the speed of the patrix roll. The relief-like portions supporting the paper are preferably shaped in the form of studs or pins arranged on the cylindrical surface of the roll and having end surfaces corresponding to the shape of the perforation holes, said end surfaces being located in cylindrical surfaces coaxial with the roll.

The invention will be described more closely with reference to a form of embodiment of a perforating machine according to the invention as illustrated in the accompanying drawings. Fig. 1 is a view in elevation of the mutual arrangement of the parts comprised in the perforating machine. Figs. 2 and 3 show various steps in the production of the holes on a larger scale. Fig. 4 shows a chip cutting tool in the form of a cutter. Fig. 5 is an axial section through the patrix roll and the cutter.

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As shown in Fig. 1, a paper web 2 wound off from a supply reel 1 is adapted to run over a freely running roller 3 round the circumference of the cylindrical surface 5 of the patrix roll 4. The roll is provided with small projecting studs and/or pins 6 arranged in positions corresponding to the positions of the perforation holes in the paper web, said studs or pins having end surfaces corresponding to the shape of the perforation holes. The studs have a height above the cylindrical surface of the roll which is only slightly, for instance 1.1 mm. greater than the thickness of the paper, but which is shown on an exaggerated scale in the drawing. In the example shown, the studs have a conical, outwardly tapering form. The paper will then rest in part on the ends of said studs or pins and in part on portions of the cylindrical surface of the patrix roll located between the studs. The roll rotates in the direction indicated by the arrow 7 and entrains the paper web 2 during its rotation.

During the rotation of the patrix roll 4, the paper web 20 first meets with a cylindrical cutter 8 with screw-shaped cutting edges or knives 9, Fig. 4, intended to work upon the portions of the paper web bearing on said studs 6. The cutter 8 rotates in the direction shown by the arrow 10 at a peripheral speed which is many times greater than that of the patrix roll 4, the peripheral portions of the cutter and the roll running in the same direction. The distance between the cutting edges of the cutter and the peripheral surfaces 11 of the studs is chosen so that the knives penetrate into the paper for approximately nine-tenths of the thickness of the paper. An arrangement for accurate adjustment of the cutter relatively to the peripheral surface of the studs will be described in the following with reference to Fig. 5.

As will appear from Fig. 2, the end surface 11 of the studs 6 facing the cutter is located in a cylindrical surface coaxial with the axis of the patrix roll. The end surface 11 is provided with a dish-shaped cavity limited by an annular edge portion 13 of said surface. When one of the cutting edges 9 first meets with the paper web, this takes place at the left side of the stud 6 (Fig. 2), said cutting edge then cutting down into the paper and reaching its greatest penetration depth when passing the plane through the axes of the patrix roll and the cutter. During the continued movement of the cutting edge 9 in the direction of the arrow 10, the cutting edge will cut off a chip while leaving a torn-up lug 14 in the paper web. The following cutting edge sets in immediately to the right of the first cut, inasmuch as the stud will now have moved somewhat to the left in the direction of the arrow 7. These cutting operations proceed, until the stud 6 and the corresponding portion of the paper web have passed the operating range of the cutter. As stated above, the cutting edges penetrate down into the paper for approximately nine tenths of the thickness thereof, the paper being thus weakened, so that the remaining fibres will be torn off together with the separated chips, thus leaving open holes. The cavity 12 has for its object to reduce the actual cutting work, so that not the whole of the paper portion located on the stud but only the portion of the paper bearing on the annular surface 13 need be cut off.

After this piercing of the paper by means of the cutter 8, the hole edges must be trimmed clean by the removal of fibre residues remaining at the edges, such residues forming a rim of torn fibres extending obliquely forwards in the direction of movement of the paper. To this end there is provided a further cutter 15 in a position displaced angularly forwards relatively to the patrix roll 4. This cutter is of the same nature as the cutter 8 but has an opposed direction of rotation and approximately the same rotary speed as that of the cutter 8. In the position shown in Fig. 3, the stud 6 and the corresponding portion of the paper have been

moved forward to the cutter 15 through the rotation of the patrix roll 4. Here, the cutting edges 16 run in the direction shown by the arrow 17, that is to say, in a direction toward the fibre residues remaining at the hole edge, said residues being thus cut off together with the previously formed lug 14. The edges are thus cleaned completely from adhering fibres.

Through the cutting operation, the hole edges will be cut off obliquely so as to form somewhat weakened edge portions 17a outside the end surface 11, as will be seen from Fig. 3. To stiffen the hole edges and to give them their final dimensions, the paper is pressed with the aid of a matrix roll 18, which is provided with a coating of a resilient material on its cylindrical surface 19, inwardly towards the cylindrical surface 5 of the roll 4. The envelope surfaces 19a of the studs are slightly conical and dimensioned so as to have at the bottom a width corresponding to the finished perforation holes. By the depression of the paper web against the cylindrical surface of the roll 4 the weakened hole edges 17a will be pressed out against and into the surrounding paper portions. By reason of the powerful pressure, by which the matrix roll 18 bears on the roll 4, the edge portions of the perforation holes become entirely smooth. Through the simultaneously effected compression of the edges these edge portions attain a considerably greater strength than that obtained in a punching operation. The roll 18 has the same diameter as that of the roll 4, and is preferably connected to the latter through a toothed gearing indicated diagrammatically by a chain-dotted line 20. After the termination of the pressing operation the paper web leaves the roll 4 and the studs 6 and follows the surface of the matrix roll for approximately one half of its circumference, being then wound up or folded in known manner.

Folding perforations may be effected in a similar manner by the arrangement of a row of pins on the cylindrical surface of the patrix roll, said row of pins paralleling the axis of rotation and said pins having the same height above the cylindrical surface 5 as that of the studs 6. In order that these folding perforations shall actually become perpendicular to the finished paper web, two fixed knives 21 are provided, Fig. 1, said knives being arranged at a mutual distance equaling the width of the finished paper web. These knives project into slots 22, 23, Fig. 5, in the surface 5 of the roll 4 and thus cut the original paper web clean along two mutually parallel planes at right angles to the axis of the roll 4, the edges of the web then becoming parallel and accurately perpendicular to the row of holes. Hereby the considerable advantage is obtained that possible lateral displacements and twists of the original paper web do not have any disturbing influence on the dimensions and the hole distribution of the finished paper web.

To permit the maintenance of narrow allowances between the cutting edges 9, 16 and the end surfaces 11 of the studs 6, certain measures must be undertaken with respect to the mounting of the cutters relatively to the patrix roll. However such mounting is practically carried out will be described with reference to Fig. 5.

Bearings 25 for the shaft 26 of the patrix roll are arranged in a frame 24. The shaft 29 of the cutter is mounted in a similar manner in bearings 28, which are in turn mounted in eccentric apertures in rings 27, which are mounted in the frame 24 and adjustable into different angular positions. By the two rings 27 being turned at the same time, the distance between the cutting edges 9 and the end surfaces of the studs 6 may be varied. However, by reason of a practically unavoidable play in the bearings 25, 28 an adjusted play between the cutting edges and the studs cannot be maintained during the rotary movement, no matter how perfectly the cutting edges and the studs might have

been dimensioned. Therefore, ball or roller bearings 30 are arranged between the roll and the cutter, said bearings being provided with races 31, which are accurately ground relatively to the axis of the cutter. These races are adapted to roll on tracks 32 arranged at the ends of the roll 4 and accurately ground relatively to the axis of the roll. The height of the tracks 32 above the roll surface 5 and the distance of the races 31 from the cylindrical surface of the cutter are chosen so that the desired play between the cutting edges and the studs is obtained, when the races 31 are adjusted by the eccentric rings 27 so as to bear on the tracks 32. By the fact that the races of the cutter are set at a pressure against the tracks of the roll, substantially all such movements are eliminated between the cutter and the roll that might otherwise occur on account of a play in the bearings 25 and 28.

The tracks 32 are somewhat wider than the races 31 to secure the same rolling surface also in case of axial displacements of the cutter. Such a displacement of the cutter is sometimes necessary to ensure a more uniform wear of the knives. The displacement may be effected either manually or automatically, in the latter case for instance by an axially oscillatory movement being imparted to the cutter.

Within the scope of the invention the constructive design may be varied in adaptation to various practical needs and desiderata. For example, the patrix may be plane instead of cylindrical in perforating sheets of paper, in which case either the cutters are displacably movable relatively to the stationary patrix or the latter and the paper sheet are together movable relatively to the stationary cutters.

What is claimed is:

1. A method of perforating paper and the like which comprises bringing the paper into contact with a patrix, the relief-like portions of which have end surfaces corresponding to the shape of the perforation holes, said paper and said patrix moving together in the same direction, working off the portions of the paper bearing on said end surfaces by means of a first chip removing tool moving in one direction and then working off said portions by means of a second chip removing tool moving in the opposite direction.

2. A method of perforating paper and the like, which comprises feeding the paper over the circumference of a rotating patrix the relief-like portions of which have end surfaces corresponding to the shape of the perforation holes, said paper and said patrix moving together in the same direction, working off the portions of the paper bearing on said end surfaces by means of a first rotating chip removing tool rotating in a direction opposite to that of the patrix and then working off said portions by means of a second rotating chip removing tool rotating in the same direction as that of the patrix.

3. A method of perforating paper and the like, which comprises feeding the paper over the circumference of a rotating patrix the relief-like portions of which have end surfaces corresponding to the shape of the perforation holes, said paper and said patrix moving together in the same direction, working off the portions of the paper bearing on said end surfaces by means of a first rotating chip removing tool rotating in a direction opposite to and at a peripheral speed many times greater than that of the patrix and then working off said portions by means of a second rotating chip removing tool rotating in the same direction with and at a peripheral speed many times greater than that of the patrix.

4. A method of perforating paper and the like which comprises bringing the paper into contact with a patrix, the relief-like portions of which have end surfaces corresponding to the shape of the perforation holes, said paper and said patrix moving together in the same direction, working off the portions of the paper bearing on said end surfaces by means of a first chip removing tool mov-

ing in one direction and then working off said portions by means of a second chip removing tool moving in the opposite direction the cutting edges of the chip removing tools penetrating into the paper to a depth corresponding approximately to the thickness of the paper but short of touching the end surfaces of the relief-like portions.

5. A device for perforating paper and the like comprising, in combination, a rotatable patrix roll rotatable in a predetermined direction, means for feeding the paper over the circumference of said rotating patrix roll, said roll being provided with paper-supporting stud means having end surfaces corresponding to the shape of the perforation holes, a first rotating chip-removing tool rotatable in a direction opposite to that of the patrix roll, and a second rotating chip-removing tool rotatable in the same direction as that of the patrix roll, said tools being positioned to work off the portions of the paper disposed on the end surfaces of said stud means.

6. A device for perforating paper and the like comprising, in combination, a rotatable patrix roll rotatable in a predetermined direction, means for feeding the paper over the circumference of said rotating patrix roll, said roll being provided with paper-supporting stud means having end surfaces corresponding to the shape of the perforation holes, a first rotating chip-removing tool rotatable in a direction opposite to and at a peripheral speed many times greater than that of the patrix roll, and a second rotating chip-removing tool rotatable in the same direction with and at a peripheral speed many times greater than that of the patrix roll, said tools being positioned to work off the portions of the paper disposed on the end surfaces of said stud means.

7. A device for perforating paper and the like comprising, in combination, a rotatable patrix roll rotatable in a predetermined direction, means for feeding the paper over the circumference of said rotating patrix roll, said roll being provided with paper-supporting stud means having end surfaces corresponding to the shape of the perforation holes, a first rotating chip-removing tool rotatable in a direction opposite to that of the patrix roll, and a second rotating chip-removing tool rotatable in the same direction as that of the patrix roll, said tools being positioned to work off the portions of the paper disposed on the end surfaces of said stud means, said end surfaces being disposed in cylindrical surfaces coaxial with the patrix roll.

8. A device for perforating paper and the like comprising, in combination, a rotatable patrix roll rotatable in a predetermined direction, means for feeding the paper over the circumference of said rotating patrix roll, said roll being provided with paper-supporting stud means having end surfaces corresponding to the shape of the perforation holes, a first rotating chip-removing tool rotatable in a direction opposite to that of the patrix roll, and a second rotating chip-removing tool rotatable in the same direction as that of the patrix roll, said tools being positioned to work off the portions of the paper disposed on the end surfaces of said stud means, said end surfaces being disposed in cylindrical surfaces coaxial with the patrix roll and being annular.

9. A device for perforating paper and the like comprising, in combination, a rotatable patrix roll rotatable in a predetermined direction, means for feeding the paper over the circumference of said rotating patrix roll, said roll being provided with paper-supporting stud means having end surfaces corresponding to the shape of the perforation holes, a first rotating chip-removing tool rotatable in a direction opposite to that of the patrix roll, and a second rotating chip-removing tool rotatable in the same direction as that of the patrix roll, said tools being positioned to work off the portions of the paper disposed on the end surfaces of said stud means, said stud means having outwardly-tapering cross-section.

10. A device for perforating paper and the like comprising, in combination, a rotatable patrix roll rotatable

in a predetermined direction, means for feeding the paper over the circumference of said rotating patrix roll, said roll being provided with paper-supporting stud means having end surfaces corresponding to the shape of the perforation holes, a first rotating chip-removing tool rotatable in a direction opposite to that of the patrix roll, and a second rotating chip-removing tool rotatable in the same direction as that of the patrix roll, said tools being positioned to work off the portions of the paper disposed on the end surfaces of said stud means, each tool being positioned relatively to the patrix roll in such manner that the cutting edges of the chip-removing tools penetrate into the paper to a depth corresponding approximately to the thickness of the paper but short of touching the end surfaces of said stud means.

11. A device for perforating paper and the like comprising, in combination, a rotatable patrix roll rotatable in a predetermined direction, means for feeding the paper over the circumference of said rotating patrix roll, said roll being provided with paper-supporting stud means having end surfaces corresponding to the shape of the perforation holes, a first rotating chip-removing tool rotatable in a direction opposite to that of the patrix roll, and a second rotating chip-removing tool rotatable in the same direction as that of the patrix roll, said tools being positioned to work off the portions of the paper disposed on the end surfaces of said stud means, each of said rotating tools and the patrix roll being provided with roller races coaxial with the tools and the patrix roll, said roller races being adapted to be set against each other by radial adjustment of the tools and the patrix roll relatively to each other.

12. A device for perforating paper and the like comprising, in combination, a rotatable patrix roll rotatable in a predetermined direction, means for feeding the paper over the circumference of said rotating patrix roll, said roll being provided with paper-supporting stud means having end surfaces corresponding to the shape of the perforation holes, a first rotating chip-removing tool rotatable in a direction opposite to that of the patrix roll, and a second rotating chip-removing tool rotatable in the same direction as that of the patrix roll, said tools being positioned to work off the portions of the paper disposed on the end surfaces of said stud means, each of said rotating tools and the patrix roll being provided with roller races coaxial with the tools and the patrix roll, said roller races being adapted to be set against each other by radial adjustment of the tools and the patrix roll relatively to each other, one of said roller races consisting of the race of an antifriction bearing disposed on one of each of said tools and said patrix roll.

13. A device for perforating paper and the like comprising, in combination, a rotatable patrix roll rotatable in a predetermined direction, means for feeding the paper over the circumference of said rotating patrix roll, said roll being provided with paper-supporting stud means having end surfaces corresponding to the shape of the perforation holes, a first rotating chip-removing tool rotatable in a direction opposite to that of the patrix roll, said tools being disposed in succession along the surface of the patrix roll and cooperating to work off the portions of the paper located on the end surfaces of said stud means, both tools being disposed to leave a small play between the end surfaces of the stud means and the cutting edges of the tools.

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