March 24, 1970 D. A. MORELLI 3,501,988

GUILLOTINE-TYPE PAPER CUTTER

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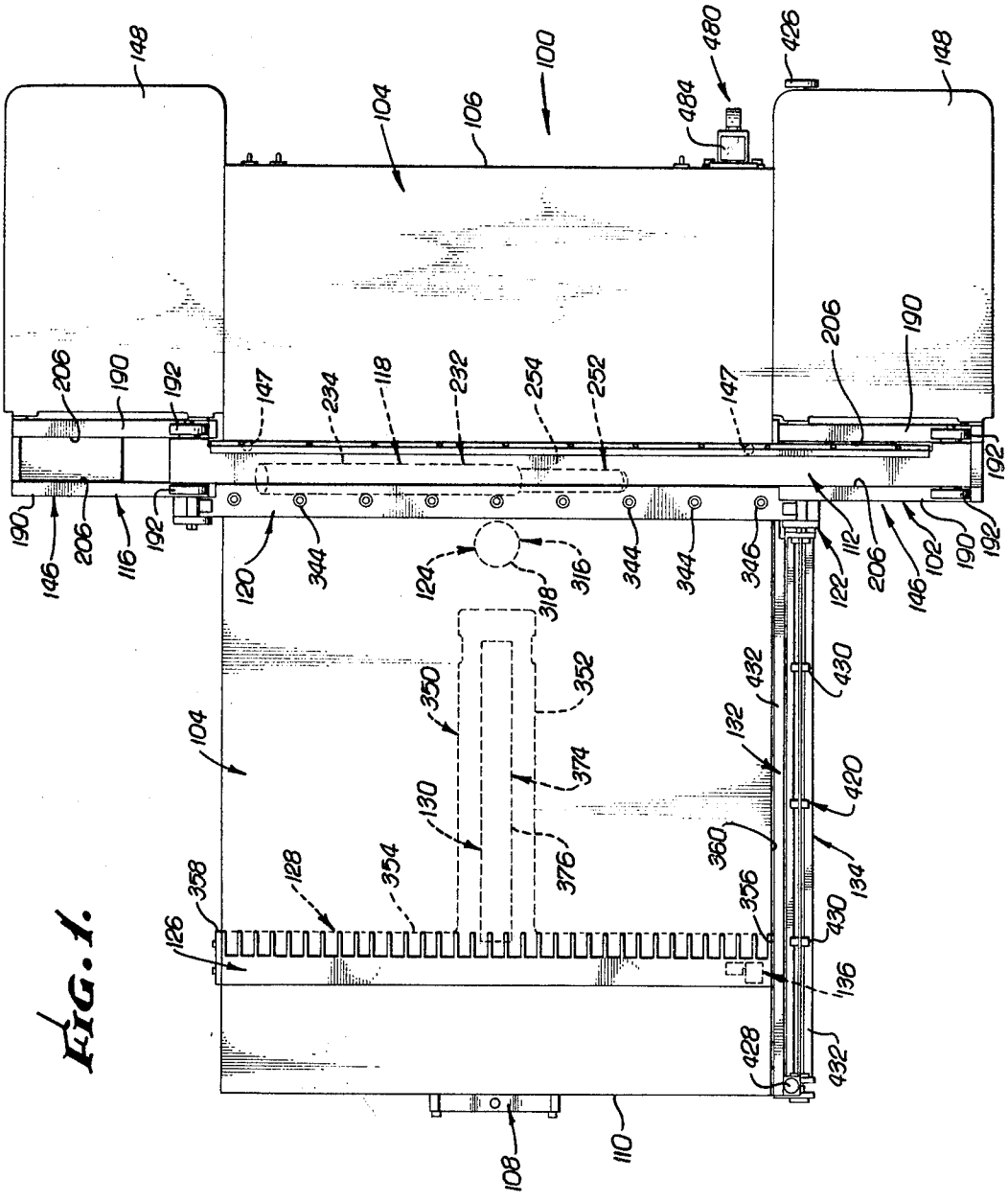


FIG. 1.

INVENTOR.
DINO A. MORELLI
BY HIS ATTORNEYS.
HARRIS, KIECH, RUSSELL & KERN

March 24, 1970 D. A. MORELLI 3,501,988

GUILLOTINE-TYPE PAPER CUTTER

Filed May 31, 1966 14 Sheets-Sheet 2

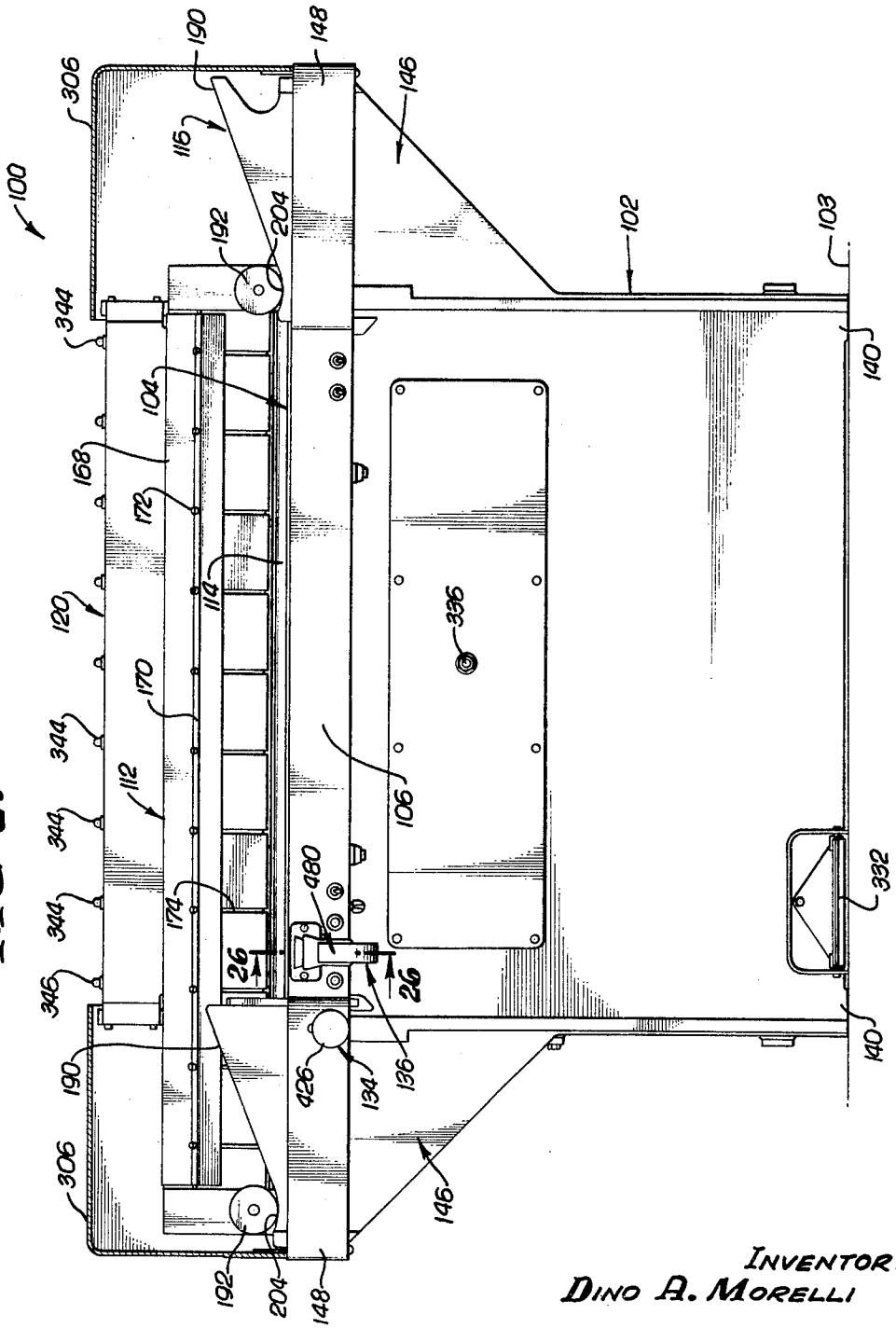


Fig. 2.

INVENTOR.
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March 24, 1970 D. A. MORELLI 3,501,988

GUILLOTINE-TYPE PAPER CUTTER

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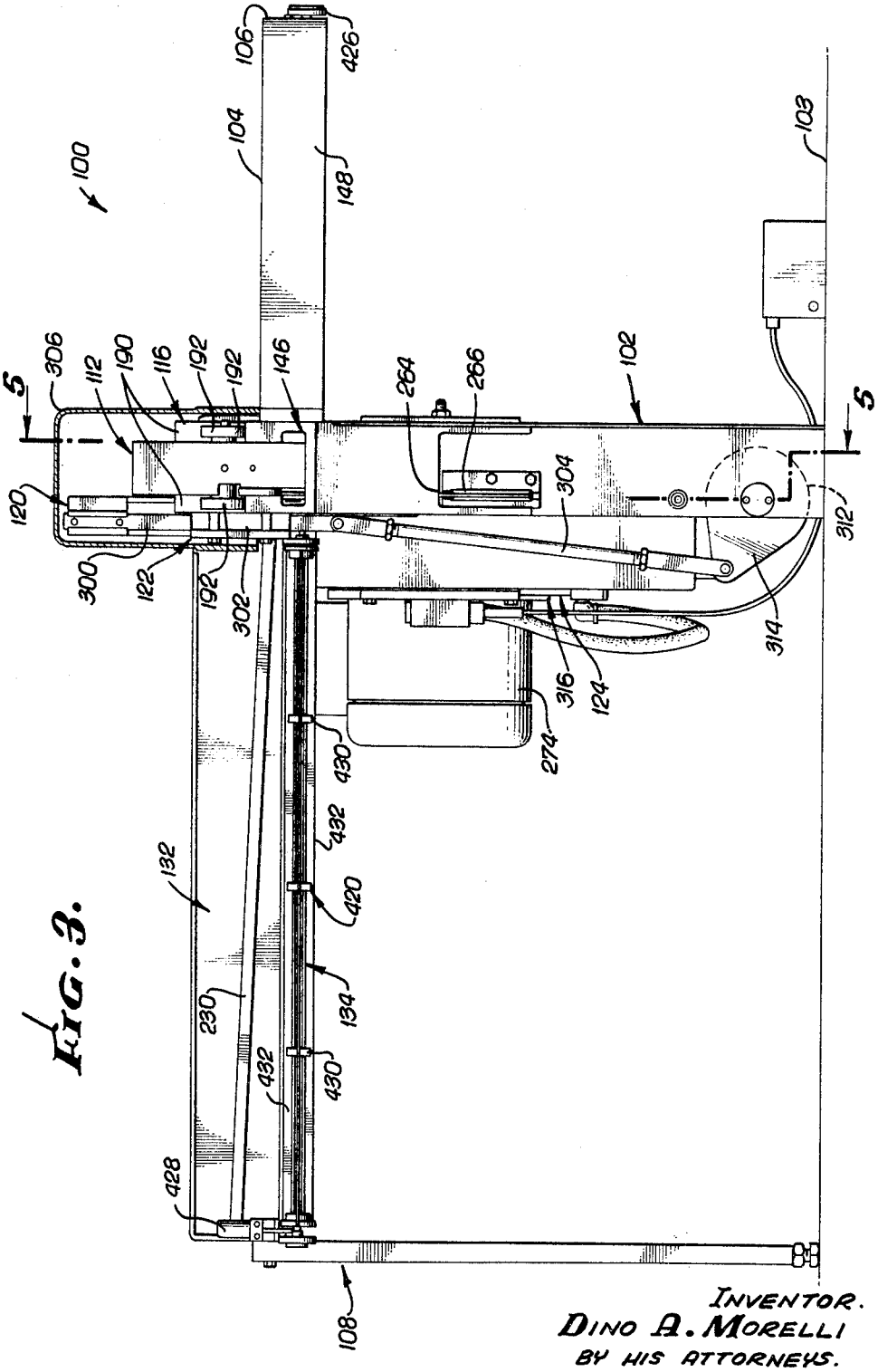


Fig. 3.

INVENTOR.
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March 24, 1970 D. A. MORELLI 3,501,988

GUILLOTINE-TYPE PAPER CUTTER

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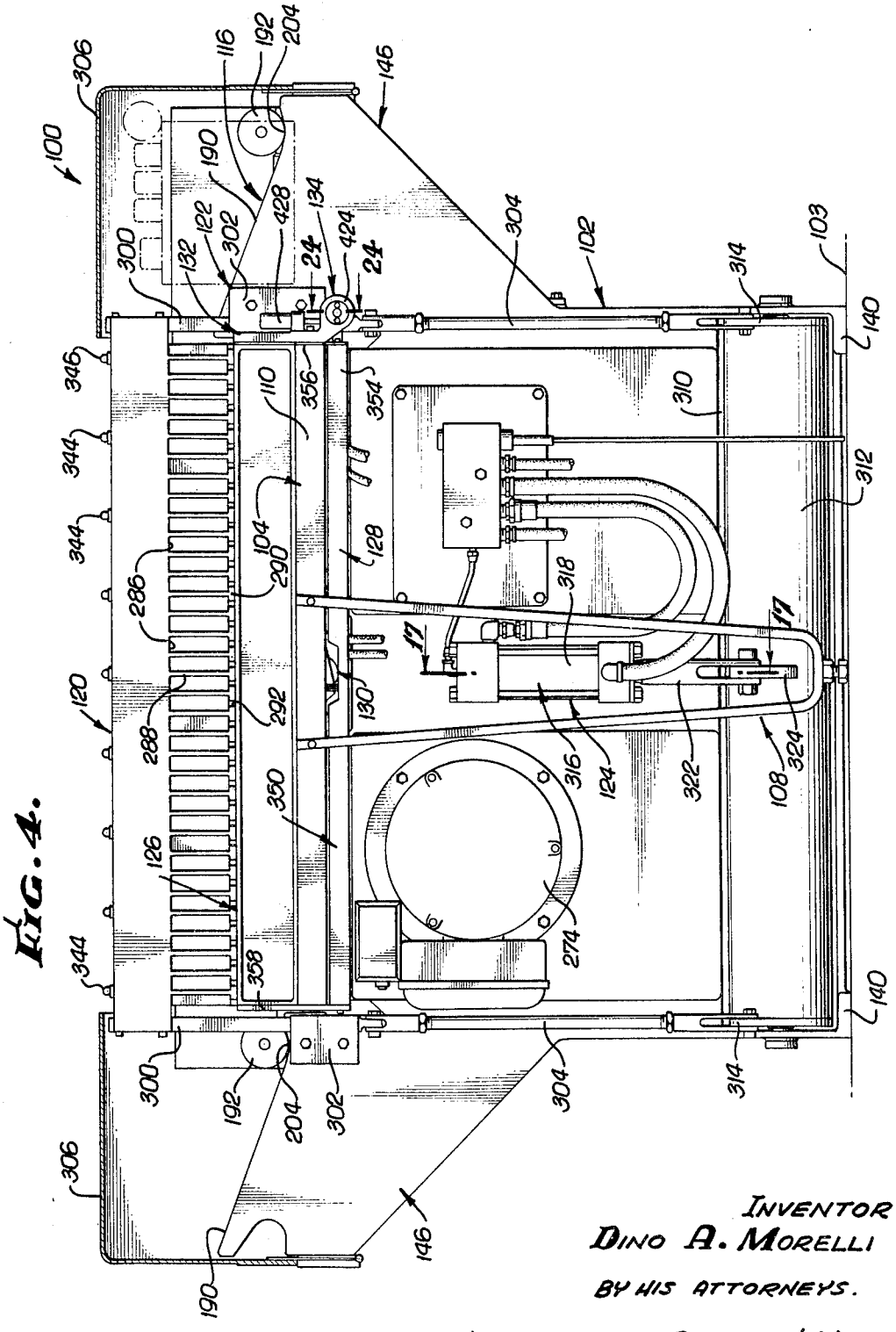


Fig. 4.

INVENTOR.
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March 24, 1970 D. A. MORELLI 3,501,988

GUILLOTINE-TYPE PAPER CUTTER

Filed May 31, 1966 14 Sheets-Sheet 5

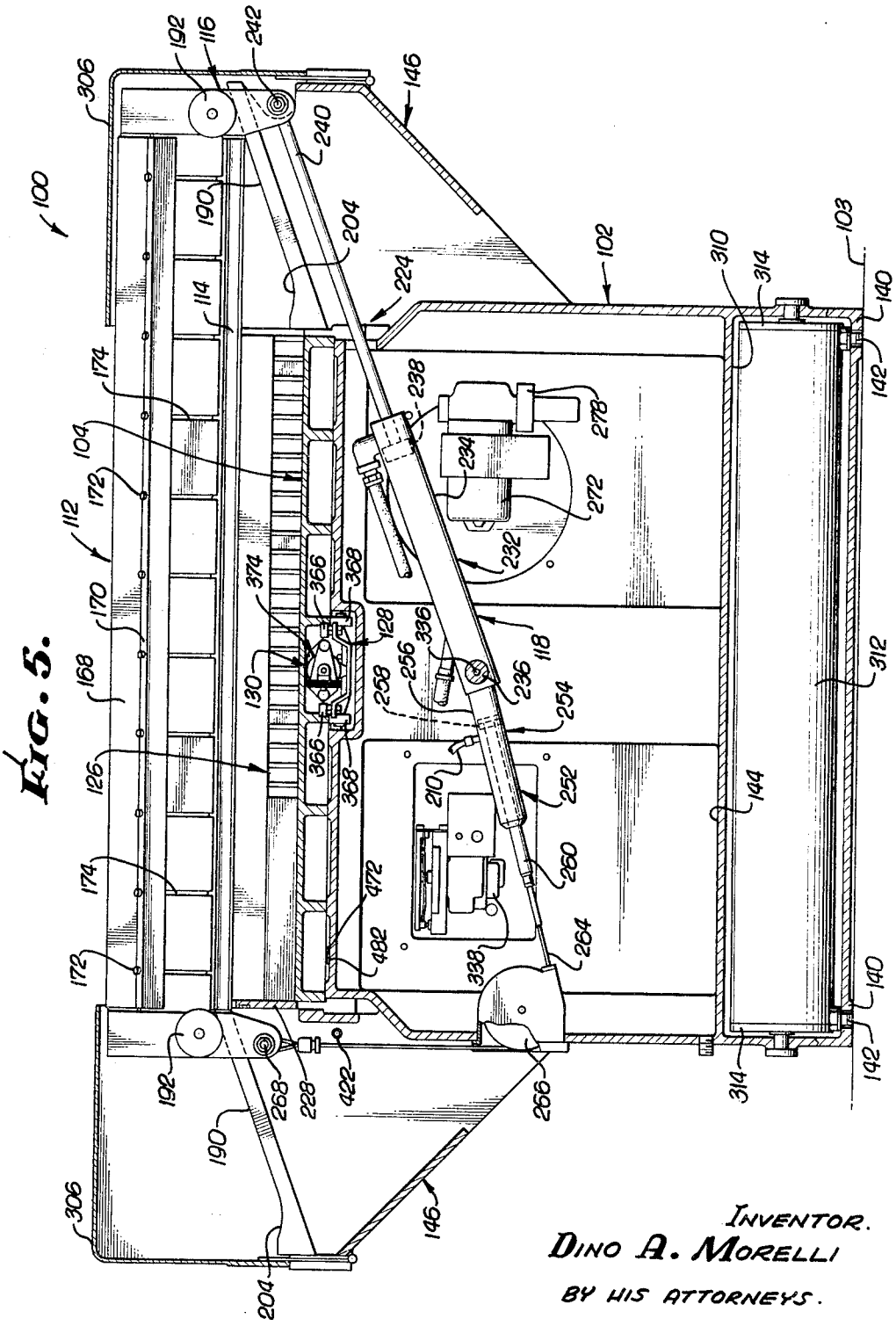


Fig. 5.

INVENTOR.
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March 24, 1970 D. A. MORELLI 3,501,988

GUILLOTINE-TYPE PAPER CUTTER

Filed May 31, 1966 14 Sheets-Sheet 6

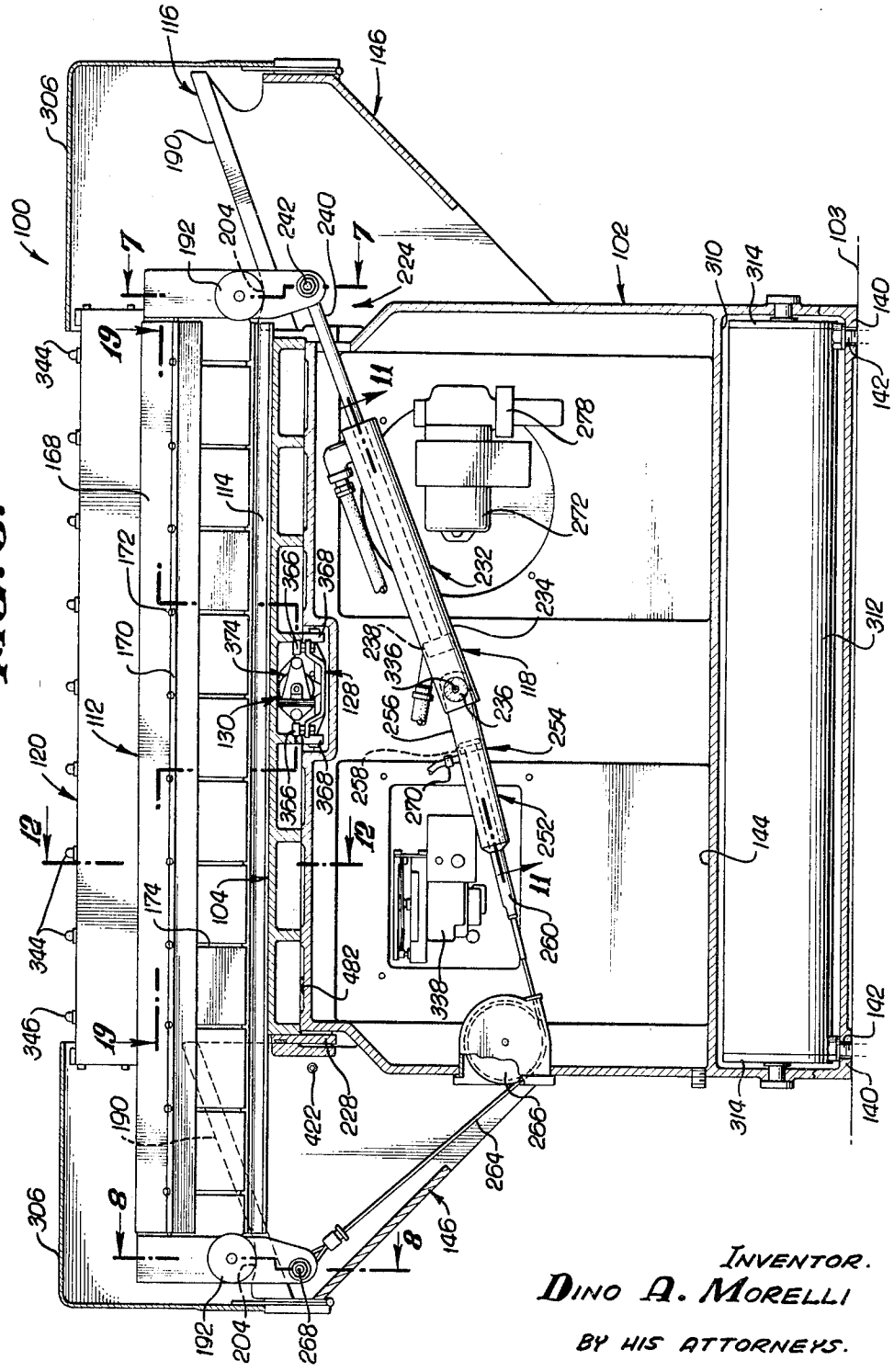


FIG. 6.

INVENTOR.
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March 24, 1970 D. A. MORELLI 3,501,988

GUILLOTINE-TYPE PAPER CUTTER

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FIG. 7.

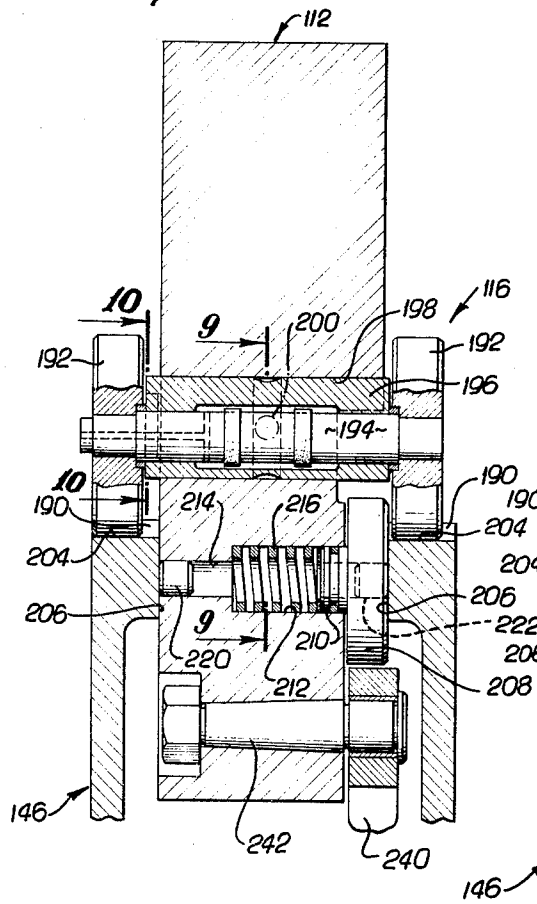


FIG. 8.

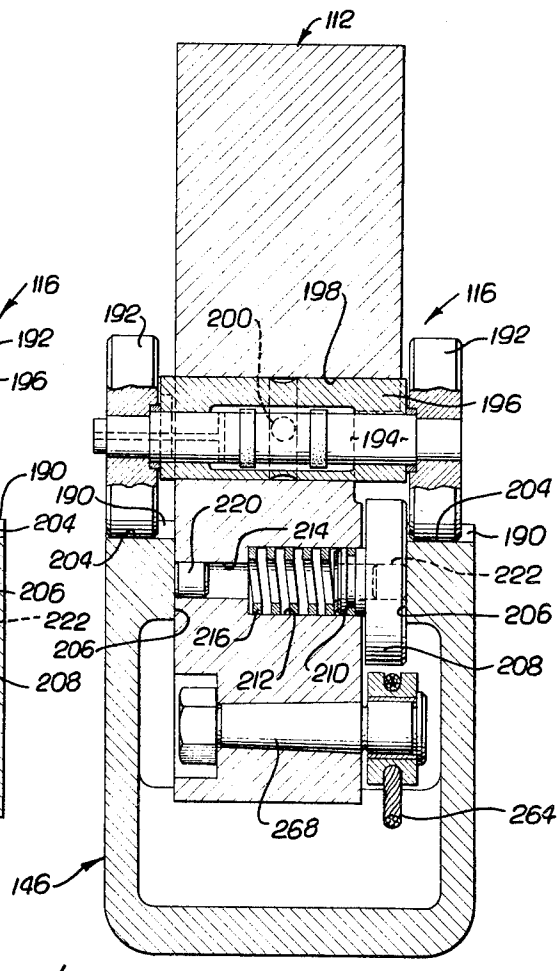


FIG. 9.

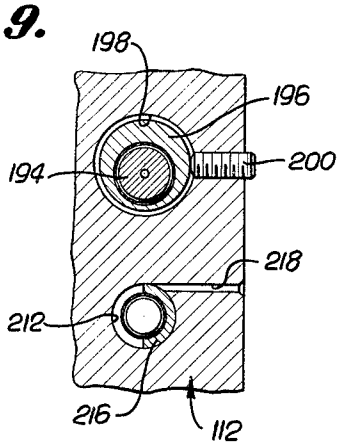
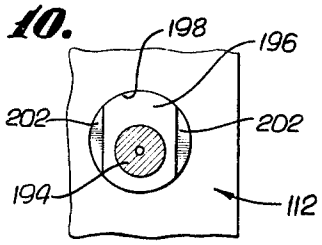


FIG. 10.



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March 24, 1970 D. A. MORELLI 3,501,988

GUILLOTINE-TYPE PAPER CUTTER

Filed May 31, 1966 14 Sheets-Sheet 8

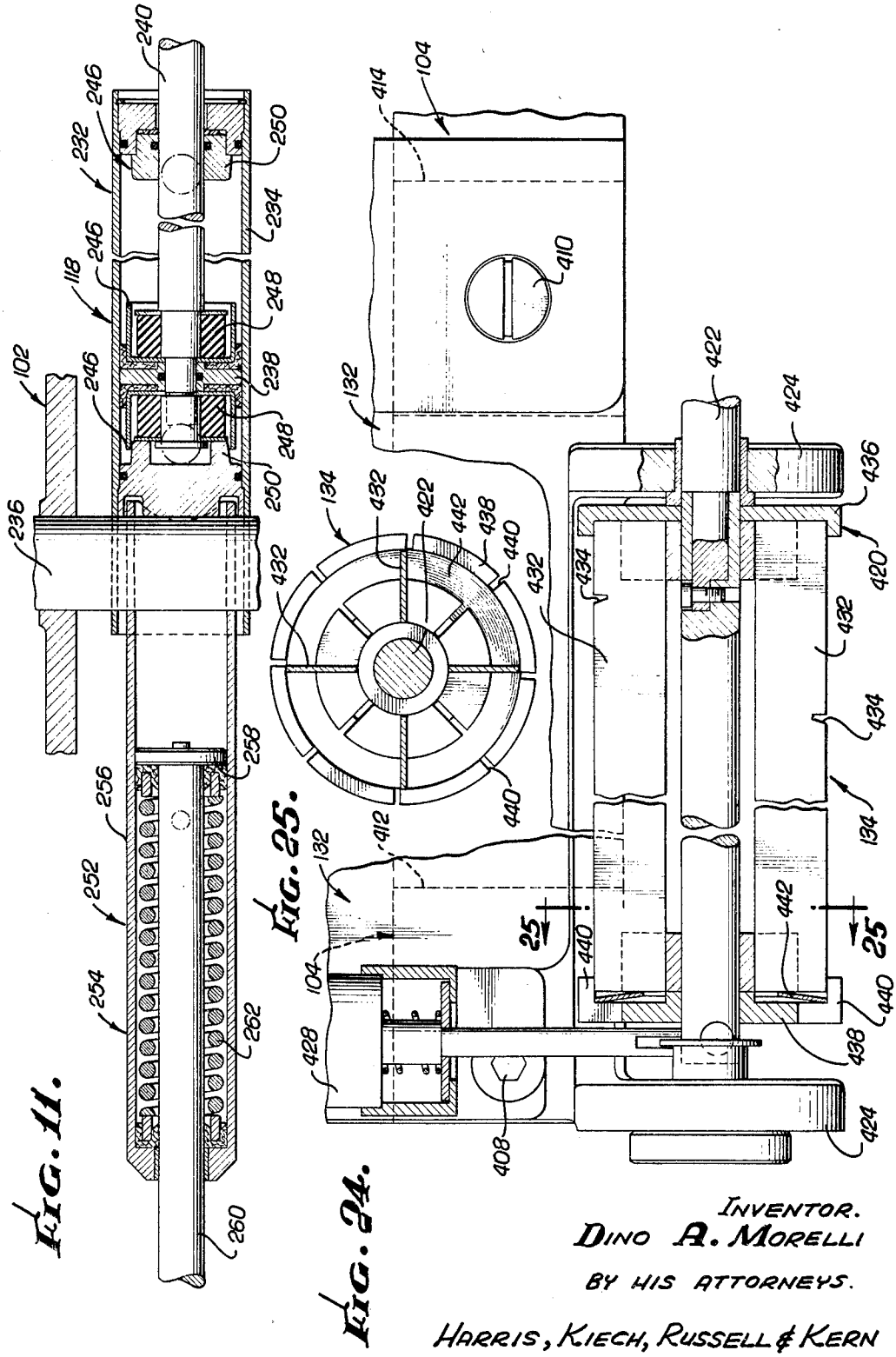


FIG. 11.

FIG. 25.

FIG. 24.

INVENTOR.
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March 24, 1970 D. A. MORELLI 3,501,988

GUILLOTINE-TYPE PAPER CUTTER

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FIG. 15.

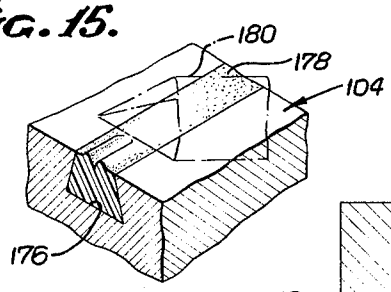


FIG. 13.

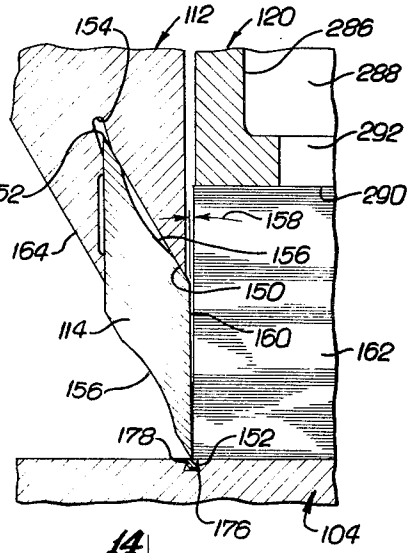


FIG. 12.

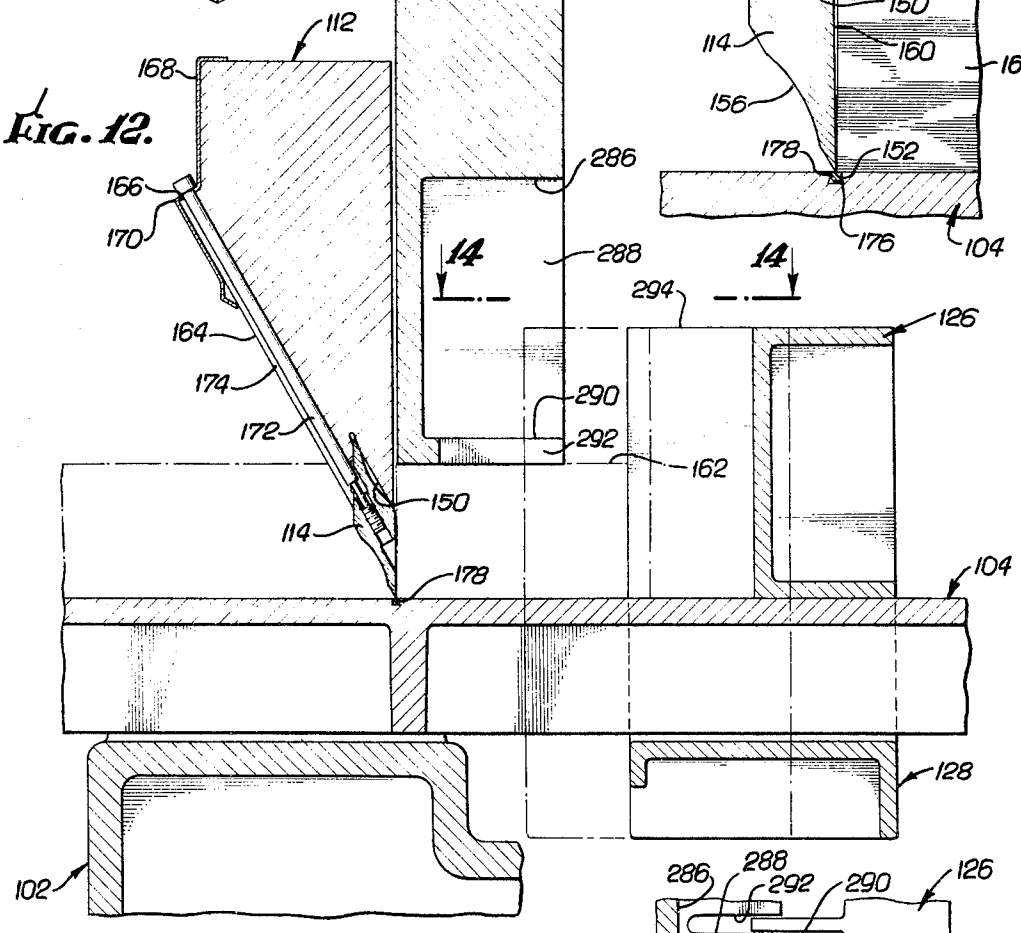


FIG. 14.

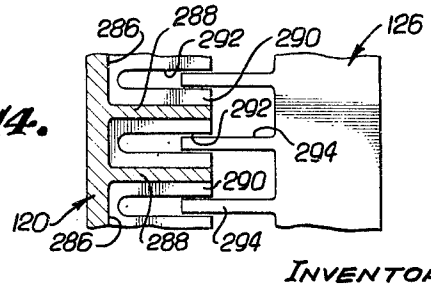
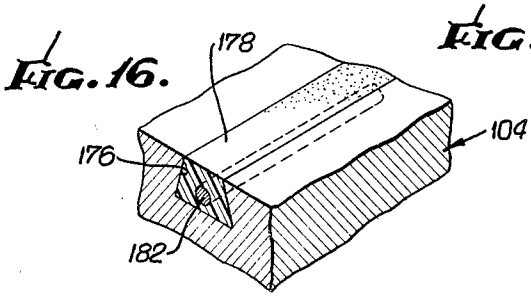


FIG. 16.



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March 24, 1970 D. A. MORELLI 3,501,988

GUILLOTINE-TYPE PAPER CUTTER

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FIG. 17.

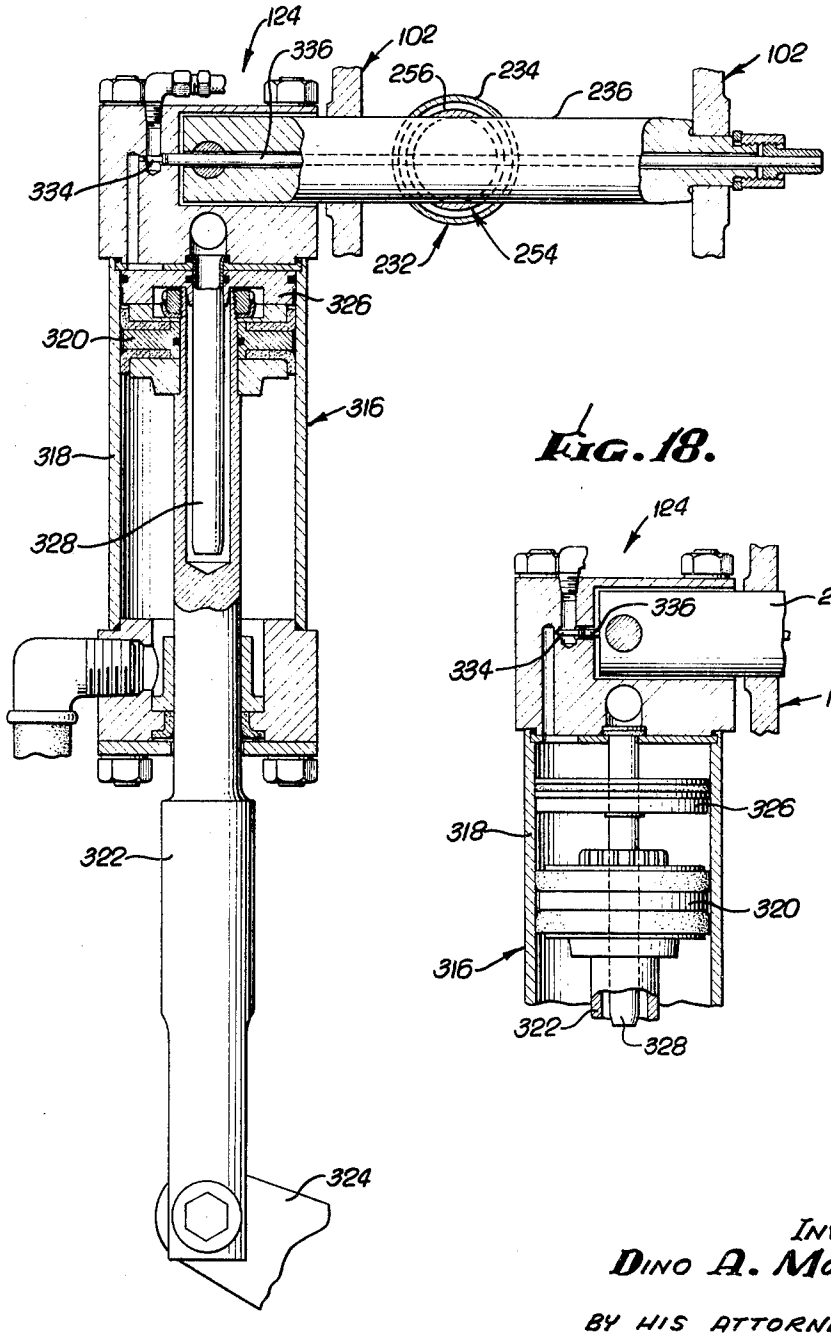


FIG. 18.

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March 24, 1970 D. A. MORELLI 3,501,988

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FIG. 19.

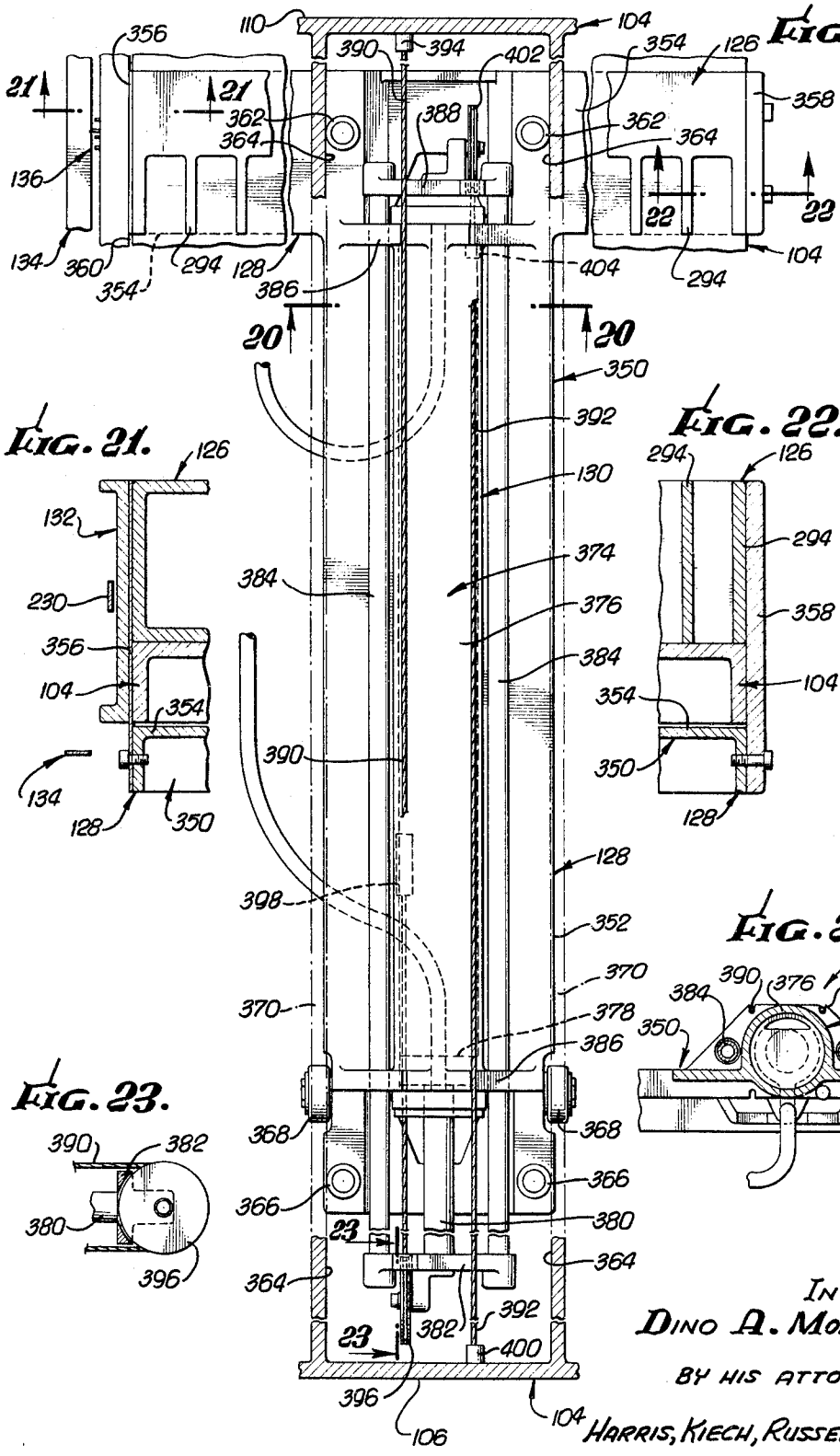


FIG. 21.

FIG. 22.

FIG. 20.

FIG. 23.

INVENTOR.
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March 24, 1970 D. A. MORELLI 3,501,988

GUILLOTINE-TYPE PAPER CUTTER

Filed May 31, 1966 14 Sheets-Sheet 12

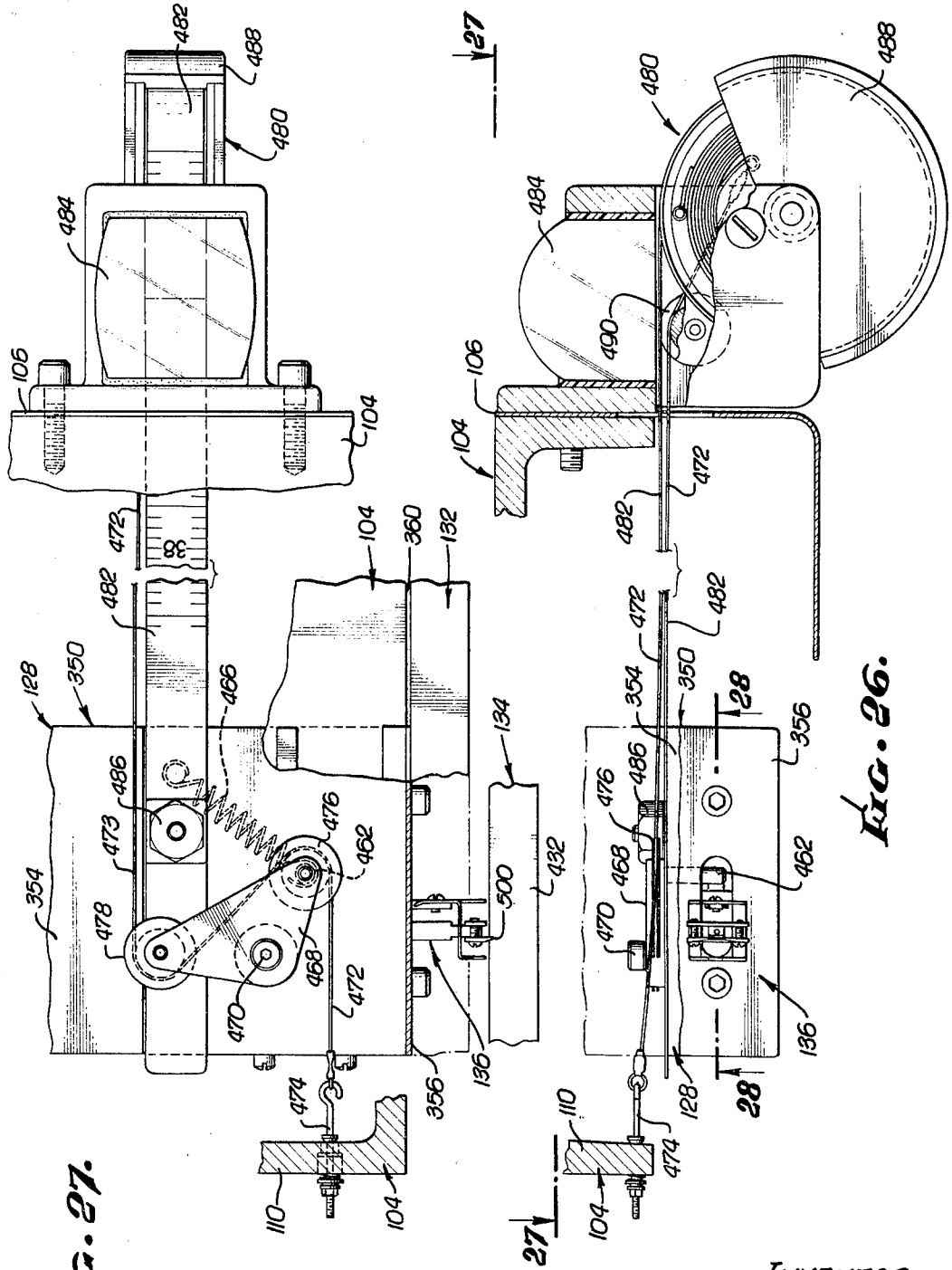


Fig. 27.

Fig. 26.

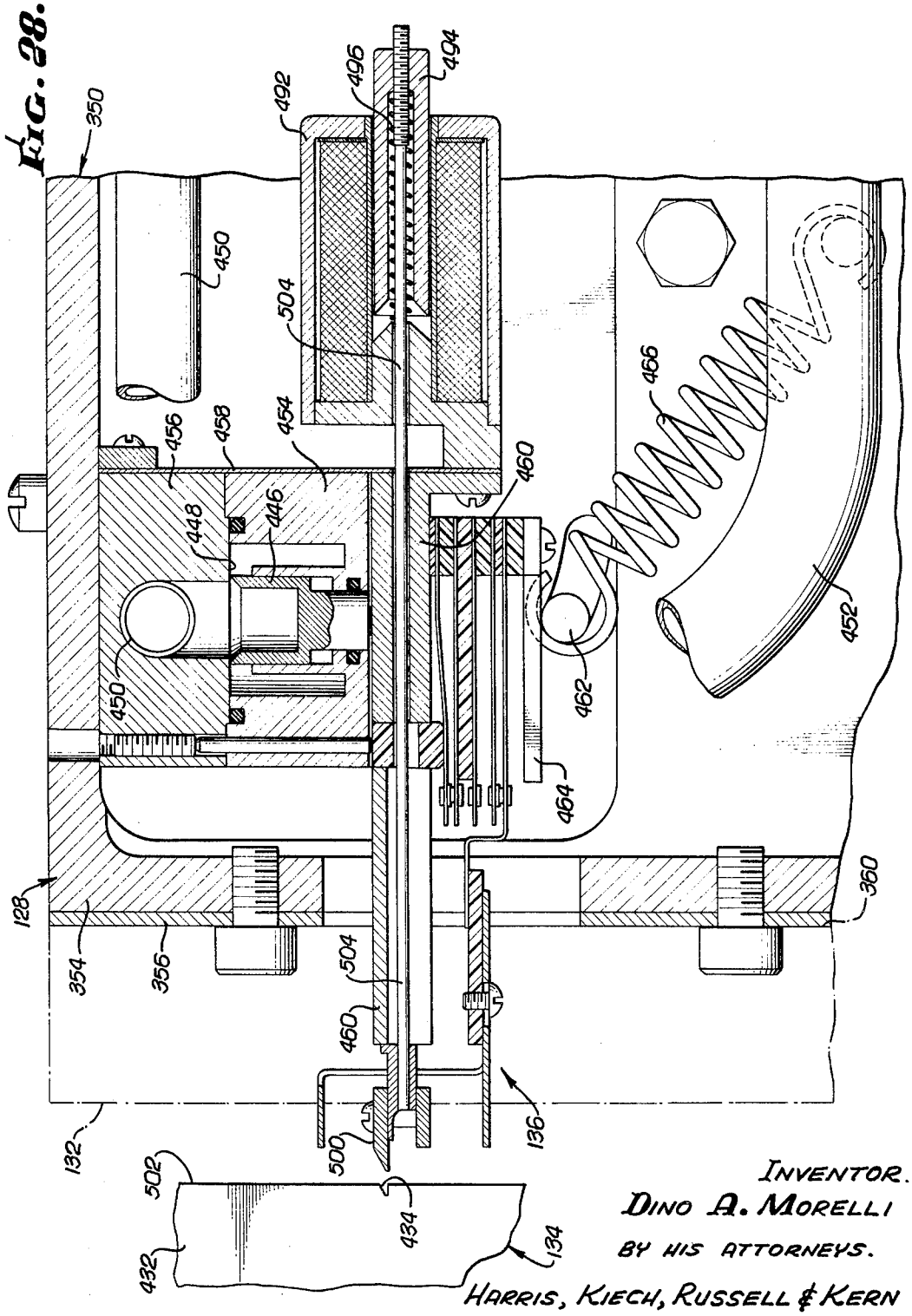
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March 24, 1970 D. A. MORELLI 3,501,988

GUILLOTINE-TYPE PAPER CUTTER

Filed May 31, 1966 14 Sheets-Sheet 13

FIG. 28.



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March 24, 1970 D. A. MORELLI 3,501,988

GUILLOTINE-TYPE PAPER CUTTER

Filed May 31, 1966 14 Sheets-Sheet 14

FIG. 29.

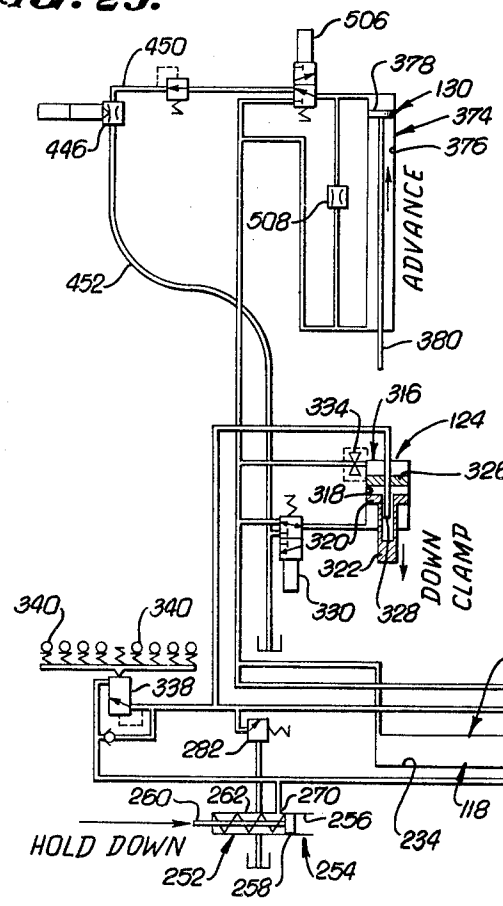
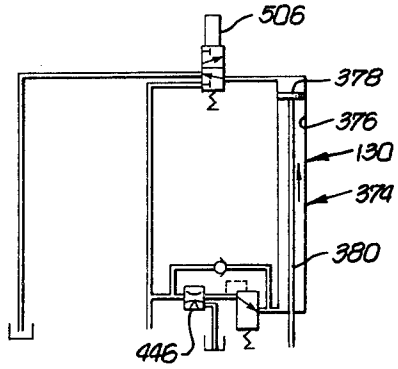


FIG. 30.



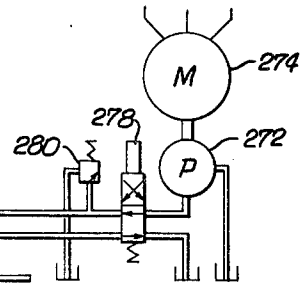


FIG. 32.

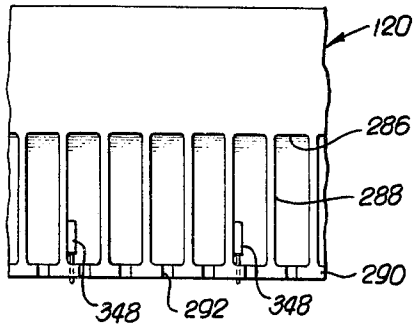
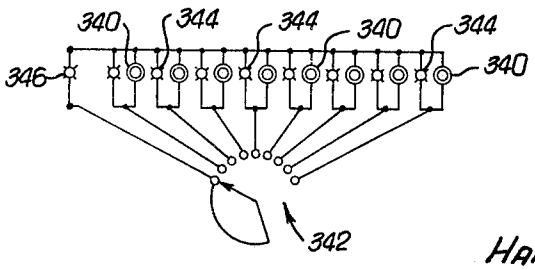


FIG. 31.



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BY HIS ATTORNEYS.

HARRIS, KIECH, RUSSELL & KERN

United States Patent Office 3,501,988
Patented Mar. 24, 1970

3,501,988

GUILLOTINE-TYPE PAPER CUTTER

Dino A. Morelli, Pasadena, Calif., assignor to California Institute Research Foundation, Pasadena, Calif., a corporation of California

Filed May 31, 1966, Ser. No. 554,029
Int. Cl. P26d 5/12
U.S. Cl. 83—171 16 Claims

ABSTRACT OF THE DISCLOSURE

A paper cutter of the guillotine type which, for a given lift-size capacity, is considerably smaller and lighter than prior paper cutters of this type and which has a low profile so that the operator, from his station at the front of the machine, can readily observe the lift of paper and the operation of components, such as the backstop, rearwardly of the knife and clamp.

The paper cutter is hydraulically powered and all hydraulic components are located below the table to prevent contamination of the upper surface of the table with hydraulic fluid, the same being true of all of the lubricating systems. The knife bar is guided at its ends by laterally sloping ramps which resist only downward forces acting on the knife bar, so that the knife bar can disengage the ramps in the event that the knife encounters an obstruction. The knife-bar drive means includes a yieldable hold-down means normally maintaining the knife bar on the ramps. The ramps are upturned at their lower ends to decelerate the knife bar at the lower end of its stroke.

The present invention relates in general to paper cutters and, more particularly, to a commercial paper cutter of the guillotine type especially suitable for use by printers, stationers, or the like, to cut lifts of paper into stacks of rectangular sheets of smaller sizes. However, various features of the invention may be embodied in other apparatuses, such as industrial paper cutters, or, more generally, machines for performing various predetermined operations on workpieces.

As background, the invention contemplates a paper cutter of the type which includes: a table for supporting a lift of paper to be cut; a guillotine-type knife above and extending laterally across the table and movable downwardly and laterally through the lift of paper to cut same with a shearing action; means for guiding the knife along a laterally sloping path to achieve the desired shearing action; means for driving the knife along its laterally sloping path; a backstop and a fence respectively engageable with rear and side edges of the lift of paper to properly orient the lift relative to the plane of cut, the backstop being above and extending laterally across the table and normally being perpendicular to the table and parallel to the plane of cut, and the fence projecting above and extending along one side edge of the table and normally being perpendicular to the table and to the plane of cut; backstop drive means for advancing the backstop forwardly toward the plane of cut to advance successive portions of the lift of paper into positions to be sheared by the knife; means for guiding the backstop along its fore-and-aft, longitudinal path; a clamp engageable with the lift of paper adjacent and rearwardly of the knife to prevent the shearing action of the knife from disturbing the uncut portion of the lift; means for guiding the clamp vertically into and out of engagement with the lift of paper; and means for driving the clamp.

As a general statement of the objects of the invention, the primary object is to provide a paper cutter of the foregoing type which is an improvement in various respects on prior paper cutters of the same type.

More particularly, general objects of the invention are to provide a paper cutter of the guillotine type which, for a give lift-size capacity, is considerably smaller and lighter than prior paper cutters of this type, thereby requiring significantly less floor space and, in most instances, requiring no special footings, or the like. For example, the invention has been embodied in a paper cutter for 42-inch by 4-inch lifts which weighs less than 3,000 pounds, as compared to prior paper cutters of the same size weighing as much as 12,000 pounds, and which requires less floor space than prior machines of the same size.

Another general object of the invention is to provide a paper cutter having a low profile so that the operator, from his station at the front of the machine, can readily observe the lift of paper and the operation of components, such as the backstop, rearwardly of the knife and clamp. More particularly, another object in this connection is to provide a paper cutter wherein the space above the knife and clamp is completely unobstructed, there being no yoke, or the like, in this region to raise the profile of the machine.

Still another general and extermely important object of the invention is to provide a paper cutter wherein all of the major components, i.e., the backstop, the knife and the clamp, are fluid driven, and specifically hydraulically driven. With this construction, various mechanical driving elements characteristic of prior machines, such as flywheels, clutches, lead screws, gear trains, and the like, are all eliminated, which is an important feature.

Another general object of importance is to provide a paper cutter which includes a floor-engaging base carrying the table, the knife, the clamp, the knife drive means and the clamp drive means, the plane of cut and the clamping zone being directly above the base so that cutting and clamping forces are transmitted directly to the base. The base supports an intermediate lateral zone of the table adjacent the front edge thereof so that the major portion of the weight of the table, and components carried thereby, is transmitted directly to the base. Consequently, it is merely necessary to provide a small auxiliary support for the rear edge of the table, which auxiliary support may be connected to the base, or engage the floor.

The base is preferably an extremely rigid structure capable of being secured to the floor at only two laterally-spaced points, the auxiliary supporting means for the rear edge of the table engaging the floor at a third point spaced rearwardly from the base in the event that it is not connected directly to the base. With such a three-point support, the machine is unaffected by any uneven settling of the floor or footings on which it is mounted.

Still another object in connection with the base is to utilize it as a reservoir for the hydraulic fluid employed to operate the backstop, knife and clamp drive means. Preferably, the fluid motors incorporated in at least some of the drive means are located within the base so that any leakage therefrom is discharged directly into the reservoir, which is a feature of the invention.

Another object of the invention is to provide a hydraulically-powered paper cutter wherein all of the hydraulic components are located below the table to eliminate any possibility of contamination of the upper surface of the table with hydraulic fluid. Another object in this connection is to locate all lubricating systems below or at points spaced laterally from the table to avoid lubricant contamination of the upper surface of the table.

An important object of the invention is to provide means for locking hydraulic fluid in the knife drive means when the knife drive means is not in operation so that the knife can descend only slowly in the event of leakage of hydraulic fluid from the knife drive means. This minimizes any possibility of injury to the operator in the event of accidental descent of the knife.

The invention contemplates mounting the laterally-extending guillotine-type blade or knife on a laterally-extending knife bar the ends of which are guided upwardly and downwardly along laterally sloping, parallel paths. A basic object of the invention in this connection is to provide a knife-bar guide means capable of resisting only downward forces acting on the knife bar, and incapable of resisting upward forces acting thereon. With this construction, the knife bar can disengage its guide means in the event that the knife encounters an obstruction, thereby eliminating any necessity for any separate overload device.

Another object of the invention is to provide a paper cutter wherein the base includes laterally sloping, parallel rams above table level on opposite sides of the table, and to provide the ends of the knife bar with ramp followers respectively engaging the ramps and movable upwardly and downwardly therealong to raise and lower the knife bar. A related object is to provide two such ramps on each side of the table in longitudinally spaced relation, the ends of the knife bar being received between the longitudinally spaced ramps of the respective pairs so that such ramps act as gibs resisting any forces applied to the knife bar longitudinally of the table.

A further and important object of the invention is to provide a hydraulic knife-bar drive means, below the table, which includes a hydraulic knife-bar drive motor of the reciprocating type oriented substantially parallel to the ramps and connected to one end of the knife bar, and which includes yieldable knife-bar hold-down means connected to the other end of the knife bar. With this construction, the knife-bar drive motor applies a cutting force to one end of the knife bar substantially in the direction of knife-bar movement, the knife-bar drive motor being inclined at a slightly greater angle than the ramps to apply a hold-down force to the corresponding knife-bar end. The yieldable hold-down means connected to the other end of the knife bar normally holds the ramp followers at such other end of the knife bar on the corresponding ramps, but permits such other end of the knife bar to rise in the event that the blade encounters an obstruction, which is an important feature. A related object is to provide a hold-down means which applies a hold-down force approximately proportional to the cutting force applied by the knife-bar drive motor.

An additional object of the invention is to provide the knife-bar ramps with arcuate valleys at their lower ends for decelerating both horizontal and vertical motion of the knife bar at the lower end of its stroke. With this construction, the knife bar can be driven at full speed until it has completed its cut through the lift of paper.

Another object of the invention is to provide the table, in the plane of cut, with a laterally extending groove containing a repairable cutting stick penetrable by the cutting edge of the blade at the bottom of its stroke. More particularly, an object is to form the cutting stick of a material capable of being smoothed, by the application of heat, or otherwise. Still more specifically, an object is to make the cutting stick of a heat softenable material having heating means embedded therein.

Yet another object of the invention is to provide the guillotine-type knife with back clearance between the knife and the plane of the cut through the lift of paper. With this construction, forward forces on the front gibs during the cutting stroke are minimized.

A further object of the invention is to provide a guillotine-type double-edged knife of diamond cross section one cutting edge of which is seated in a downwardly-facing, inverted, V-shaped groove in the knife bar to expose the other cutting edge. Another object in this connection is to secure the knife to the knife bar by means of laterally spaced, upwardly and forwardly sloping bolts threaded into the knife at their lower ends and having heads at their upper ends seated against the knife bar, the bolts being disposed in forwardly facing, upwardly and forwardly sloping channels in the front of the knife bar. With this construction, the knife may be removed from its V-shaped groove merely by loosening the bolts sufficiently to permit lateral withdrawal thereof from the bolt channels. Thus, the bolts serve as a means for handling the knife, which is an important feature.

Another object in the foregoing connection is to provide the bolts with a low spring rate and to provide them with a diameter which is small and a length which is large as compared to the cross sectional dimensions of the blade. With this bolt construction, once the bolts have been tensioned, they will hold the knife in its V-shaped groove in a positive manner even if cutting forces drive the knife farther into its groove.

It is conventional in paper cutters of the type under consideration to provide the clamp or clamp bar and the backstop with laterally spaced clamping and pushing fingers, respectively, which intermesh in the forwardmost position of the backstop to permit advancing the rear edge of the lift of paper as close as possible to the plane of cut prior to making the last cut through the lift. An object of the invention in this connection is to make the clamping fingers on the clamp bar laterally wider than the pushing fingers on the backstop to obtain a given area of clamping engagement with a minimum clamp-bar dimension longitudinally of the table. This construction minimizes waste at the rear edge of the lift of paper, which is an important feature.

An additional object of the invention is to provide a hydraulic clamp-bar drive means which includes an upright clamp-bar drive cylinder below the table, rearwardly of (or within) the base, and connected to the ends of the clamp bar. More particularly, an object in this connection is to provide clamp-bar guide means on the base at opposite sides of the table, a laterally-extending torque-transmitting member below the table and having cranks at its ends which are connected to the respective ends of the clamp bar, and means connecting the clamp-bar drive motor to the torque-transmitting member.

Still another object of the invention is to provide the clamp-bar drive motor with an adjustable stroke so that if the machine is used to cut lifts of paper of less than maximum height, it is unnecessary to move the clamp bar through its maximum stroke. This results in a considerable reduction in the time required to make a number of cuts in a low lift of paper.

A further object of the invention is to provide clamping-force control means responsive to the widths of the particular lift of paper being cut for applying to such lift a clamping force which is a function of its width. A related object is to provide such a clamping-force control means which may either be manually operated, or which automatically senses the width of the lift of paper and adjusts the clamping force accordingly.

It is essential that the backstop move longitudinally of the table along a path which is perpendicular to the plane of cut, and one of the most important objects of the invention is to achieve this result with a T-square backstop guide means located below the table and having a longitudinally extending leg which projects forwardly from the backstop and which is located under the front portion of the table when the backstop is in its forwardmost position. This construction achieves a very substantial reduction in the over-all length of the machine, as opposed to a construction wherein the longitudinally-extending leg of the T-square guide means projects rearwardly from the backstop. The end result is a considerable reduction in the floor space required by the machine, elimination of a slot in the table, and a considerable reduction in the weight of the machine, since it permits most of the weight of the machine to be carried by the base in the manner hereinbefore outlined.

Another and important object in connection with the backstop guide means is to incorporate in the longitudinally-extending leg of the T-shaped backstop carrier a hydraulic motor of the reciprocating type, and to utilize in conjunction with such motor a motion multiplying

means, e.g., a motion doubler, for producing a backstop stroke greater than, e.g., double, the stroke of the motor. With this construtcion, the longitudinally-extending leg of the carrier may be made short enough to be received between the backstop and the front edge of the table when the backstop is in its forwardmost position, without increasing the distance between the backstop and the front edge of the table beyond that required to handle normal stacks of sheets cut from the lift.

The T-shaped backstop carrier has a laterally extending cross bar located under the table and connected at its ends to the ends of the backstop above the table. An object in this connection is to provide connectors or connecting means, between the ends of the backstop and the ends of the cross bar of the T-shaped backstop carrier, which are movable along the side edges of the table and which are laterally thin. A related object is to run the connector at the fence end of the backstop in a laterally narrow slot between the fence and the corresponding edge of the table, such slot being sufficiently narrow that it does not interfere with proper support for the corresponding side edge of the lift of paper.

Still another important object of the invention is to provide an automatically-programmed paper cutter having a backstop programmer extending along one of the side edges of the table and having backstop control means on the backstop carrier and engageable with the backstop programmer to control the backstop drive means. With this construction, the paper cutter may be programmed to cut a lift of paper in a predetermined pattern automatically. A related object is to mount the backstop programmer on the fence and to mount the backstop control means on the corresponding end of the cross bar of the backstop carrier. Still another object is to provide a backstop programmer which includes a capstan rotatable about a longitudinal axis and carrying circumferentially spaced, longitudinally extending, programming members selectively engageable by the backstop control means upon rotation of the capstan.

A further object of the invention is to provide a backstop control means which includes a backstop control valve in one of the fluid lines leading to the respective ends of the cylinder of the backstop drive motor. A related object is to provide means for manually adjusting the maximum opening of the backstop control valve to limit the backstop speed.

The foregoing objects, advantages, features and results of the present invention, together with various other objects, advantages, features and results thereof which will be obvious to those skilled in the art to which the invention relates, may be achieved with the exemplary embodiments of the invention described in detail hereinafter and illustrated in the accompanying drawings, in which:

FIG. 1 is a plan view on a reduced scale of a guillotine-type paper cutter of the invention with certain covers removed;

FIG. 2 is a front elevational view, partially in section, of the paper cutter;

FIG. 3 is a side elevational view, partially in section, of the paper cutter showing the left side thereof;

FIG. 4 is a rear elevational view, partially in section, of the paper cutter;

FIG. 5 is a transverse sectional view through the paper cutter which is taken along the arrowed line **5—5** of FIG. 3 and which shows the knife bar of the paper cutter in its upper position;

FIG. 6 is a view which is identical to FIG. 5 except that it shows the knife bar in its lower position;

FIGS. 7 and 8 are enlarged, fragmentary sectional views respectively taken along the arrowed lines **7—7** and **8—8** of FIG. 6 and showing a knife-bar guide means for guiding the ends of the knife bar upwardly and downwardly along laterally sloping, parallel paths;

FIGS. 9 and 10 are fragmentary sectional views respectively taken as indicated by the arrowed lines **9—9** and **10—10** of FIG. 7 and showing details of the knife-bar guide means;

FIG. 11 is an enlarged, fragmentary sectional view taken as indicated by the arrowed line **11—11** of FIG. 6 and showing a knife-bar drive means of the invention;

FIG. 12 is an enlarged, fragmentary sectional view taken as indicated by the arrowed line **12—12** of FIG. 6 and showing a knife bar and a clamp bar of the paper cutter in cross section;

FIG. 13 is a fragmentary sectional view duplicating a portion of FIG. 12 on an enlarged scale and showing a guillotine-type blade or knife of the paper cutter in cross section;

FIG. 14 is a fragmentary sectional view taken generally as indicated by the arrowed line **14—14** of FIG. 12, but showing a backstop of the paper cutter advanced nearly to its forwardmost position relative to the clamp bar;

FIG. 15 is a fragmentary isometric sectional view illustrating a repairable cutting stick of the invention and a method of repairing it;

FIG. 16 is a view similar to FIG. 15 but showing an alternative repairable cutting stick and means for repairing it;

FIG. 17 is an enlarged, fragmentary sectional view taken as indicated by the arrowed line **17—17** of FIG. 4 and showing a clamp-bar drive means of the paper cutter;

FIG. 18 is a fragmentary sectional view duplicating a portion of FIG. 17 but showing various parts of the clamp-bar drive means in different relative positions;

FIG. 19 is an enlarged, fragmentary sectional view taken as indicated by the arrowed line **19—19** of FIG. 6 and showing a backstop guide and drive means of the invention;

FIGS. 20, 21, 22 and 23 are fragmentary sectional views respectively taken as indicated by the arrowed lines **20—20**, **21—21**, **22—22** and **23—23** of FIG. 19, and showing details of the backstop guide and drive means;

FIG. 24 is an enlarged, fragmentary sectional view taken as indicated by the arrowed line **24—24** of FIG. 4 and illustrating a backstop programmer of the invention;

FIG. 25 is a transverse sectional view through the backstop programmer which is taken as indicated by the arrowed line **25—25** of FIG. 24;

FIG. 26 is an enlarged, fragmentary sectional view taken as indicated by the arrowed line **26—26** of FIG. 2 and illustrating a backstop position-indicating and control means of the paper cutter of the invention;

FIG. 27 is a view taken as indicated by the arrowed line **27—27** of FIG. 26;

FIG. 28 is a mirror image of an enlarged, fragmentary sectional view taken as indicated by the arrowed line **28—28** of FIG. 26 and illustrating details of the backstop control means;

FIG. 29 is a diagrammatic view illustrating the hydraulic system of the paper cutter;

FIG. 30 is a fragmentary diagrammatic view illustrating an alternative for a portion of the hydraulic system of FIG. 29, and, more specifically, an alternative backstop control means;

FIG. 31 is a diagrammatic view of a manually-operated clamping-force control means for the clamp bar of the paper cutter; and

FIG. 32 is a fragmentary rear elevational view of the clamp bar of the paper cutter showing an automatic clamping-force control means.

GENERAL DESCRIPTION

Throughout the drawings, the guillotine-type paper cutter of the invention is designated generally by the numeral **100** and includes the following general components:

A supporting means or structure comprising a laterally extending base **102** engageable with a floor **103**, a table

104 connected to the base adjacent but rearwardly of the front edge 106 of the table, and an auxiliary table support 108 located on the longitudinal centerline of the table and connected to the rear edge 110 thereof, such auxiliary support being shown as engaging the floor 103, but being connectible directly to the base as an alternative;

A knife bar 112 mounted on the base 102 and located above and extending laterally across the table 104, the knife bar being positioned directly above the base so that paper cutting forces are transmitted directly to the base;

A guillotine-type blade or knife 114 carried by the knife bar 112 and extending laterally across the table 104;

Knife-bar guide means 116 on the base 102 at opposite sides of the table 104, and on opposite ends of the knife bar 112, for guiding the knife bar upwardly and downwardly along a laterally sloping path, the knife-bar path sloping downwardly to the left in the particular construction illustrated;

Hydraulic knife-bar drive means 118 carried by the base 102 below the table 104, and connected to the ends of the knife bar 112, for moving the knife bar upwardly and downwardly along its laterally sloping path;

A clamp bar 120 located above and extending laterally across the table 104 adjacent and behind the knife bar 112 and adapted to clamp a lift of paper against the table as a lateral cut through the lift is made by the knife 114;

Clamp-bar mounting and guide means 122 carried by the base at opposite sides of the table 104 for guiding the clamp bar 120 upwardly and downwardly relative to the table;

Clamp-bar drive means 124 carried by the base 102 below the table 104 for moving the clamp bar 120 upwardly and downwardly relative to the table;

A backstop 126 extending laterally across the table 104 and slidable on the upper surface of the table between a rearward position adjacent the rear edge 110 of the table and a forward position adjacent the knife and clamp bars 112 and 120, the backstop being engageable with the rear edge of the lift of paper to advance successive portions of the lift to the operating station occupied by the knife and clamp bars;

T-square backstop guide means 128 located below the table 104 and connected to the ends of the backstop 126 along the side edges of the table for guiding the backstop longitudinally of the table between its rearward and forward positions;

Hydraulic backstop drive means 130 below the table 104 and incorporated in the T-square backstop guide means 128 for moving the backstop 126 longitudinally of the table 104 between its rearward and forward positions;

A fence 132 extending longitudinally of the table 104 along one side edge of the table, preferably the left side edge thereof, and engageable with the corresponding side edge of the lift of paper to guide the lift longitudinally of the table;

A backstop programmer 134 mounted on the fence 132 and extending along the corresponding side edge of the table 104; and

Backstop control means 136 movable with the backstop 126 and engageable with the backstop programmer to control the backstop drive means 130.

The foregoing general components of the paper cutter 100 of the invention will be considered in more detail hereinafter under corresponding headings.

Base 102

Except for the small fraction of the weight of the paper cutter 100 which is carried by the auxiliary support 108 in the particular construction illustrated, the entire weight of the machine is transmitted to the floor 103 through two laterally-spaced, floor-engaging feet 140 on the base, which feet may be secured to the floor by bolts 142, FIGS. 5 and 6. As will be pointed out hereinafter, many of the components of the paper cutter 100 are mounted directly on the base 102 so that the weights thereof are transmitted directly to the base, the weights of the remaining components being transmitted thereto indirectly through the table 104. Preferably, the base 102 is an extremely rigid casting so that it provides proper support for all of the components of the machine despite uneven settling of the floor 103, or the like.

In addition to supporting virtually the entire weight of the paper cutter 100, the base 102 is provided internally thereof with a reservoir 144 for the hydraulic fluid used to power such components as the knife-bar drive means 118, the clamp-bar drive means 124 and the backstop drive means 130. Thus, the base 102 serves a dual function. Additionally, as will be described later, various hydraulic components of the paper cutter 100 are mounted on the base 102 within or above the reservoir 144 formed thereby so that any leakage from such components is discharged directly into the reservoir, which is an important feature.

In addition to the foregoing structural features, the base 102 is provided on opposite sides of the table 104 with two integral, laterally spaced supports 146 for the knife-bar and clamp-bar guide means 116 and 122, such supports projecting upwardly above the upper surface of the table. These supports 146 are rigidly interconnected by the base 102 itself, thereby obviating any necessity for any interconnecting yoke, or the like, above the knife and clamp bars 112 and 120. Thus, the space above the knife and clamp bars 112 and 120 and between the supports 146 is unobstructed to provide the paper cutter 100 with a low profile. Consequently, the operator of the paper cutter 100, from his station at the front of the machine, can readily observe the lift of paper on the table 104 rearwardly of the knife and clamp bars 112 and 120, and can readily observe the operation of such components as the backstop 126 which are located behind the knife and clamp bars. This low profile, and its attendant advantages, represent an important feature of the invention.

Table 104

The table 104 is essentially a rectangular plate having a plane upper surface. The table 104 is suitably stiffened both laterally and longitudinally by integral lateral and longitudinal stiffening ribs on its lower surface, which ribs will not be described in detail. The table 104 is suitably bolted to the base 102 at 147, FIG. 1, below the knife bar 112 so that the cutting forces, which are the major forces applied to the table, do not tend to alter the positional relationship between the table and the base. Lateral extensions 148 are secured to the table 104 forwardly of the base 102 to provide additional working areas to receive stacks of paper from the lift being cut.

Knife bar 112 and knife 114

Referring particularly to FIGS. 5, 12 and 13 of the drawings, the knife bar 112 is essentially a beam of sufficient length to span the space between the two supports 146 on the base 102 at opposite sides of the table 104. The knife bar 112 is provided in its lower edge with a downwardly-facing, inverted, V-shaped groove 150. The knife 114 is a guillotine-type double-edged knife of diamond cross section complementary to the V-shaped groove 150. As shown in FIGS. 12 and 13, the knife 114 is seated in the V-shaped groove 150 with one cutting edge 152 of the knife exposed and with the other disposed in a protective cavity 154 at the apex of the groove 150. As will be apparent, with this construction, cutting forces acting on the knife 114 merely serve to seat it more firmly in its V-shaped groove 150.

Preferably, the two halves of the knife 114 are hollow ground, as indicated at 156. This facilitates resharpening of the cutting edges 152 by minimizing the amount of material which must be removed.

An important feature of the invention is that each half of the knife **114** is provided, as best shown in FIG. 13, with back clearance **158** between the corresponding back plane **160** and the lift **162** being cut. The back clearance **158**, which may be of the order of one degree, is important because it minimizes the forward reaction force applied to the knife bar **112** as the result of the interaction between the knife **114** and the lift **162** during the shearing operation.

Considering the manner in which the knife **114** is held in its V-shaped groove **150**, and referring particularly to FIGS. 5 and 12 of the drawings, the knife bar **112** is provided with an upwardly-and-forwardly sloping surface **164** terminating at its upper edge in an upwardly-and-forwardly facing shoulder **166**. Covering part of the top and front sides of the knife bar **112** is a clip **168** having a portion **170** complementary to and seated on the shoulder **166**. Seated on the portion **170** of the clip **168** are the heads of long, slender bolts **172** which slope downwardly and rearwardly, parallel to the surface **164**, and which are threaded at their lower ends into the knife **114**, the hollow ground surfaces of the knife being generally parallel to the bolts **172**. The surface **164** of the knife bar **112** is provided therein with laterally spaced, downwardly-and-rearwardly sloping channels **174** therein which receive the respective bolts **172**.

It will be apparent that, with the foregoing construction, the knife **114** is held in its V-shaped groove **150** by tightening the bolts **172** to seat the heads thereof against the shoulder **166** on the knife bar **112**, through the intervening portion **170** of the clip **168**. In order to remove the knife **114**, it is merely necessary to loosen the bolts **172** sufficiently to permit the portion **170** of the clip **168** to be slipped downwardly and forwardly off the shoulder **166** on the knife bar. Subsequently, the bolts **172** can be withdrawn downwardly and forwardly from their channels **174**, whereupon the knife **112** can be removed from its V-shaped groove **150**. The clip **168** may be used as a handle for removal and subsequent handling of the knife **114**, thereby avoiding any necessity for handling the knife itself, which is an important feature. A similar procedure may be followed in installing the knife **114**.

It will be noted that the holes in the knife **114** for the bolts **172** extend entirely through the knife so that the bolts can be threaded into such holes from either end thereof. This permits reversing the position of the knife so that the other cutting edge **152** thereon can be utilized. As will be apparent, this reversal of the bolt position can be accomplished with one of the hollow ground surfaces of the knife **114** lying flat on a suitable supporting surface, thereby avoiding any necessity for handling the knife itself during this operation.

Considering another important feature of the invention, the diameter of the bolts **172** is quite small as compared to the cross sectional dimensions of the knife **114**, and the length of the bolts is large as compared thereto. More particularly, the diameter of the bolts **172** is but a fraction of the smallest cross sectional dimension of the knife **114**, and the length of the bolts is at least double the largest cross sectional dimension of the knife. Additionally, the bolts **172** have a low spring rate which, coupled with their long length and small diameter, result in holding the knife **114** in its V-shaped groove **150** in a positive manner even if cutting forces drive the knife further into its groove. Thus, it is unnecessary to retighten the bolts **172** after the machine has been in operation for a time.

As shown in FIGS. 12, 13, 15 and 16, the table **104** is provided in its upper surface with a dovetail groove **176** in the plane of cut of the operative cutting edge **152** of the knife **114**. The groove **176** contains a cutting stick **178** capable of being penetrated by the operative cutting edge **152** of the knife **114** at the lower end of the stroke of the knife bar **112**, thereby providing sufficient downward cutting edge travel to insure cutting the lowermost sheet of paper in the lift **162**. An important feature of the invention is that the cutting stick **178** is repairable. One way of accomplishing this is to make the cutting stick **178** of an alloy which is heat softenable at a relatively low temperature. Thus, the cutting stick **178** can be repaired, i.e., provided with a smooth upper surface, by running a soldering iron **180**, FIG. 15, or other heating device, over the upper surface of the cutting stick. FIG. 16 illustrates an alternative wherein the heat softenable cutting stick **178** has a suitable heating element **182**, such as a resistance heating element, embedded therein. By energizing the heating element **182** sufficiently to melt the alloy of the cutting stick **178**, it will automatically have its upper surface restored to a smooth surface. Other repairable cutting sticks formed of suitable plastic materials may also be used.

Knife-bar guide means **116**

The knife bar **112** is guided along its laterally sloping path by laterally sloping, parallel ramps **190** on the supports **146** at opposite sides of the table **104**. Each support **146** is provided with two such ramps **190** spaced apart in the fore-and-aft or longitudinal direction, as shown in FIGS. 1, 7 and 8 of the drawings. The angle of inclination of the ramps **190**, which preferably slope downwardly to the left, is such as to provide an optimum cutting angle for the knife **114**, e.g., a cutting angle of the order of 20° to 25°.

The knife bar **112** is provided at each end thereof with two ramp follower wheels **192** spaced apart in and rotatable about an axis extending in the fore-and-aft direction, as best shown in FIGS. 7 and 8. The wheels **192** are seated on and rollable along the respective ramps **190** to guide the knife bar **112** upwardly and downwardly along its laterally sloping path.

As best shown in FIGS. 7 and 8, the wheels **192** at each end of the knife bar **112** are mounted on a shaft **194** journalled in an eccentric sleeve **196** in a bore **198** through the corresponding knife-bar end, the eccentric sleeve being secured by a set screw **200**, FIG. 9. As best shown in FIG. 10, each eccentric sleeve **196** is provided at one end thereof with flats **202** engageable by a wrench, not shown, for adjusting the angular position of such eccentric sleeve. With this construction, the angular positions of the eccentric sleeves **196** may be adjusted to raise or lower the knife bar **112** as required to obtain the desired penetration of the operative cutting edge **152** of the knife **114** into the cutting stick **178**. For example, the adjustment provided by the eccentric sleeves **196** may be used to compensate for decreases in the spacings of the cutting edges **152** of the knife **114** due to repeated sharpenings.

As best shown in FIGS. 2 and 5, the ramps **190** are provided at their lower ends with upwardly concave, arcuate terminal portions or valleys **204**. The valleys perform the important function of providing for overtravel of the knife bar **112** as it is decelerated at the lower end of its stroke. The fact that the knife bar **112** must go upwardly slightly as the wheels **192** traverse the valleys **204** increases the deceleration of the knife bar **112**. Consequently, the knife bar **112** may be driven downwardly at full speed until the knife **114** has cut entirely through the lift of paper, the knife bar subsequently being decelerated as the wheels **192** thereon negotiate the valleys **204** at the lower ends of the ramps **190**.

Referring particularly to FIGS. 7 and 8, the supports **146** on the base **102** at opposite sides of the table **104** comprise longitudinally spaced plates which provide each support with longitudinally spaced gibs **206** receiving the corresponding knife-bar end therebetween and restraining same against movement in the fore-and-aft direction. The upper edges of the plates forming the gibs **206** constitute the ramps **190**. This construction provides a very compact and simple means for guiding the knife bar **112** along its

laterally sloping path while simultaneously restraining it against fore-and-aft movement.

The ends of the knife bar **112** are provided on the forward side of the knife bar with thrust bearings **208** respectively engageable with the front gibs **206** to resist forward forces on the knife bar resulting from the guillotine action of the knife **114**. As previously pointed out, forward forces on the knife bar **112** are minimized by providing the knife **114** with the back clearance **158**. The rear face of the knife bar **112** directly engages the rear gibs **206**, no thrust bearings being necessary at these points because rearward forces on the knife bar are negligible.

The thrust bearings **208** are provided with bosses **210** which project rearwardly into and are suitably sealed relative to counterbores **212** in the respective ends of the knife bar **112**, the counterbores **212** terminating in bores **214** through the rear face of the knife bar. Compression springs **216** in the counterbores **212** bias the thrust bearings **208** against the front gibs **206**.

Considering the manner in which the gibs **206** are lubricated, each end face of the knife bar **112** is provided with an oil passage **218**, FIG. 9, leading to the corresponding counterbore **212**. The rear end of the corresponding bore **214** is provided with an oil-porous plug **220** through which oil in the corresponding counterbore **212** may seep to lubricate the corresponding rear gib **206**. Each thrust bearing **208** is provided therein with an oil-porous plug **222** through which oil may seep from the corresponding counterbore **212** to lubricate the corresponding front gib **206**. This provides a very simple and direct lubricating system for the gibs **206**. Also, it will be noted that since the supports **146** for the knife bar **112** are spaced laterally from the side edges of the table **104**, it is impossible for any of the lubricating oil for the gibs **206** to contaminate the upper surface of the table.

As best shown in FIG. 6, the space between the longitudinally-spaced ramp-and-gib-forming portions of the right-hand support **146** communicates with the upper surface of the table **104** to provide a paper chute designated generally by the numeral **224**. Small scraps of paper produced by the knife **114**, as in making trim cuts in cutting cards, labels, or the like, may be discharged from the table **104** into a suitable waste-paper receptacle, not shown, through the paper chute **224**.

The left-hand support **146** provides a wedge-shaped notch, not shown, to receive the knife **114** at the lower end of its stroke. If not prevented, paper scrap from the table **104** could pass through this notch and foul a part of the knife-bar drive means **118** to be described hereinafter. To prevent this, the invention provides a paper deflector **228**, FIG. 6, movable upwardly and downwardly with the knife bar **112** and closing the wedge-shaped notch mentioned. To provide the proper motion for the paper deflector **228**, it is mounted on a long arm **230**, FIG. 3, pivotally connected to the rear end of the fence **132**. A suitable spring, not shown, biases the paper deflector **228** upwardly against the sloping front surface of the knife **114** so that the paper deflector **228** moves upwardly and downwardly with the knife bar **112**. In doing this, it constantly keeps the aforementioned wedge-shaped notch in the left-hand support **146** closed.

Knife-bar drive means **118**

As will be apparent, the knife-bar guide means **116** resists only downward forces acting on the knife bar **112** and is incapable of resisting upward forces acting thereon. Such upward forces are resisted by the knife-bar drive means **118** in a manner which provides an automatic overload relieving system, as will be described subsequently in this section.

As best shown in FIGS. 5 and 6 of the drawings, the knife-bar drive means **118** includes a hydraulic knife-bar drive motor **232** of the reciprocating type disposed within the base **102** so that any leakage therefrom discharges directly into the reservoir **144**. The knife-bar drive motor **232** includes a cylinder **234** one end of which is anchored by means of a longitudinally-extending pin **236** spanning the interior of the base **102** and suitably secured to the front and rear walls of the base. Reciprocable in the cylinder **234** is a piston **238** having connnected thereto a piston rod **240** which projects from the opposite end of the cylinder. The outer end of the piston rod **240** is connected to the right-hand end of the knife bar **112** by a pin **242**, as best shown in FIG. 7.

As will be apparent, extension and contraction of the knife-bar drive motor **232** respectively result in upward and downward movement of the knife bar **112** along its ramps **190**. The knife-bar drive motor **232** is substantially parallel to the ramps **190**, but is oriented at a slightly steeper angle so that it applies to the right-hand end of the knife bar **112** a force component acting to maintain the corresponding wheels **192** in engagement with the corresponding ramps **190**. Thus, the knife-bar drive motor **232** restrains the right-hand end of the knife bar **112** against upward movement.

Referring to FIG. 11 of the drawings, the ends of the cylinder **234** and the corresponding ends of the piston **238** are formed to provide two dashpot means, each designated generally by the numeral **246**, for decelerating the piston **238** and the knife bar **112** at the ends of their respective strokes. Additionally, the piston **238** carries elastomeric bumpers **248** respectively engageable with stops **250** at the ends of the cylinder **234**. The elastomeric bumpers **248** supplement the decelerating actions of the dashpot means **246** to eliminate shock at the ends of the stroke of the knife bar **112**.

The knife-bar drive means **118** includes yieldable, hydraulic, hold-down means **252** for restraining the left-hand end of the knife bar **112** against upward movement tending to disengage the left-hand wheels **192** from the left-hand ramps **190**. However, the yieldability of the hold-down means **252** permits the left-hand end of the knife bar **112** to rise in the event of an overload, which may result from an excessively thick lift of paper, a dull cutting edge **152** on the knife **114**, an obstruction, or the like. This is an important feature since it avoids any necessity for a separate system to protect against an overload on the knife **114**.

Considering the knife-bar hold-down means **252** in more detail, it also includes a hydraulic motor **254** of the reciprocating type within the base **102**. The knife-bar hold-down motor **254**, as best shown in FIGS. 5, 6 and 1, includes a cylinder **256** connected at one end to the same pin **236** as the cylinder **234** of the knife-bar drive motor **232**. Disposed in the cylinder **256** is a piston **258** having connected thereto a piston rod **260** projecting from the opposite end of the cylinder. A compression spring **262** encircling the piston rod **260** biases the piston **258** toward the anchored end of the cylinder **256**. As shown in FIGS. 5 and 6, the free end of the piston rod **260** has connected thereto one end of a cable **264** which is trained under a pulley **266** carried by the base **102** and which has its other end connected to a pin **268** on the left-hand end of the knife bar **112**, as best shown in FIG. 8. The cable **264** is suitability sealed between the pulley **266** and the hold-down motor **254** to prevent leakage of hydraulic fluid from the base **102** along the cable. (The purpose of the hereinbefore-described paper deflector **228** is to prevent paper scraps from fouling the cable **264** and pulley **266**.)

The relative positions of the pulley **266** and the left-hand ramps **190** are such that the left-hand end of the knife bar **112** moves up and down such ramps with very little extension and contraction of the hold-down motor **254**. Thus, the hold-down piston **258** is subject to relatively little movement from the positions shown in FIGS. 5 and 6. The hold-down cylinder **256** is provided with a pressure inlet fitting **270** which applies hydraulic pressure to the hold-down piston **258** in a direction to tension the cable **264**, this fitting being so located that it con-

stantly applies hydraulic pressure to the hold-down piston **258** in such direction during normal operation of the hold-down means **252**. As will be described hereinafter, the hydraulic pressure applied to the hold-down piston **258** is preferably substantially the same as the hydraulic pressure applied to the knife-bar drive motor **232**. The total hold-down force applied to the left-hand end of the knife bar **112** is equal to the sum of the hydraulic force acting on the hold-down piston **258** and the force provided by the spring **262**. This total force is preferably at least approximately proportional to the cutting force applied to the knife bar **112** by the knife-bar drive means **118**.

In the event of an overload on the knife **114**, the left-hand end of the knife bar **112** immediately starts to rise to protect against the overload. This results in extension of the hold-down motor **254**, in opposition to the actions of hydraulic pressure and the spring **262** on the hold-down piston **258**. The distance that the left-hand end of the knife bar **112** can rise is limited by the location of the pressure inlet fitting **270**, which produces a hydraulic lock as soon as it is covered by the hold-down piston **258** to prevent the left-hand end of the knife bar from moving upwardly from between the corresponding gibs **206**. If this upward motion of the left-hand end of the knife bar **112** is insufficient to relieve the overload, the right-hand end of the knife bar can also move upwardly, in opposition to the action of the knife-bar drive motor **232**, to completely relieve the overload. In all instances of overloading, however, the left-hand end of the knife bar **112** leaves the left-hand ramps **190** first.

FIG. 29 of the drawings illustrates the hydraulic connections to the knife-bar drive and hold-down motors **232** and **254**. Since FIG. 29 is large self-explanatory, the hydraulic system, as it pertains to the knife-bar drive and hold-down motors **232** and **254**, will be considered only briefly.

The hydraulic system of the paper cutter **100** includes a pump **272** drawing hydraulic fluid from the reservoir **144**, and located within the reservoir in accordance with the hereinbefore-discussed object of minimizing hydraulic leakage problems by locating as many hydraulic components as possible within the reservoir. The pump **272** is suitability mounted on the rear wall of the base **102** and is driven by an electric motor **274** mounted on the rear wall of the base externally of the reservoir **144**.

The hydraulic system includes a four-way solenoid valve **278** which controls the application of pressure to the knife-bar drive and hold-down motors **232** and **254** in a manner which will be apparent from FIG. 29. When the solenoid valve **278** is de-energized, it occupies the position shown in FIG. 29 and actuates the knife-bar drive motor **232** to move the knife bar **112** to its upper position. When the solenoid **278** is energized, it causes the knife-bar drive motor **232** to move the knife bar **112** to its lower position. Since, when the solenoid valve **278** is de-energized, it actuates the knife-drive motor **232** in a direction to move the knife bar **112** to its upper position, it will be apparent that the knife bar is automatically held in its upper position as a safety measure. Even when the pump drive motor **274** is de-energized, the knife bar **112** can descend only slowly as fluid leaks from the system. This further safeguards the operator from possible injury.

Low-pressure and high-pressure relief valves **280** and **282** are located in the hydraulic system on the downstream side of the solenoid valve **278**, the former providing a constant bias pressure throughout the entire system, and the latter limiting the maximum pressure developed in the system. It will be noted that the low-pressure relief valve **280** is operative during upward movement of the knife bar **112**, and that the high-pressure relief valve **282** is operative during the cutting stroke of the knife bar. The maximum pressure thus produces the cutting stroke of the knife bar **112**, and the bias pressure produces the return stroke thereof. It will be understood that the relief valves **280** and **282** discharge into the reservoir **144**. To take care of leakage problems, they are also preferably mounted within the base **102** above the reservoir **144**, along with such other components as the knife-bar drive and hold-down motors **232** and **254**, the pump **272**, and the solenoid valve **278**.

The hydraulic system of FIG. 29 will be considered further hereinafter in considering such components of the paper cutter **100** as the clamp-bar drive means **124**, the backstop drive means **130**, and the like.

Clamp bar **120**

As best shown in FIGS. 4 and 12, the clamp bar **120** is a beam of generally rectangular cross section which laterally spans the table **104** just behind the knife bar **112**, the rear face of the knife bar and the front face of the clamp bar being juxtaposed. The lower portion of the rear face of the clamp bar **120** is provided with laterally spaced recesses **286** separated by laterally spaced, vertical ribs **288** terminating at their lower ends in laterally spaced clamping feet or fingers **290** engageable with the upper surface of the lift of paper **162** adjacent the plane of cut of the knife **114**. The clamping feet **290** are integrally interconnected at their forward ends and are laterally separated rearwardly of their forward ends by laterally spaced notches **292** in the lower surface of the clamp bar **120**. The clamping feet **290** are considerably wider than the notches **292** separating them.

As shown in FIGS. 12 and 14, the backstop **126** is provided on its forward face with laterally spaced, vertical pushing fingers or ribs **294** the widths of which are slightly less than the widths of the notches **292**, and considerably less than the widths of the clamping feet **290**. As shown in FIG. 14, the pushing ribs **294** on the backstop **126** and the clamping feet **290** on the clamp bar **120** intermesh as the backstop approaches its forwardmost position, the backstop being shown somewhat short of its forwardmost position in FIG. 14. The intermeshing of the pushing ribs **294** and the clamping feet **290** insures that the rear edge of the lift **162** can be pushed almost to the plane of cut of the knife **114**. The fact that the clamping feet **290** on the clamp bar **120** are laterally wider than the pushing ribs **294** on the backstop **126** insures obtaining the necessary area of clamping engagement with the lift **162** with a minimum clamp-bar dimension longitudinally of the table. This construction minimizes waste at the rear edge of the lift of paper.

Another possible function which the clamp bar **120** is capable of performing is that of a punch press. More particularly, the clamp bar **120** can be equipped with suitable dies, not shown, for performing such functions as punching holes through the lift of paper, making diagonal cuts across the corners of the lift, and the like.

Clamp-bar guide means **122**

As shown in FIGS. 3 and 4, the ends of the clamp bar **120** are supported by vertical bars **300**, preferably of square cross section, which extend downwardly through guides **302** mounted on the rear sides of the supports **146** on the base **102** at opposite sides of the table **104**. Pivotally connected to the lower ends of the support bars **300**, below the guides **302**, are the upper ends of connecting rods **304** forming part of the clamp-bar drive means **124** to be described in the next section. Since the principal force on the clamp bar **120** is a downward force applied thereto through the support bars **300** acting in tension, these support bars can be of relatively small cross section.

The ends of the knife and clamp bars **112** and **120** and the knife-bar and clamp-bar guide means **116** and **122** are all enclosed by covers **306**. These covers are suitably hinged to the supports **146**, in a manner not specifically shown, so that they may be swung laterally outwardly for access to the components normally enclosed thereby.

Clamp-bar drive means **124**

As shown in FIGS. 3, 4 and 5 of the drawings, the base **102** is provided with a rearwardly facing recess **310**, below the reservoir **144**, for a laterally-extending torque-transmitting member **312**. The latter is preferably a torque tube and is suitably mounted for pivotal movement about its axis on the laterally-spaced side walls of the base **102**. The torque tube **312** is provided at its ends with cranks **314** to which the lower ends of the connecting rods **304** are pivotally connected. With this construction, pivoting of the torque tube **312** back and forth serves to raise and lower the clamp bar **120** out of and into engagement with the lift of paper **162**.

The clamp-bar drive means **124** also includes a hydraulic clamp-bar drive motor **316** of the reciprocating type. This drive motor is located rearwardly of the base **102** and includes a vertical cylinder **318** the upper end of which, as shown in FIG. 17, is suitably secured to a rearwardly-projecting portion of the previously-described pin **236** for anchoring the knife-bar drive and hold-down cylinders **234** and **256**. Vertically reciprocable within the cylinder **318** is a clamp-bar drive piston **320** having connected thereto a depending piston rod **322** the lower end of which is pivotally connected, as shown in FIGS. 3 and 4, to a crank **324** on the torque tube **312** intermediate the ends thereof. With this construction, upward and downward movement of the clam-bar drive piston **320** in its cylinder **318** respectively produce upward and downward movement of the clamp bar **120**.

A feature of the invention is that the clamp-bar drive motor **316** is provided with an adjustable stroke so that if the paper cutter **100** is used to cut lifts of paper of less than maximum height, it is unnecessary to move the clamp bar **120** through its maximum stroke, thereby resulting in a considerable reduction in the time required to make number of cuts in a low lift of paper. Considering how this is accomplished within the cylinder **318**, between the piston **320** and the upper end of the cylinder, is a floating annular stop means **326** for limiting the stroke of the piston **320**. The annular stop means **326** is shown in a stroke limiting position in FIG. 18, and is shown in a nonlimiting position, in which it permits the full stroke of the piston **320**, in FIG. 17. The annular stop means **326**, which is positioned in a manner to be described, surrounds an inlet tube **328** which depends from the upper end of the cylinder **318** and which serves to apply hydraulic pressure to the upper end of the piston **320**. The manner in which the inlet tube **328** and the lower end of the cylinder **318** are connected in the hydraulic system is shown in FIG. 29 of the drawings. The line leading to the lower end of the cylinder **318** is provided with a manually-operated three-way valve **330** which may be actuated by a foot pedal **332**, FIG. 2, to permit manual dropping of the clamp bar **120** onto the lift of paper **162**, instead of moving the clamp bar downwardly into engagement with the lift of paper under power. This permits engagement of the clamp bar **120** with the lift of paper **162** with a minimum possibility of disturbing the lift.

Adverting to the stroke adjustment of the clamp-bar drive motor **316**, the space between the upper end of the cylinder **318** and the annular stop means **326** may be supplied with hydraulic fluid by opening a needle valve **334** having an actuating stem **336** which extends forwardly through the pin **236** so as to be accessible from the front of the paper cutter **100**. The needle valve **334** is connected in the hydraulic system as shown in FIG. 29.

By opening the needle valve **334**, hydraulic fluid at the hereinbefore-discussed bias pressure is delivered to the space between the upper end of the cylinder **318** and the annular stop means **326** to move the annular stop means downwardly to the desired stroke-limiting position, as shown, for example, in FIG. 18. Once the annular stop means **326** is positioned as desired, the needle valve **334** is closed to lock hydraulic fluid in the cylinder **318** between the upper end thereof and the annular stop means **326**. This fixes the annular stop means **326** in the desired stroke-limiting position by means of a hydraulic lock. If it is desired later to re-set the annular stop means **326** for a longer stroke for the clamp-bar drive motor **316**, this may be accomplished by opening the needle valve **334** and operating the knife-bar and clamp-bar drive motors **232** and **316** through a number of cycles sufficient to bleed off the requisite amount of hydraulic fluid from the space between the annular stop means **326** and the upper end of the cylinder **318**.

Turning again to FIG. 29 of the drawings, it will be noted that when the solenoid valve **278** is de-energized, which is the condition shown in FIG. 29, and when the manual clamp-bar drop valve **330** is not activated, the bias pressure holds both the knife bar **112** and the clamp bar **120** in their upper positions. The clamp bar **120** can be dropped into engagement with the lift of paper **162** by actuation of the manual clamp-bar drop valve **330**. The solenoid valve **278**, when energized, energizes both the clamp-bar drive motor **316** and the knife-bar drive motor **232** downwardly. A sequence valve **338** located ahead of the knife-bar drive motor **232**, as shown in FIG. 29, insures that the cutting stroke of the knife **114** will not be initiated until the necessary clamping force has been applied to the clamp bar **120**, the clamping force required being proportional to the width of the lift of paper **162**. In the following section, two different clamping-force control means are described.

Clamping-force control means

Referring to FIG. 29, the sequence valve **338** is capable of adjustment to adjust the downwardly-acting hydraulic pressure applied to the clamp-bar drive piston **320**, whereby to adjust the clamping force applied to the lift of paper by the clamp bar **120**. As shown diagrammatically in FIG. 29, the desired adjustment of the sequence valve **338** is accomplished by energizing some or all of a plurality of solenoids **340**, depending on the width of the lift of paper to be clamped. Preferably, there is a direct proportional relationship between the width of the lift of paper and the number of the solenoids **340** to be energized, as will be clear hereinafter. There is also a direct proportional relationship between the number of energized solenoids and the clamping pressure built up in the clamp-bar drive cylinder **318** before the sequence valve **338** permits energization of the knife-bar drive motor **232**. In other words, after the desired clamping force is applied to the lift of paper by the clamp bar **120**, the sequence valve **338** permits energization of the knife-bar drive motor **232** in the direction to produce the cutting stroke of the knife **114**.

FIG. 31 of the drawings show a clamping-force control means of the invention which is manually operated. More particularly, FIG. 31 shows a selector switch **342** having fixed terminals to which the solenoids **340** are connected in parallel. Indicator lights **344** are connected in parallel with the respective solenoids **340**. (The switch **342** has an additional position wherein it energizes an "on" light **346** merely indicating that the clamping-force control means is "on." The "on" light **346** is located at the extreme left end of the exposed portion of the clamp bar **120** for convenience, as shown in FIG. 5, for example.)

The indicator lights **344** are mounted on top of the clamp bar **120** in laterally spaced relation, as shown, for example, in FIG. 5. As the movable contact of the switch **342** is moved from the left to right, as viewed in FIG. 31, the indicator lights **344** on the clamp bar **120** are successively energized from left to right. In using this clamping-force control means, the movable contact of the switch **342** is moved to the right until all of the indicator lights **344** above the lift of paper to be cut are energized. In other words, the number of the indicator lights **344** which are energized is proportional to the width of the

lift of paper to be clamped. Correspondingly, the number of solenoids **340** which are energized is proportional to the width of the lift of paper, whereby the sequence valve **338** is caused to develop in the clamp-bar drive cylinder **318** a hydraulic pressure proportional to the width of the lift of paper, and thus a clamping force proportional to the width thereof. Once the necessary clamping pressure has been developed in the clamp-bar drive cylinder **318**, the sequence valve **338** permits the application of hydraulic pressure to the knife-bar drive motor **232** in a direction to produce the cutting stroke of the knife **114**.

In lieu of the foregoing manual clamping-force control means, an automatic clamping-force control means, responsive to the width of the lift of paper to be clamped, may be used. Such an arrangement is shown fragmentarily in FIG. 32 as comprising a series of normally-open switches **348** spaced apart laterally of the clamp bar **120** and engageable with a lift of paper under the clamp bar. As will be apparent, the number of the switches **348** which are closed upon engagement with the lift of paper depends on the width of the lift of paper. The switches **348** are respectively connected in series with the sequence-valve solenoids **340** so that, as a number of switches are closed proportional to the width of the lift of paper, a number of solenoids are energized proportional to the width of the lift of paper, thereby causing the sequence valve **338** to develop in the clamp-bar drive cylinder **318** a clamping pressure proportional to the width of the lift of paper before permitting energization of the knife-bar drive motor **232** to cause the cutting stroke of the knife **114**.

Backstop **126**

The backstop **126** is simply a beam of suitable cross section extending laterally across the table **104** and slidable longitudinally of the table on the upper surface thereof. As hereinbefore described, the backstop **126** is provided with the forwardly-projecting pushing ribs **294** which engage the rear edge of the lift paper and which are interleaved with the clamping feet **290** on the clamp bar **120** in the forwardmost position of the backstop. The manner in which the backstop **126** is guided and driven will now be considered under corresponding headings.

T-square backstop guide means **128**

The guide means **128** for guiding the backstop **126** longitudinally of the table **104** along a path perpendicular to the plane of cut of the knife **114** includes a T-shaped backstop carrier or T-square **350**, FIGS. 1 and 19, below the table. The backstop carrier **350** includes a longitudinally-extending leg **352** (sometimes referred to herein as a longitudinally-extending track follower for a reason to become apparent) which projects forwardly from the backstop and which is located below the forward portion of the table **104**, i.e., below the portion of the table between the front edge **106** thereof and the knife and clamp bars **112** and **120**, when the backstop **126** is in its forwardmost position. The backstop carrier **350** also includes, at the rearward end of the longitudinally-extending leg **352**, a laterally-extending cross bar **354** located below and spanning the space between the side edges of the table **104**.

As best shown in FIGS. 19, 21 and 22, connecting means or connectors **356** and **358** respectively connect the left-hand and right-hand ends of the backstop **126** to the corresponding ends of the cross bar **354** adjacent the corresponding side edges of the table **104**. The left-hand connector **356** is a thin plate movable longitudinally of the left-hand edge of the table **104** in a laterally-narrow slot **360** between such table edge and the fence **132**. The slot **360** is formed by mounting the fence **132** on the table **104** in a position spaced laterally outwardly from the left-hand edge of the table. It will be noted from FIG. 21 in particular that the laterally-thin connector plate **356** is disposed between and is guided by the left-hand edge of the table **104** and the fence **132**. Consequently, there is no tendency for the connector plate **356** to buckle. The laterally-narrow slot **360** provided for the connector plate **356** does not interfere with proper movement of the left-hand edge of the lift of paper along the right-angle corner between the table **104** and the fence **132**. The connector **358** between the right-hand ends of the backstop **126** and the cross bar **354** is a relatively thick plate, as best shown in FIGS. 19 and 22.

Referring to FIG. 19, the T-square **350** is provided adjacent its rearward end with two laterally-spaced, horizontal wheels **362** respectively engageable with laterally-spaced, vertical, longitudinal tracks **364** formed by longitudinal ribs on the under side of the table **104**. At the forward end of the T-square **350** are two similar, laterally-spaced, horizontal wheels **366** respectively engageable with the same vertical, longitudinal tracks **364**. These tracks are perpendicular to the plane of cut of the knife **114** and thus serve to guide the T-square **350**, and hence the backstop **126**, along a longitudinal path perpendicular to the plane of cut. Preferably, the horizontal wheels **362** and **366** are adjustably mounted on eccentrics, not shown, to insure proper engagement thereof with the tracks **364**, and to insure that horizontal lines in the frontal plane of the backstop **126** are parallel to the plane of cut.

The backstop **126** and the rearward end of the T-square **350** are supported by the table **104**, the lower surface of the backstop sliding on the upper surface of the table. The front end of the T-square **350** is supported by a portion of the backstop drive means **130**, as will be described hereinafter. It will be noted that when the backstop **126** pushes a lift of paper forwardly along the table **104**, frictional resistance acts rearwardly on the backstop to tend to lift the forward end of the longitudinally-extending leg **352** of the T-square **350**. To prevent this, the longitudinally-extending leg **352** is provided adjacent its forward end with two laterally-spaced, vertical wheels **368** respectively engageable with laterally-spaced, horizontal longitudinal tracks **370** formed by the lower sides of the longitudinal ribs which forms the vertical longitudinal tracks **364**. The vertical wheels **368** are also adjustably mounted on eccentrics, not shown, to permit adjusting the frontal plane of the backstop **126** into absolute parallelism with the plane of cut.

The T-square backstop guide means **128** composed of the foregoing elements guides the backstop **126** along a longitudinal path perpendicular to the plane of cut of the knife **114** in a positive and reliable manner. Additionally, because of the fact that the T-square **350** projects forwardly, instead of rearwardly, a substantial reduction in the overall length of the paper cutter **100** is achieved.

Backstop drive means **130**

As suggested in FIG. 1 and as shown in detail in FIG. 19, the backstop drive means **130** includes a hydraulic backstop drive motor **374** of the reciprocating type extending longitudinally of and carried by the longitudinally-extending leg **352** of the T-square **350**. The backstop drive motor **374** includes a longitudinally-extending cylinder **376** which is shown as formed integrally with and as constituting part of the longitudinally-extending leg **352** of the T-square **350**. The cylinder **376** is connected in the hydraulic system as shown in FIG. 29 and contains a piston **378** having connected thereto a forwardly projecting piston rod **380**. The forward end of the piston rod **380** is rigidly connected to a crosshead **382** having rigidly secured thereto two laterally-spaced, longitudinally-rearwardly-extending rods **384**. These rods extend through and are longitudinally guided and supported by longitudinally spaced guides **386** on the longitudinally-extending leg **352** of the T-square **350**. The rearward ends of the rods **384** are interconnected, rearwardly of the rearmost guide **386**, by another crosshead **388** similar to the crosshead **382**. As will be apparent, the crossheads **382** and **388** and the

rods **384** interconnecting them move longitudinally in unison with the piston **378** and the piston rod **380**.

The table **104**, the cylinder **376** and the piston **378** are interconnected by a motion multiplying means, specifically a motion doubler, which causes the backstop **126** to move through a distance equal to substantially twice the stroke of the backstop drive motor **374**. This motion doubler comprises a cable system, composed of longitudinally-extending, laterally-spaced cables **390** and **392**, which will now be described.

One end of the cable **390** is anchored to the rear edge **110** of the table **104** at **394**, FIG 19. From the anchor **394**, the cable **390** extends forwardly, above the longitudinally-extending leg **352** of the T-square **350** and through the guides **386**, to a pulley **396**, FIGS. 19 and 23, mounted on the front crosshead **382**. The cable **390** is trained around the pulley **396** and extends rearwardly under the longitudinally-extending leg **352**, being anchored to such leg at **398**. In a similar but reversed manner, the cable **392** is anchored to the front edge **106** of the table **104** at **400**. From the anchor **400**, the cable **392** extends rearwardly, above the longitudinally-extending leg **352** of the T-square **350** and through the guides **386**, to a pulley **402** carried by the rear crosshead **388**. The cable **392** is trained around the pulley **402** and extends forwardly under the longitudinally-extending leg **352**, being anchored to such leg at **404**.

With the foregoing cable system, the longitudinal travel of the T-square **350**, and the backstop **126** connected thereto, is substantially twice the stroke of the backstop drive motor **374**. Thus, this construction further minimizes the over-all length of the paper cutter **100** by insuring that the backstop drive means **130** is received entirely within the normal working space present forwardly of the backstop when the backstop is in its forwardmost position. The cables **390** and **392** are so routed that the tensions therein act to bias the forward end of the T-square **350** upwardly. This maintains the vertical wheels **368** on their tracks **370** in opposition to the action of gravity on the front end of the T-square **350**, thereby maintaining the frontal plane of the backstop **126** parallel to the plane of cut.

Fence 132

The fence **132** is simply a wall which extends longitudinally along the left edge of the table **104** and projects above the upper surface of the table a distance somewhat greater than the maximum paper-lift height to be handled. As shown in FIG. 24 of the drawings, the fence **132** is secured to the left edge of the table **104** adjacent its rearward and forward ends by bolts **408** and **410**. These bolts extend through shims **412** and **414** of sufficient thickness to provide the required slot **360** for the connector plate **356** between the backstop **126** and the cross bar **354** of the T-square **350**.

Backstop programmer 134

As shown generally in FIGS. 1 and 3, the backstop programmer **134** comprises a longitudinally-extending capstan **420** mounted on the fence **132** laterally outwardly thereof and laterally opposite the left-hand end of the cross bar **354** of the T-square **350**. The capstan **420** includes a longitudinally-extending shaft **422**, best shown in FIG. 24, which is rotatable in suitable bearings **424** on the fence **132**. The shaft **422** extends forwardly to the front of the paper cutter **100** and may be rotated manually by a knob **426** thereon at the front of the machine. Alternatively, the shaft **422** may be rotated by a solenoid **428** located at the rear end of the fence **132** and connected to the shaft in a manner to rotate it in step-by-step fashion upon successive energizations of the solenoid. A suitable indexing means, not shown, releasably retains the shaft **422** in any one of a plurality of circumferentially spaced positions.

Rigidly mounted on the shaft **422** are longitudinally spaced collars **430** provided therein with circumferentially spaced, radial slots receiving circumferentially spaced program bars **432**. The indexing means mentioned is capable of presenting the outer edge of any one of the program bars **432** to the backstop control means **136** to be described hereinafter. The outer edge of each program bar **432** is provided with notches **434** which program the backstop **126** as required to make the desired cuts through the lift of paper.

The program bars **432** are retained in their radial slots in the collars **430** by inserting the ends of the program bars into cup-shaped retaining members **436** and **438** respectively mounted on the shaft **422** adjacent the front and rear ends of the fence **132**, as best shown in FIG. 24. The rear retaining member **438** is provided therein with radial slots **440** which are circumferentially offset slightly from the radial slots in the collars **430**, as will be clear from FIG. 25. The rear ends of the program bars **432** may be inserted in the circumferentially-offset slots **440** by twisting them slightly, whereupon they automatically position themselves in engagement with the skirt of the cup-shaped retaining member **438**. A Belleville washer **442** within the rear retaining member **438** and engaging the rear ends of the program bars **432** pushes the program bars forwardly against the retaining member **436**, which acts as a reference with respect to the plane of cut.

It will be understood that the program bars **432** are notched to provide different programs for the paper cutter **100**, i.e., to cause the backstop **126** to advance the lift of paper through different increments, depending upon requirements. The backstop program can be changed readily merely by rotating the capstan **420** to present the outer edge of a different program bar **432** to the backstop control means **136**. FIGS. 27 and 28 illustrate the positional relationship between the selected program bar **432** and the backstop control means **136**, the latter being described in the next section.

The program bars **432** may be notched in different ways to provide the desired backstop program. For example, they may be notched in advance at locations spaced predetermined distances from the forward, or reference, ends thereof, the spacings of the notches being determined by the desired spacings of the cuts to be made through lifts of paper. Alternatively, a particular program bar **432** may be notched by the paper cutter **100** itself during a manually-controlled initial run of a series. This can be accomplished by providing means, not shown, for positioning a blank program bar longitudinally of the table **104** in a location to have one edge thereof notched by a suitable notching punch, not shown, mounted on the backstop **126**, or its carrier **350**. Such a notching punch could be hydraulically actuated, particularly if mounted on the backstop carrier **350** below the table **104**.

Backstop control means 136

Referring to FIG. 28 of the drawings, the backstop control means **136** includes a backstop control valve **446** which is a cup-shaped, knife-edged valve engageable with a valve seat **448** to control the exhaust of hydraulic fluid from the backstop drive motor **374** during forward or advancing movement of the backstop **126**. The hydraulic fluid exhausted from the backstop drive motor **374** flows to the backstop control valve **446** through a line **450** and is returned to the reservoir **144** through a line **452**. The lines **450** and **452** are shown fragmentarily in FIG. 28, attention being directed to FIG. 29 for a complete, albeit schematic, showing of the connections to the backstop control valve **446**.

Continuing to refer to FIG. 28, the backstop control valve **446** is carried by and is movable relative to a valve block **454** to increase and decrease the spacing between the backstop control valve and its valve seat **448**. The valve block **454** abuts a support block **456** which provides the valve seat **448** and which is mounted on the left end of the cross bar **354** of the T-square **350**. A leaf spring **458** connected to the support block **456** and spanning the

valve block **454** supports a throttle arm **460** against which the end of the backstop control valve **446** remote from the valve seat **448** is seated. As will be apparent, the leaf spring **458** can flex to permit movement of the throttle arm **460** in directions to move the backstop control valve **446** toward and away from its seat **448**.

It will be noted that since the hydraulic fluid exhausted by the backstop drive motor **374** flows through the line **450** toward the backstop control valve **446**, the pressure of such fluid tends to unseat the backstop control valve in opposition to the action of the leaf spring **458** supporting the throttle arm **460**. The distance that the backstop control valve **446** can move off its seat **448** is adjustably controlled by a stop pin **462** engageable with a stop arm **464** suitably connected to the throttle arm **460**. Thus, the stop pin **462** serves as a means for limiting the extent to which the stop control valve **446** can move off its seat. Consequently, it serves as a means for limiting the rate of exhausting of hydraulic fluid from the backstop drive motor **374**, and thus the speed of advance of the backstop **126**.

Considering the manner in which the position of the stop pin **462** is adjusted, it is biased in a direction to permit maximum opening of the backstop control valve **446** by a spring **466**. Turning to FIG. 27, the stop pin **462** is mounted on one end of a lever **468** pivotally connected to the T-square cross bar **354** at **470**. The spring **466** tends to pivot the lever **468** in the counterclockwise direction to increase the degree of opening of the backstop control valve **446**, and thus the backstop speed. Pivoting of the lever **468** in the clockwise direction decreases the maximum opening of the backstop control valve **446**, and thus decreases the backstop speed. The latter effect is achieved by a control cable **472**, as will be described in the next paragraph.

One end of the control cable **472** is secured to the rear edge **110** of the table **104** by a securing means **474**. From this point, the cable **472** extends forwardly and is trained around pulleys **476** and **478** at opposite ends of the lever **468**, the pulley **476** being concentric with the stop pin **462**. From the pulley **478**, the control cable **472** extends forwardly to the front of the paper cutter **100**, as shown in FIGS. 26 and 27. Mounted on the front edge **106** of the table **104** is a reel **480** for a backstop-position-indicating tape **482** viewable through a magnifying lens **484**. The tape **482** extends rearwardly to and is connected at its rearward end to the left end of the T-square cross arm **354**, at **486**. The tape **482** is so graduated that, when viewed through the lens **484**, it indicates the distance from the frontal plane of the backstop **126** to the plane of cut of the knife **114**. The reel **480** is a spring reel which winds the tape **482** as the backstop **126** advances, and permits the tape to unwind as the backstop is returned to its rearmost position.

The reel **480** for the backstop-position-indicating tape **482** has a housing **488** which is pivotable about the axis of the reel and to which the forward end of the control cable **472** is connected, after passing over a pulley **490**. In FIGS. 26 and 27, the reel housing **488** is shown as having been pivoted in the clockwise direction into a position to locate the stop pin **462** for the backstop control valve **446** as shown in FIG. 28. Under these conditions, the backstop control valve **446** is seated to prevent the backstop drive motor **374** from advancing the backstop **126**. By pivoting the reel housing **488** in the counterclockwise direction, FIG. 26, the control cable **472** is relaxed to permit the spring **466** to move the stop pin **462** in a direction permitting unseating of the backstop control valve **446**. The speed of advance of the backstop **126** is limited to a value dependent upon the extent to which the reel housing **488** is pivoted in the counterclockwise direction from the position shown in FIG. 26.

Considering FIG. 28 of the drawings, the throttle arm **460** carries a solenoid **492** having an armature **494** which is movable toward and away from the backstop programmer **134** and which is biased away from the programmer by a spring **496**. Upon energization of the solenoid **492**, the armature **494** is displaced toward the backstop programmer **134** to displace a program-bar sensor **500** into engagement with the adjacent edge **502** of the particular program bar **432** selected by rotating the capstan **420** in the manner hereinbefore discussed. The sensor **500** is connected to the armature **494** by a rod **504** which extends through and is guided by the throttle arm **460** and which is threadedly connected to the armature **494** for adjustment purposes to insure proper engagement of the sensor with the program-bar edge **502** upon energization of the solenoid **492**.

Considering the operation of the backstop control means **136**, it will be assumed that the backstop drive motor **374** is energized in a direction to advance the backstop **126** so as to advance a lift of paper on the table **104** toward the plane of cut of the knife **114**. It will also be assumed that the solenoid **492** is energized to maintain the sensor **500** in engagement with the selected program-bar edge **502**. Thus, as the backstop **126** is advanced, the sensor **500** slides forwardly along the selected program-bar edge **502**.

As the lift of paper on the table **104** approaches the desired position relative to the plane of cut of the knife **114**, the sensor **500** encounters a corresponding notch **434** in the program-bar edge **502**, and is caused to enter such notch by the biasing force provided by the solenoid **492**. Entry of the sensor **500** into the notch **434** terminates the forward movement of the sensor, while the backstop carrier **350** continues to move forwardly. Such forward movement of the backstop carrier **350** relative to the sensor **500** causes the throttle arm **460** to displace the backstop control valve **446** toward, and ultimately into engagement with, its seat **448**. This cuts off the exhaust of hydraulic fluid from the backstop drive motor **374**, thereby terminating the forward movement of the backstop and the lift of paper. It will be noted that the exhaust of hydraulic fluid from the backstop drive motor **374** is cut off gradually so that the backstop **126**, and the lift of paper being advanced thereby, are decelerated gradually to avoid any overtravel of the lift of paper. The various parts of the backstop control means **136** are so positioned relative to each other, and relative to the notches **434** in the program bars **432**, that lifts of paper are stopped relative to the plane of cut of the knife **114** at precisely the points where transverse cuts are to be made.

During the return stroke of the backstop drive motor **374**, the solenoid **492** is de-energized. Consequently, the sensor **500** is disengaged from the backstop programmer **134** under such conditions. De-energization of the solenoid **492** also disengages the sensor **500** from the particular program-bar notch **434** in which it is disposed during forward movement of the backstop **126**, thereby permitting resumption of such forward movement into the next backstop position.

As previously indicated, FIG. 29 of the drawings illustrates the hydraulic system associated with the backstop drive motor **374** and illustrates the manner in which the backstop control valve **446** controls the exhaust from this motor. The hydraulic system for the backstop drive motor **374** includes a three-way solenoid valve **506** the position of which determines whether the backstop drive motor **374** is energized to produce advance or return movement of the backstop **126**, or is de-energized. It will be noted that the advance stroke is effected by applying bias pressure to the rod side of the piston **378** and exhaust pressure, as modified by the backstop control valve **446**, to the opposite side of this piston. The return stroke is effected by applying bias pressure to both sides of the piston **378** and utilizing the differential area resulting from the presence of the piston rod **380**.

It will be noted that the ends of the backstop drive cylinder **376** are interconnected by an orifice **508**. This

orifice compensates for any leakage past the backstop control valve **446** when it is held against its seat **448** by the sensor **500** in one of the program-bar notches **434**. More particularly, the orifice **508** represents a compensating leak greater than any anticipaetd leak past the backstop control valve **446**. Consequently, the backstop **126** cannot creep while it is being restrained by the sensor **500** in one of the program-bar notches **434**.

FIG. 30 illustrates an alternative hydraulic circuit for the backstop drive motor **374** in which the backstop control valve **446** meters hydraulic fluid at bias pressure to the motor, instead of metering the exhaust therefrom. It is thought that the operation of this modification will be clear from FIG. 30 so that a further description is not required.

Control of electrical components

The various electrical components of the paper cutter **100** which have been referred to herein may be energized in any suitable manner. For example, they can be controlled manually, although it is preferable that an automatic control system therefor be provided to achieve completely automatic operation of the paper cutter. However, since the manner in which the various electrical components are controlled forms no part of the prseent invention, it will not be considered further herein.

What is claimed is:

1. In a guillotine-type paper cutter, the combination of:
(a) a knife bar;
(b) a guillotine-type blade carried by said knife bar;
(c) knife-bar guide means for guiding the ends of said knife bar upwardly and downwardly along sloping parallel paths; and
(d) said knife-bar guide means resisting only downward forces acting on said knife bar and being incapable of resisting upward forces acting thereon.

2. In a guillotine-type paper cutter, the combination of:
(a) supporting means including a table for supporting a lift of paper to be cut;
(b) laterally sloping, parallel ramps carried by said supporting means at opposite sides of said table;
(c) a knife bar located above and extending laterally across said table and provided at its ends with ramp followers respectively engaging said ramps and movable upwardly and downwardly therealong to raise and lower said knife bar;
(d) said ramps being provided with arcuate valleys at their lower ends for decelerating said knife bar at the lower end of its travel;
(e) a guillotine-type blade carried by said knife bar; and
(f) knife-bar drive means for moving said knife bar upwardly and downwardly along said ramps.

3. In a guillotine-type paper cutter, the combination of:
(a) supporting means including a table for supporting a lift of paper to be cut;
(b) laterally sloping, parallel ramps carried by said supporting means at opposite sides of said table;
(c) a knife bar located above and extending laterally across said table and provided at its ends with ramp followers respectively engaging said ramps and movable upwardly and downwardly therealong to raise and lower said knife bar;
(d) a guillotine-type blade carried by said knife bar;
(e) knife-bar drive means carried by said supporting means below said table and connected to said knife bar for moving said knife bar upwardly and downwardly along said ramps;
(f) said knife-bar drive means including a fluid drive motor of the reciprocating type connected to said supporting means and to one end of said knife bar; and
(g) said knife-bar drive means including hold-down means connected to said supporting means and to the other end of said knife bar for holding the ramp follower at said other end of said knife bar on the corresponding ramp.

4. A paper cutter according to claim **3** wherein said fluid drive motor is substantially parallel to said ramps.

5. A paper cutter as defined in claim **3** wherein said hold-down means includes a fluid motor of the reciprocating type.

6. In a guillotine-type paper cutter, the combination of:
(a) supporting means including a table for supporting a lift of paper to be cut;
(b) laterally sloping, parallel ramps carried by said supporting means at opposite sides of said table;
(c) a knife bar located above and extending laterally across said table and provided at its ends with ramp followers respectively engaging said ramps and movable upwardly and downwardly therealong to raise and lower said knife bar;
(d) there being two of said ramps and two of said ramp followers at each side of said table in longitudinally spaced relation;
(e) the two ramps at each side of said table receiving the corresponding end of said knife bar therebetween and respectively providing gibs for restraining the corresponding end of said knife bar against movement longitudinally of said table;
(f) a guillotine-type blade carried by said knife bar; and
(g) knife-bar drive means carried by said supporting means below said table and connected to said knife bar for moving said knife bar upwardly and downwardly along said ramps.

7. In a guillotine-type paper cutter, the combination of:
(a) supporting means including a table for supporting a lift of paper to be cut;
(b) a knife bar located above and extending laterally across said table;
(c) a guillotine-type blade carried by said knife bar;
(d) knife-bar guide means interconnecting said knife bar and said supporting means for guiding said knife bar upwardly and downwardly along a laterally sloping path;
(e) hydraulic knife-bar drive means mounted on said supporting means below said table and connected to said knife bar for moving said knife bar upwardly and downwardly along said laterally sloping path; and
(f) said knife-bar drive means including a hydraulic motor of the reciprocating type substantially parallel to said laterally sloping path and directly connected to said knife bar, said motor being inclined at a slightly steeper angle than said path to hold said knife bar on said path.

8. In a guillotine-type paper cutter, the combination of:
(a) supporting means including a table for supporting a lift of paper to be cut;
(b) a knife bar located above and extending laterally across said table;
(c) knife-bar guide means for guiding said knife bar upwardly and downwardly relative to said table along a laterally sloping path;
(d) knife-bar drive means for moving said knife bar upwardly and downwardly along said laterally sloping path;
(e) a guillotine-type blade carried by said knife bar and having a laterally extending cutting edge;
(f) a laterally extending groove in said table below said blade to receive the cutting edge of said blade when said knife bar is in its lowermost position;
(g) a repairable cutting stick in said groove and penetrable by said cutting edge of said blade;
(h) said cutting stick being formed of a heat softenable smoothable material capable of being smoothed, upon the application of heat thereto, to repair said cutting stick; and
(i) heating means embedded in said cutting stick.

9. In a guillotine-type paper cutter, the combination of:
(a) supporting means including a table for supporting a lift of paper to be cut;
(b) a knife bar located above and extending laterally across said table;
(c) knife-bar guide means for guiding said knife bar upwardly and downwardly relative to said table;
(d) knife-bar drive means for moving said knife bar upwardly and downwardly; and
(e) a guillotine-type blade carried by said knife bar and engageable with the lift of paper and having back rake to provide back clearance between said blade and the plane of the cut through the lift of paper.

10. In a guillotine-type paper cutter, the combination of:
(a) supporting means including a table for supporting a lift of paper to be cut;
(b) a knife bar located above and extending laterally across said table;
(c) knife-bar guide means for guiding said knife bar upwardly and downwardly along a laterally sloping path;
(d) knife drive means for moving said knife bar upwardly and downwardly along said laterally sloping path;
(e) said knife bar having a downwardly-facing, inverted, V-shaped groove in its lower surface;
(f) a guillotine-type double-edged blade of diamond cross section seated in said groove with one of its cutting edges exposed;
(g) laterally spaced bolts interconnecting said knife bar and said blade and extending generally upwardly from said blade for seating said blade in said groove;
(h) the diameter of said bolts being small as compared to the cross sectional dimensions of said blade and the length of said bolts being large as compared thereto; and
(i) said bolts having a low spring rate which, coupled with their long length and small diameter, result in holding said blade in said groove in a positive manner even if cutting forces drive the blade further into said groove.

11. In combination:
(a) a knife bar having a downwardly-facing, inverted, V-shaped groove in its lower surface;
(b) a guillotine-type double-edged blade of diamond cross section seated in said groove with one of its cutting edges exposed;
(c) laterally spaced, generally upright bolts having heads at their upper ends seated against an upper surface of said knife bar and extending generally downwardly into and being threaded into said blade to seat said blade in said V-shaped groove;
(d) said knife bar having generally upright channels therein which receive said bolts; and
(e) whereby said blade may be removed from said V-shaped groove merely by loosening said bolts sufficiently to permit lateral withdrawal thereof from said channels.

12. The combination set forth in claim 11 wherein:
(a) the diameter of said bolts is small as compared to the cross sectional dimensions of said blade and the length of said bolts is large as compared thereto; and wherein
(b) said bolts have a low spring rate which, coupled with their long lengths and small diameter, result in holding said blade in said V-shaped groove in a positive manner even if cutting forces applied to said blade drive it farther into said groove.

13. In combination:
(a) supporting means provided with two laterally-spaced pairs of laterally sloping, parallel ramps;
(b) said ramps of each pair providing longitudinally spaced gibs in facing relation; and
(c) a laterally-extending member having ends respectively disposed between and engaging the gibs of the corresponding pairs and respectively provided with ramp followers engaging the ramps of the corresponding pairs.

14. In a guillotine-type paper cutter, the combination of:
(a) a knife bar;
(b) a guillotine-type blade carried by said knife bar;
(c) knife-bar guide means for guiding the ends of said knife bar upwardly and downwardly along sloping parallel paths; and
(d) said knife-bar guide means including means for guiding the ends of said knife bar upwardly as the ends of said knife bar reach the lower ends of said sloping paths.

15. In combination:
(a) laterally-spaced, laterally-sloping, parallel ramps;
(b) a laterally-extending member provided with laterally-spaced ramp followers respectively engaging said ramps;
(c) drive means connected to one end of said member for moving said member upwardly and downwardly along said ramps; and
(d) yieldable hold-down means connected to the other end of said member for yieldably maintaining the ramp follower at said other end of said member on the corresponding ramp.

16. In a guillotine-type paper cutter, the combination of:
(a) a laterally-extending hollow base;
(b) a table carried by said base;
(c) a knife bar located above and extending laterally across said table and positioned above said base;
(d) a guillotine-type knife carried by said knife bar and extending laterally across said table;
(e) a clamp bar above and extending laterally across said table adjacent and rearwardly of said knife bar;
(f) a mounting pin extending longitudinally through said base below said table;
(g) knife-bar guide means for guiding said knife bar upwardly and downwardly along a laterally sloping path;
(h) clamp-bar guide means for guiding said clamp bar upwardly and downwardly;
(i) a hydraulic knife-bar drive motor of the reciprocating type interconnecting said mounting pin and one end of said knife bar;
(j) a knife-bar hold-down means interconnecting said mounting pin the other end of said knife bar; and
(k) a hydraulic clamp-bar drive motor of the reciprocating type interconnecting said clamp bar and said mounting pin.

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