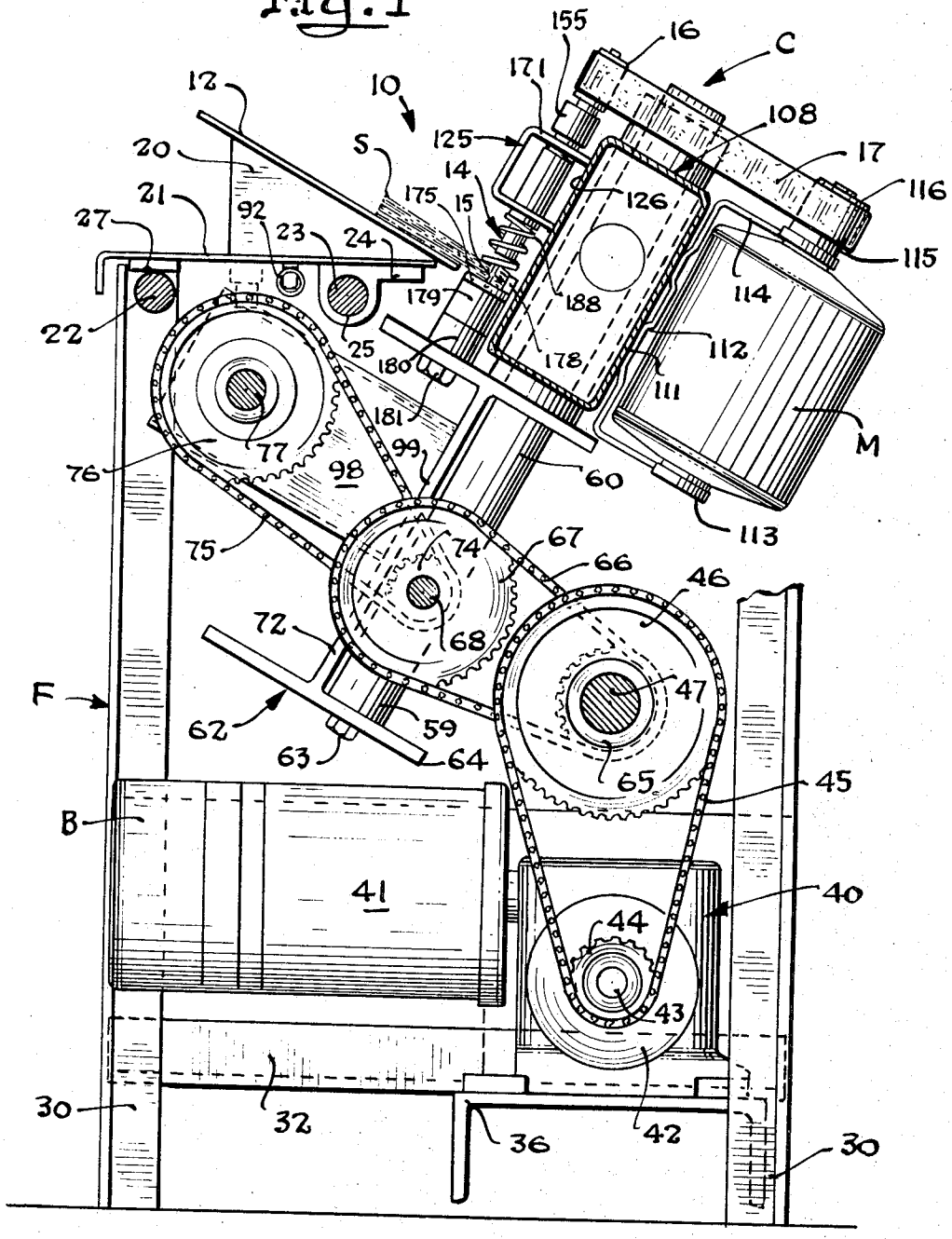
Dec. 12, 1967 W. L. HOLLOWAY ET AL 3,357,280

PERFORATING APPARATUS

Filed March 16, 1965 4 Sheets-Sheet 1

Fig. 1



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PERFORATING APPARATUS

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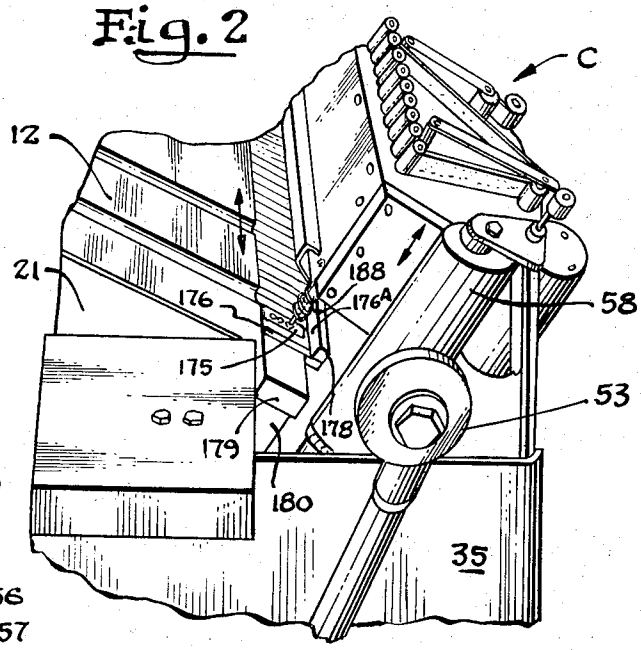
Fig. 2



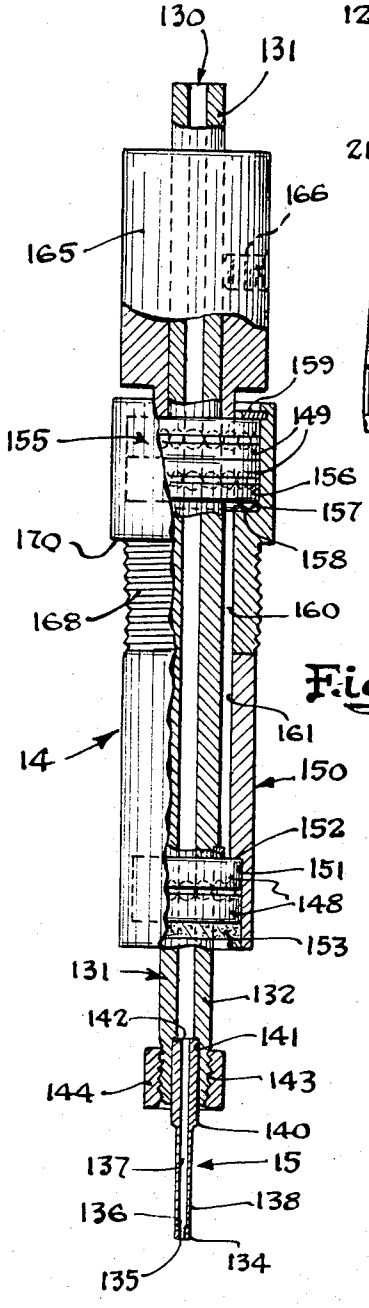


Fig. 3

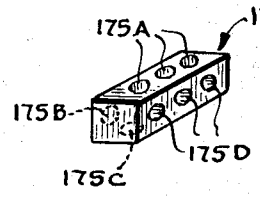
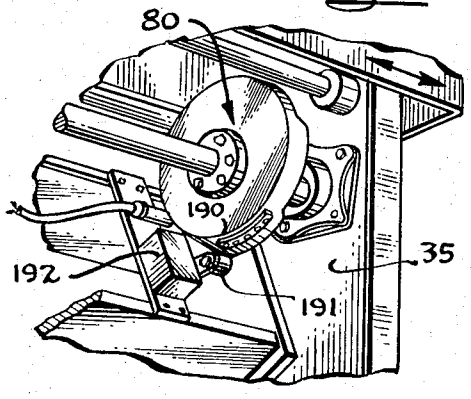


Fig. 8

Fig. 4



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PERFORATING APPARATUS

Filed March 16, 1965 4 Sheets-Sheet 3

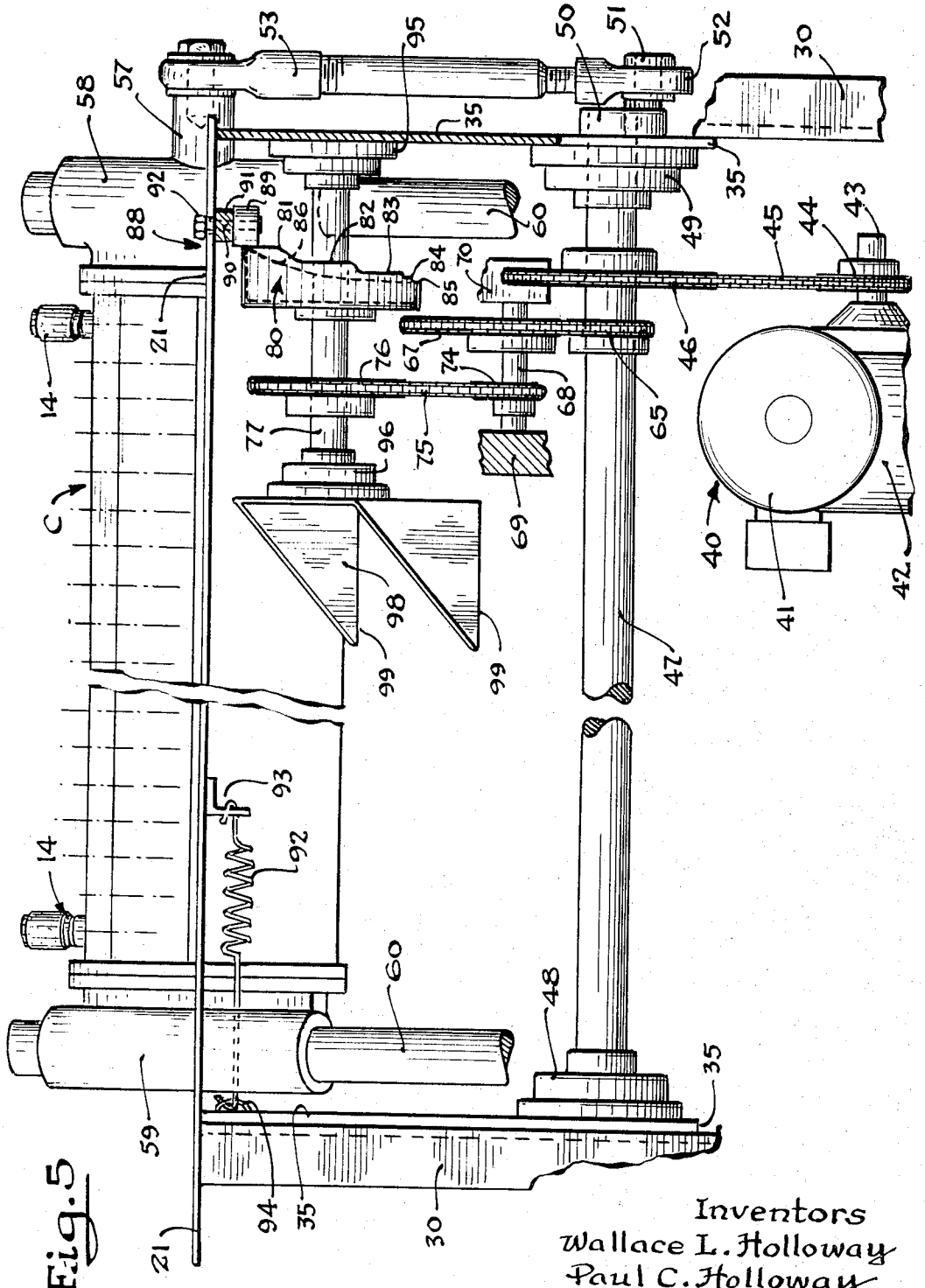

Fig. 5

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PERFORATING APPARATUS

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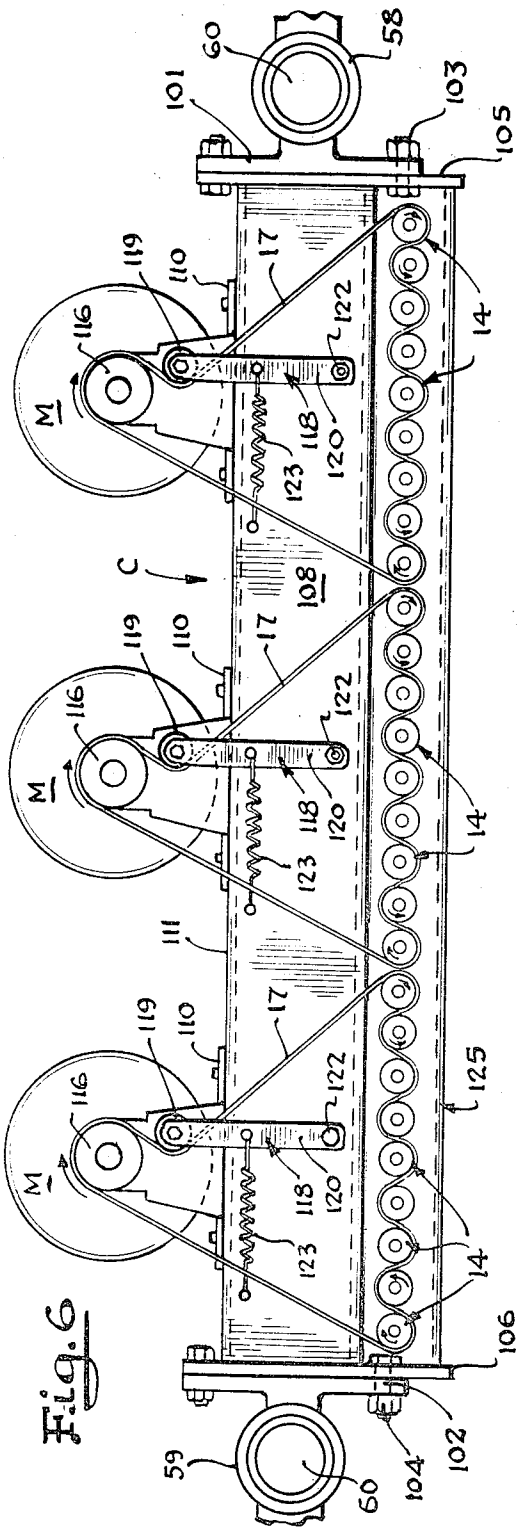

Fig. 6

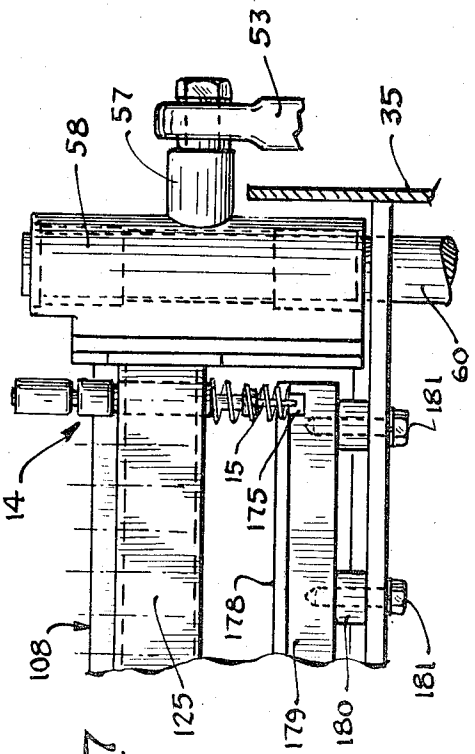

Fig. 7

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PERFORATING APPARATUS

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Filed Mar. 16, 1965, Ser. No. 440,221
2 Claims. (Cl. 77—22)

ABSTRACT OF THE DISCLOSURE

Stacked sheets on a support are perforated, for receipt of a spiral binder or the like, and holes in repeated series are made by relative indexing between the support and a plurality of drills. The drills are oppositely rotated, and are presented to the sheets by relative movement between the drills and the sheets. A control is interposed to cause cyclic operation of indexing and reciprocation.

The present invention relates to an apparatus for perforating and more particularly to a perforating apparatus including a plurality of rotatable members for simultaneously perforating a plurality of holes.

The present invention is directed to an apparatus particularly suited for forming simultaneously large numbers of relatively small diameter perforations at very close distances relative to one another. Also the present invention is particularly adapted to forming such small diameter holes in relatively thick material with increased efficiency over heretofore known perforating apparatus.

The present invention is advantageously employed for the drilling of the large number of small holes formed along the edges of sheets of paper which are to be bound together by a spiral wire into the commonly known wire bound notebook. One form of such notebook includes a large number of small holes having a diameter of approximately one-tenth of an inch and holes spaced on approximately one-quarter inch centers. One heretofore known method of forming such holes was to punch simultaneously a number of such small holes in a one-eighth inch stack of sheets of paper. The forming of such holes in only one-eighth inch stacks has been found to be rather uneconomical in the amount of handling time required for positioning, aligning and punching the holes in each of the one-eighth inch stacks. Accordingly, an object of the present invention is a new and improved apparatus for more efficacious and economical forming of a plurality of closely centered holes of relatively small diameters in relatively thicker stacks of sheets or materials. More specifically, an object of the invention is the drilling of large numbers of small holes spaced from one another at close distances in a stack of paper sheets of one-half inch or more in thickness by a new and improved apparatus. Although it has been known to drill holes in papers from a plurality of drills, the prior art apparatus has drilled holes of much larger sizes, such as 5/16" in diameter holes, and at more widely spaced locations, sometimes there being only two or three spaced locations along the peripheral edge portion of a sheet. A further object of the present invention is the ability to closely space a long series of drills and to drive the closely spaced drills to form simultaneously a large number of closely spaced holes during a single drilling operation.

A further object of the invention is automatically drilling a first series of closely spaced holes and then automatically indexing the drills and material relative to one another and drilling another series of holes between holes previously formed thereby affording holes more closely spaced than the spacing between the drills.

With machines for perforating paper sheets, there is accumulated large amounts of chaff, chips or the like

and accordingly the further object of the present invention is a new and improved apparatus for handling and disposing of the chips and chaff being generated during a perforating operation. In the preferred embodiment of the invention, and as another object thereof, the small perforating elements are characterized by a hollow bore through which the chips and chaf travel upwardly away from the material being drilled. Another object is a machine wherein the chips and chaff are moved upwardly through hollow drilling elements which are supported in an inclined position to cause the chips exiting the drills to move by gravity away from the tops of the hollow drills.

Another object of the present invention is the use of the same drill construction for each drill thereby permitting rapid interchange and replacement of drills without regard to whether or not the drill is of a left or right hand twist or spiral.

Another object of the present invention, is rotating a long series of perforating elements by a driving belt interwound between adjacent perforating elements to rotate said perforating elements in opposite directions to prevent twisting of the work piece during a drilling operation.

Another object of the invention is to facilitate the handling of stacks of sheets on a support canted to the vertical and the removing of chips by having the perforating elements also disposed at an angle oblique to the vertical.

A general object of the invention is a new and improved apparatus for automatic drilling a plurality of series of closely spaced and relatively small diameter holes.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show preferred embodiments of the present invention and the principles thereof and what is now considered to be the best mode contemplated for applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention.

In the drawings:

FIG. 1 is a partial sectional view of a perforating apparatus constructed in accordance with the principles of the present invention;

FIG. 2 is a perspective view of supporting a plurality of drilling means;

FIG. 3 is an enlarged view of a drilling means;

FIG. 4 is a perspective view of an indexing cam and a limit switch operated thereby;

FIG. 5 is a partial sectional view and front elevational view;

FIG. 6 is a plan view of the carriage and drilling means thereon;

FIG. 7 is an elevational view of a drilling means and carriage; and

FIG. 8 is an enlarged view of a plastic block.

Referring now to the drawings and more particularly to FIG. 1, there is illustrated a perforating or drilling apparatus **10** having a main stationary frame F including a work or material supporting table **12** and a plurality of drilling or perforating means **14** carried on a head or carriage C movable relative to material to cause the drilling means **14** to drill the material. The drilling apparatus **10** is particularly adapted for drilling a stack of sheets S of paper, supported on the inclined table **12** with the lower edge portions of the sheets S being drilled by the plurality of drilling means **14** each including a small drill **15**. Preferably, each of the drilling means **14** has at its upper end a pulley **16** in driven engagement with a drive belt **17** which is driven by a motor M.

The drilling apparatus **10** is particularly adapted for drilling simultaneously a large number of closely centered holes. As best seen in FIG. 6, there are three drilling motors M each of which has a driving belt **17** driven by its respective driving motor M for rotating nine separate and individual drilling means **14**. As will be brought out more fully hereinafter, the novel construction of the drilling means **14** and the driving thereof by the driving belts **17**, permits a longer length of the drilling elements **14** than possible with previously known constructions. With the drilling apparatus **10**, constructed in accordance with the illustrated embodiment of the invention, twenty-seven individual and separate holes are drilled along the edges of the sheets S during a single drilling operation.

The perforating apparatus **10**, in this preferred embodiment of the invention has the drilling means **14** disposed on 1¼ inch centers so that the center lines of the respective holes being drilled in the sheets S are spaced on 1¼ inch centers. For the one particular form of wire bound notebook paper, it is required that the holes be drilled on ¼ of an inch centers; and accordingly, drilling of five successive sets of twenty-seven holes with the center lines of the holes being spaced ¼ inch apart is accomplished in a unique fashion under the present invention. For this purpose, the supporting plate **12** for the sheets S is indexed automatically ¼ of an inch for four operations to bring the sheets into registry below the drills **15** to add four additional perforations within the 1¼-inch hole spacing formed by the first drilling operation. More particularly, the supporting plate **12** is supported by gussets **20** attached to a top plate **21** adapted for sliding movement along a pair of parallel slide or guide rods **22** and **23**, FIG. 1. A plurality of spaced brackets **24** are secured beneath the top plate **21** and have a bore **25** therein closely dimensioned to the diameter of the guide rod **23**. Thus, the brackets **24** may slide transversely along the stationary guide rod **23**. A wear plate **27** is secured beneath the top plate **21** and rests on the top of the rod **22** and partakes of sliding engagement along the top surface of the rod **22** with movement of the top plate **21**.

The stationary main frame F for the cutting apparatus **10** includes four spaced angles **30** disposed at the four corners of the cutting apparatus **10** and extending from the floor upwardly to the plane of the top plate **21**. Extending between each of the four spaced angles **30** are a number of other angles **32** typically represented for providing lower braces at the lower portion of the frame F. Also secured between the angles **30** and forming an outer covering are left and right side plates **35**, FIGS. 2, 4 and 5. These side plates **35** extend between the front and rear angles **32** along the left and right sides of the perforating apparatus **10**.

As best seen in FIG. 1, a lower channel **36** spans the lower braces **32** at the left and right sides of the perforating apparatus **10**. The channel **36** supports a driving means **40** for causing the automatic indexing of the table **12** and the sheets S and for causing the automatic reciprocation of the carriage C for moving the drills **15** into and from engagement with the sheets S. More specifically, the driving means **40** includes an electric motor **41** which drives a gear reducer means **42** which has an output shaft **43** having a sprocket **44** for driving a chain or belt **45**. The electric motor **41** has secured thereto a brake means B for stopping rotation of the motor **41** and sprocket **44** at a given position for a purpose to be explained hereinafter. The driving belt **45** is entrained about a larger sprocket **46** secured to a shaft **47** for rotating the shaft **47** in bearing supports **48** and **49** secured to the respective left and right side plates **35**. The shaft **47** has an end portion **50**, FIG. 5, disposed outwardly of the right side plate **35**. The end portion **50** has an offset portion constituting a crank arm **51**. The crank arm **51** is journaled in a suitable bearing in the lower end of a connecting rod **52** which has its upper end **53** secured to an arm **57** of a sleeve **58** on the carriage C for reciprocating the carriage C carrying the drills **15**. Thus,

it will be understood that the rotation of the shaft **47** and crank arm **51** causes the connecting rod **53** to move vertically the carriage C holding the drills **15**.

As best seen in FIGS. 5 and 6, the carriage C has at the left end thereof another sliding guide sleeve **59**, in addition to the sliding guide sleeve **58**, for assuring the parallel movement of the carriage C along the spaced guiding rods **60** which are suitable secured to a main supporting I-beam **62**, FIG. 1, by fasteners **63**, inserted through a lower web **64** of the I-beam **62**.

Thus, the rotation of the shaft **47** and the crank arm **51** causes the carriage C to slide downwardly and upwardly along the vertical guide rods **60**. As the carriage C moves downwardly the drills **15** move downwardly into engagement with the sheets S through the sheets S; and as the carriage C is moved upwardly the drills **15** are lifted out of the holes formed and lifted out of engagement with the top sheet S of the stack of sheets S.

The driving shaft **47** of the driving motor means **40** controls both the lifting of the carriage C containing the drilling means **14** and the automatic indexing movement of the supporting table **12** for the sheets S in timed relationship to the position of the drills **15** carried by the carriage C. Manifestly, the indexing of the sheets and the supporting table **12** is at a time when the drills **15** are free of the sheets S and the carriage C is at or about its upper limit of movement. To provide this timing relationship between the lifting of the drills and the indexing of the carriage C, the driving shaft **47** has secured thereto a driving sprocket **65** for driving a chain **66** to drive a sprocket **67** secured on a stub shaft **68**. The stub shaft **68** is journaled for rotation between a pair of supporting blocks **69** and **70** which are secured to the central web **72** of the I-beam **62**. The shaft **68** drives a smaller sprocket **74** secured thereto to turn a chain **75** entrained about a larger sprocket **76** secured to a shaft **77**. These intermediate sprockets **67** and **74** are provided to step down the speed of rotation of the shaft **77** to about ⅛ of the rotational speed of the shaft **47**. Thus, the shaft **47** will move through five rotations of its crank arm **51** and reciprocation of the carriage C for each revolution of the shaft **77**, which shaft **77** controls the indexing steps of the supporting table **12** by means of an indexing cam means **80**, FIG. 5.

As best seen in FIG. 5, the cam means **80** is secured to the shaft **77** for rotation therewith. Along the right peripheral edge of the cam **80**, FIG. 5, are formed a series of stepped cam surfaces **81**, **82**, **83**, **84** and **85**, leading to a return cam surface **86**. Secured to the underside of the top plate **21** is a cam follower **88**, FIG. 5, which has a roller **89** biased into engagement with the peripheral righthand edge of the indexing cam **80** to follow the contour of the cam **80**. The roller **89** of the follower **88** is supported on a stud **90** inserted through a supporting plate **91** and secured by a nut **92** to the top plate **21**.

The top plate **21** and the supporting table **12** secured thereto are biased leftwardly, as seen in FIG. 5, to urge the cam follower **89** against the rightward edge of the indexing cam **80** by a contractile spring **92**, FIG. 5, hooked into a bracket **93** secured to the underside of the plate **21** and hooked at its opposite end into an anchor **94** secured to the left side plate **35**. It will be remembered that the top plate **21** and the supporting table **12** are adapted for sliding movement across the shafts **22** and **23** and this sliding movement under these shafts **22** and **23** is under control of the indexing cam **80**. Thus, as the indexing cam **80** turns to bring the successive cam surfaces **81**, **82**, **83**, **84** and **85**, into engagement with the cam follower **88**, the contractile spring **92** is permitted to pull the top plate **21** through a succession of leftward movements along the sliding bars **22** and **23**. The spacing between each of the respectively adjacent cam surfaces **81**, **82**, **83**, **84** and **85**, is ¼ of an inch so that the contractile spring **92** is able to move the supporting table **12** through a distance of ¼ of an inch as each of the respective cam surfaces

81, 82, 83, 84, and 85, are rotated into position and engaged by the cam follower 88. The cam surface 86 is adapted to engage the cam follower 88 and force the cam follower 88 and table 12 to return rightwardly 1¼ inches to the original starting position, at which position, the cam follower 88 is again in engagement with the cam surface 81.

As seen in FIG. 5, the right end of the cam shaft 77 is journaled in a bearing mounting means 95 secured to the right supporting side plate 35 and the left end of the cam shaft 77 is journaled in a bearing mounting means 96. The bearing mounting means 96 is secured to a U-shaped bracket 98 which has the lower edges thereof 99 secured to the central web 72 of the I-beam 62, as best seen in FIG. 1. The I-beam 62 extends across the entire width of the machine and is supported by the opposite side plates 35. The I-beam 62 supports the opposed vertical guide shafts 60 for the carriage C.

The carriage C includes the guide sleeves 58 and 59 which are formed on the outer ends of the brackets 101 and 102, which in turn are secured by fasteners 103 and 104 to end plates 105 and 106 at the opposite ends of the carriage C. The end plates 105 and 106 are secured to a hollow rectangular, supporting member 108, FIGS. 1 and 6. The rectangular member 108 supports the three driving motors M at three spaced locations as determined by the location of the supporting brackets 110 secured to the rearward side 111 of the member 108. As best seen in FIG. 1, the brackets 110 are U-shaped with a central supporting portion 112, FIG. 1, a lower leg 113 supporting the bottom of the motor and an upper leg 114 supporting the upper portion of a motor M. Each motor M has a driving shaft 115 with a sheave or driving pulley 116 secured thereto for rotating its respective driving belt 17. The driving belt 17 is preferred to be wrapped about at least 180° of the pulley 116 by means of a belt tightener 118, FIG. 6, which includes a roller 119 in engagement with the driving belt 17 and a pivot support arm 120 pivotally mounted on the top of the member 108. The support arm 120 is pivotally mounted on a pivot stud 122 secured in an appropriate manner to the member 108. A contractile spring 123 is secured intermediate the rod 120 and is secured to the member 108 at a spaced location to exert a strong biasing force on the belt 17 to keep the belt 17 under tension and wrapped about the driving pulley 116. The frictional characteristics of the drive pulley 116 are found to be improved by the use of a composition pulley having a phenolic base.

An important aspect of the present invention is the manner of rotation of the respective drilling means 14 so that adjacent ones of the drills 15 rotate in opposite directions to alleviate the tendency of the drills 15 to twist the paper sheets S relative to the supporting table 12 during a drilling operation. For this purpose the driving belts 17 are interwound among the driving pulleys to engage opposite sides of the respective pulley 116 of adjacent drilling elements 14 thereby rotating the adjacent drilling elements 14 in opposite directions. As seen in FIG. 6, each of the motors M turns its respective pulley 116 in a clockwise direction. Therefore, the leftmost drill 15 in FIG. 6 will be rotating in a clockwise direction whereas the adjacent drilling element 14 is moving in a counterclockwise direction. This alternate rotation of the drills 15 occurs for each of the three sets of nine drills. Each of the driving means, motors and related parts is identical for the three sets of nine drills.

The drilling elements 14 are supported on the carriage C by means of a U-shaped channel 125 secured to a front wall 126 of the rectangular member 108. The manner of mounting the drills under the principles of the present invention facilitates the close spacing of the drills and likewise the frictional driving of the drills 15 by the belts 17, also facilitates the close spacing of drills 15. The construction of the drill means 14 is best described in conjunction with FIG. 3 wherein a drilling means 14 is illustrated in an enlarged view. For the purpose of removing chips and chaff resulting during a cutting operation, each of the cutting means 14 has a hollow bore 130 extending completely therethrough from the very top of a hollow shaft 131 through the tip of the drill 15 secured to the lower end 132 of the hollow shaft 131. Thus, the hollow bore 130 provides a bore or channel through which the chips or chaff of the paper cuttings move upwardly to be collected from the top of the hollow shaft 131. As will be readily recognized, the drilling through a large number of sheets of paper comprising a ½-inch or ⅝-inch stack of sheets S results in a large number of individual chips and other paper chaff being formed at the end of the drills 15. A large tray (not shown) is supported adjacent the upper ends of the hollow shafts 131 to receive the chips exiting therefrom. Preferably, the tray is inclined with respect to the horizontal to afford a downward gravity feed for the chips being collected on the tray.

In the illustrated embodiment of the invention, the drilling elements are adapted to drill holes having a diameter of approximately 1/10 of an inch. Thus, it will be realized that the drilling element 15 is drilling a relatively small hole through a relatively large thickness of stock or workpiece constituted by the sheets S. Preferably, the drills 15 have at their tips 134, FIG. 3, a bore 135 of a smaller diameter than a bore 137 formed in the upper portion of the drill 15. The small diameter bore 135 compresses and forms the cut chips into a convex configuration until the chips reach a shoulder 136 leading to an enlarged bore 137 at which time the chips are allowed to expand slightly from their lowered or convex configuration. The chips are thus packed tightly together and are adhered to one another as they move upwardly in the bore 130 in the hollow shaft 131. When the adhered chips have moved to the top thereof, the adhered chips break off in small columns having a plurality of chips in a column. It has been found that this compression of the chips and the forming thereof into columns in the tip of the drill facilitates drilling and chip removal.

The preferred form of the drill 15 is a hollow drill of the non-twist type. That is, the drill is not grooved or formed with the spirals of a conventional twist drill but has a generally cylindrical outer surface 138 uninterrupted by the conventional spiral grooves of the conventional rtwist drill. Also, the drills 15 are all identical and interchangeable with one another. With the twist drills, however, the drills would be of opposite right and left hand spirals or twists in order to drill because of the opposite rotation of adjacent drills. Hence, the interchangeability of the twist drills is limited as compared with non-twist drills employed in the preferred embodiment of the invention. While not shown, the tips of the drills 15 are thin walled and relatively sharp at the edges thereof. The tips of the drills 15 become worn and dulled with use. The drills 15 are sharpened by holding a carbide tool moved thereagainst while the drills are rotating. Preferably, the drills are sharpened without removing from the drilling means or the drills 15. Thus, the amount of down or service time for sharpening the large number of drills 15 is enhanced with the present cutting apparatus 10.

A wider upper portion 140 of a drill 15 is adapted to be fitted within a cylindrical opening 141 therefor in the lower end 132 of the hollow shaft 131. The top of a drill 15 abuts against a shoulder 142 formed at the upper end of the cylindrical bore 141. Preferably, the outer peripheral surface of the lower end 132 of the hollow shaft 131 is threaded at 143 and a threaded tightening nut 144 is adapted to be turned to exert a clamping force on the upper portion 140 of the drill element 15 in the conventional manner of a chucking apparatus.

The hollow shaft 131 is journaled for rotation at spaced locations by a single roller bearing 148 and a pair of upper ball bearings 149. An outer and lower housing 140 has a wide bore 151 at its lower end for receiving the bearings 148 which are held against an upper shoulder

152 of the bore 151 by a seal and retainer means 153 secured at the lower portion of the bore 152. In a similar manner the upper bearings 149 are disposed in an upper housing 155 having a bore 156 in which the bearings are disposed. Preferably, an annular spring 157 is disposed on a shoulder 158 of the bore 156 to support the bearings 149 and a retainer ring 159 is disposed at the upper end of the bore to retain the bearings 149 in position.

Thus, it will be seen that the hollow shaft 132 is journaled for rotation through aligned bores 160 and 161 in the housings 150 and 155.

For the purposes of turning a hollow shaft 131 and its drill 15, the upper end of the hollow shaft 131 has a cylindrical pulley 165 disposed on the hollow shaft 131 and secured thereto by a set screw 166. The pulley 165 is driven by frictional engagement of a driving belt 17 in contact with its outer peripheral surface.

The outer surface of the upper housing 155 is threaded at 168 and formed with an upper shoulder 170 for engagement with the top surface 171, FIG. 1, of the U-shaped bracket 125. The lower housing 150 has a smaller diameter than the threaded portion 168 so that the lower housing can be inserted through apertures formed in the bracket 125. A drilling means 14 may, thus, be adjusted in the vertical direction by turning the top threaded portion 168 in the upper portion 171 of the bracket 125. Suitable means may be employed to lock releasably each of the drilling means 14 in an adjusted positon on the bracket 125.

To facilitate the drilling of the bottom sheet S of the stacks of sheets, it is preferred that a plurality of small plastic backup bars 175, FIG. 2, be disposed in a plate 176. Preferably, each of the backup bars 175 has a plurality of apertures therein for receiving the end of the drills 15 so that the drills are more certain to perforate the bottom sheet of paper resting on the upper surface of a backup bar 175. The backup bars 175 preferably have small apertures 175A, 175B, 175C and 175D, formed on the four respective sides of the bar. Thus, when the perforations on one side of the bar 175 are no longer effective, the bar 175 can be turned to bring another one of its sides upwardly to receive a drill 15. As best seen in FIGS. 1 and 2, a stop bar 178 is secured to the rearward end of the plate 176 and projects above the plane of the plate 176 to provide a stop or guide means for aligning the rearward edges of the sheets S. The edge 176A of the stop bar 176 is rearward of the vertical plane of the drills 15 to register the rearward edges of the sheets S rearward of the holes formed therein. As best seen in FIG. 1, the plate 175 is secured on supporting bars 179 and 180 secured by fasteners 181 to the upper web of the I-beam 62.

A brief description of the operation of the cutting apparatus 10 is provided hereinafter for an aid in understanding the operation of the cutting apparatus 10. It will be observed that the supporting plate or table 12, FIG. 1, is inclined with respect to the vertical to facilitate manual insertion and registration of the sheets S. The inclination of the table 12 and the drills 15 opens the working area to the operator for insertion of a stack of sheets on the table 12 and beneath the drills 15. Gravity assists the operator's sliding the stack of sheets S along the table 12 and against the vertical stop bar 178 whereupon the rearward edges of the sheets S are aligned for receiving along the periphery of the sheets a plurality of apertures. Having thus aligned the sheets, the operator depresses a control button (not shown) such as a foot switch or other suitable button not shown, which causes the energization of the driving means 40 and the motors M for the drills 15. As the driving motor 40 begins to rotate, it turns the driving shaft 47 to move the crank arm 51 downwardly to bring the drills 15 into engagement with the top sheet S of the stack of sheets and further downward movement of the carriage C moves the drills 15 into engagement with the sheets. The motors M are energized and drive their respective driving belts 17 to turn the drills 15 to cut holes through the stack of sheets with the chips therefrom moving upwardly through the bores in the drill and the hollow shaft 131.

During this initial drilling operation, the cam follower 88 is disposed against the cam surface 81 from the index cam 80. The drills 15 perforate through the last sheet of paper and move into the respective apertures 175A of the plastic blocks 175 to assure perforation of the last sheet. The hold-down springs 188 surrounding each of the drill elements 15 assure the removal of the drill 15 from the sheets of paper as the crank arm 151 moves the connecting rod 53 upwardly to lift the carriage C upwardly. As the crank arm 51 finishes its first rotation with the drills 15 lifted from the top sheet of the stack of sheets, the cam follower 88 follows an inclined surface on the cam 80 into engagement with the cam surface 82. The cam follower 88 is biased into engagement with the cam by the contractile spring 92 acting through the top plate 21. The top plate 21 and support table 12 slide along the guide shafts 22 and 23 for ¼ of an inch of movement as the follower 88 moves from engagement of the cam surface 81 to the cam surface 82.

Thus, when the crank arm 51 starts downwardly again, the sheets of paper have been indexed ¼ of an inch. The drills 15 engage the respective sheets S a second time to make the second set of perforations spaced at ¼" center line spacing from the first set of twenty-seven holes. The preceding operations are again followed as the crank 51 lifts the drills 15 upwardly from the stack of sheets. The cam follower 88 moves into engagement with the surface 83 of the indexing cam 80 and allows the table 12 and the sheets S to move ¼ of an inch to the left. Thus, upon re-engagement of the sheets, the third set of holes are drilled at center line spacing of ¼ of an inch from the second set of holes. The fourth and fifth set of holes are drilled in the same manner, as hereinbefore described, as the crank arm 51 reciprocates the carriage C and the table 12 is indexed leftwardly, FIG. 5. After drilling the fifth set of holes, an actuator 190, FIG. 4, operates a following arm 191 on a limit switch 192 to stop operation of the motor 41 and to actuate a brake B to stop the rotation of the driving motor 41 with the drills 15 and the carriage C in their upper position. The operator may then remove the now perforated stack of sheets S and insert a new stack of sheets S and actuate a new drilling cycle.

If desired, means can be provided to over-ride the automatic stop operation after the fifth set of holes by the limit switch 192. This over-riding of the stopping operation is employed when the operator is sufficiently skilled to remove the stack of sheets S and insert a new stack of sheets without requiring a stop period of time for this function.

From the foregoing it will be seen that the present invention provides a novel perforating apparatus 10 adapted to drill simultaneously a large number of perforations at close spacing. Manifestly, different spacings other than ¼ inch can be made and the present invention is not limited to a particular spacing of drills, thickness of material being drilled, nor to sheets of paper. Also, the unique driving and configuration of the drilling elements facilitates removal of chips, chaff and the like. Moreover, the present invention performs automatic perforation and indexing operations to form small perforations at closely spaced centers through relatively thick workpieces in an efficacious manner.

Hence, while a preferred embodiment of the invention has been described and illustrated, it is to be understood that this is capable of variation and modification.

We claim:

1. In a perforating machine for simultaneously perforating a stack of sheet material with a first series of holes and additional series of holes interspaced between the first series of holes, a frame means, supporting means

on said frame means for said stack of sheet material, a plurality of drill elements each adapted to form a hole in said stack of material, driving means to rotate adjacent ones of said drill elements in opposite directions to prevent twisting of the stacked sheets, indexing means adapted to impart indexing movement to said support means transversely on said frame means in order to re-position said stack of material beneath said drills, reciprocating means for reciprocating said drill elements and said support means relative to one another to move said drill elements into engagement with said material and to remove said drill elements from said material, and cyclic control means for causing cyclic operation of said indexing means and said reciprocating means for the different series of said holes.

2. In a perforating machine for simultaneously perforating a stack of sheet material with a first series of holes and additional series of holes interspaced between the first series of holes, a frame means, supporting means on said frame means for said stack of sheet material, a plurality of perforating means each having a hollow drill element, each of said hollow drill elements adapted to form a hole in said stack of material, driving belt means in driving engagement with said perforating means to rotate adjacent ones

of said drill elements in opposite directions to prevent twisting of the stacked sheets indexing means including a cam follower on said support means, said indexing means also including a rotatable cam adapted to move said cam follower and said support means transversely on said frame means in order to re-position said stack of material beneath said drills, reciprocating means for reciprocating said drill elements and said support means relative to one another to move said drill elements into engagement with said material and to remove said drill elements from said material, and cyclic control means for causing cyclic operation of said indexing means and said reciprocating drills for the different series of said holes.

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