United States Patent

Colinet et al.

[15] **3,686,987**

[45] ***Aug. 29, 1972**

[54] **MACHINE FOR AND PROCESS OF DIECUTTING**

[72] Inventors: **Rene D. Colinet; William I. Bulmash,** both of Philadelphia, Pa.

[73] Assignee: **Industrial Research Laboratory, Inc.,** Philadelphia, Pa.

[*] Notice: The portion of the term of this patent subsequent to Nov. 9, 1987, has been disclaimed.

[22] Filed: **Oct. 19, 1970**

[21] Appl. No.: **81,853**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 855,905, Sept. 8, 1969, Pat. No. 3,618,437.

[52] **U.S. Cl.** **83/37,** 83/328

[51] **Int. Cl.** **B23b 29/00**

[58] **Field of Search**............83/37, 38, 321, 327, 328

[56] **References Cited**

UNITED STATES PATENTS

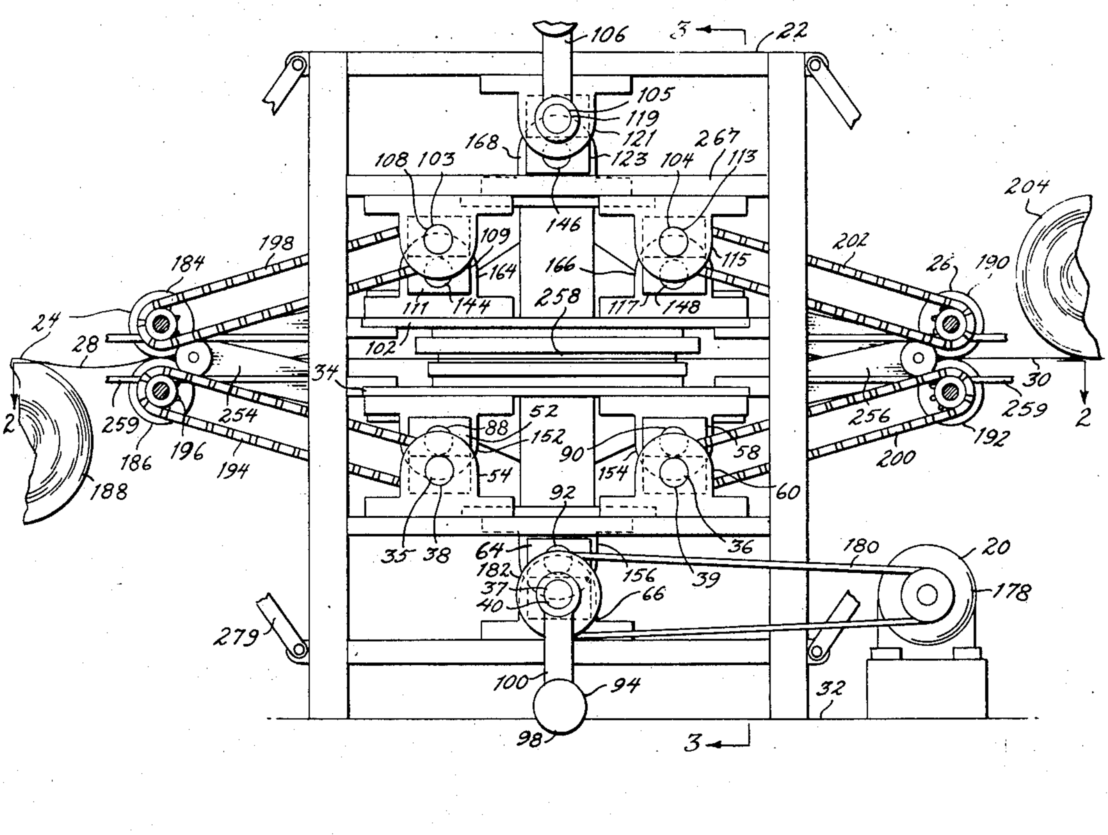
3,203,288	8/1965	Blumer	83/328 X
3,333,495	8/1967	Stuchberry	83/328 X
3,618,437	11/1971	Colinet	83/37

Primary Examiner—Andrew R. Juhasz
Assistant Examiner—David R. Melton
Attorney—Jackson, Jackson & Chovanes

[57] **ABSTRACT**

Die and backer, constantly facing each other, travel in cooperating paths which bring them closer to each other with sheet material sandwiched between, all traveling at the same speed in the same direction, and then together to effect a contour cut. The die may move in a circular path or a quasi elliptical path and the backer may move in a similar path to the die or may move in a linear path. The two sides of the backer may be somewhat relatively dephased to produce a rocking component of motion and a rocking cut. Specific preferred structure includes shafts in sets of three and transmission of motion from below the sheet material to above it by pairs of lever arms attached to rollers in roller guides.

23 Claims, 18 Drawing Figures



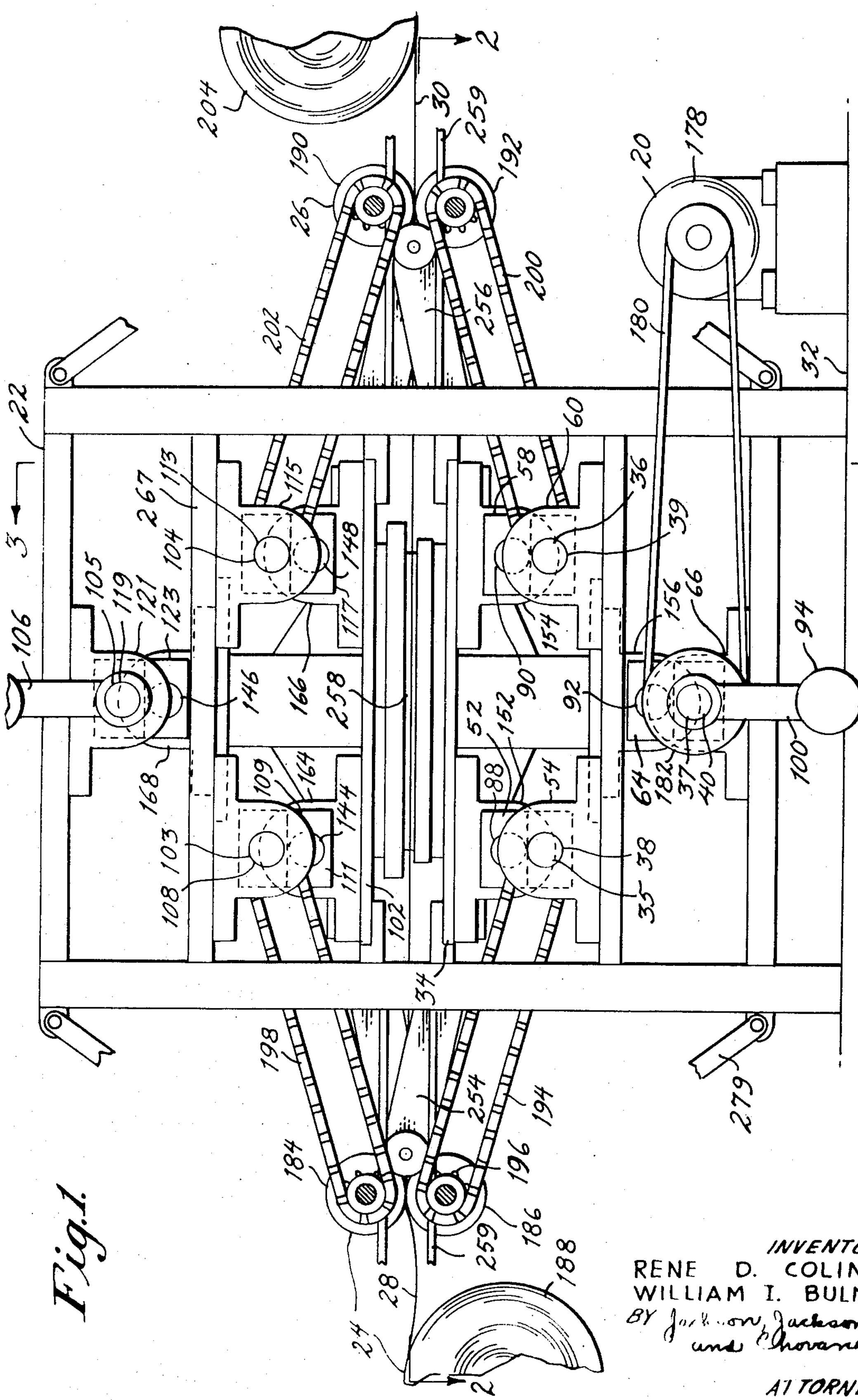
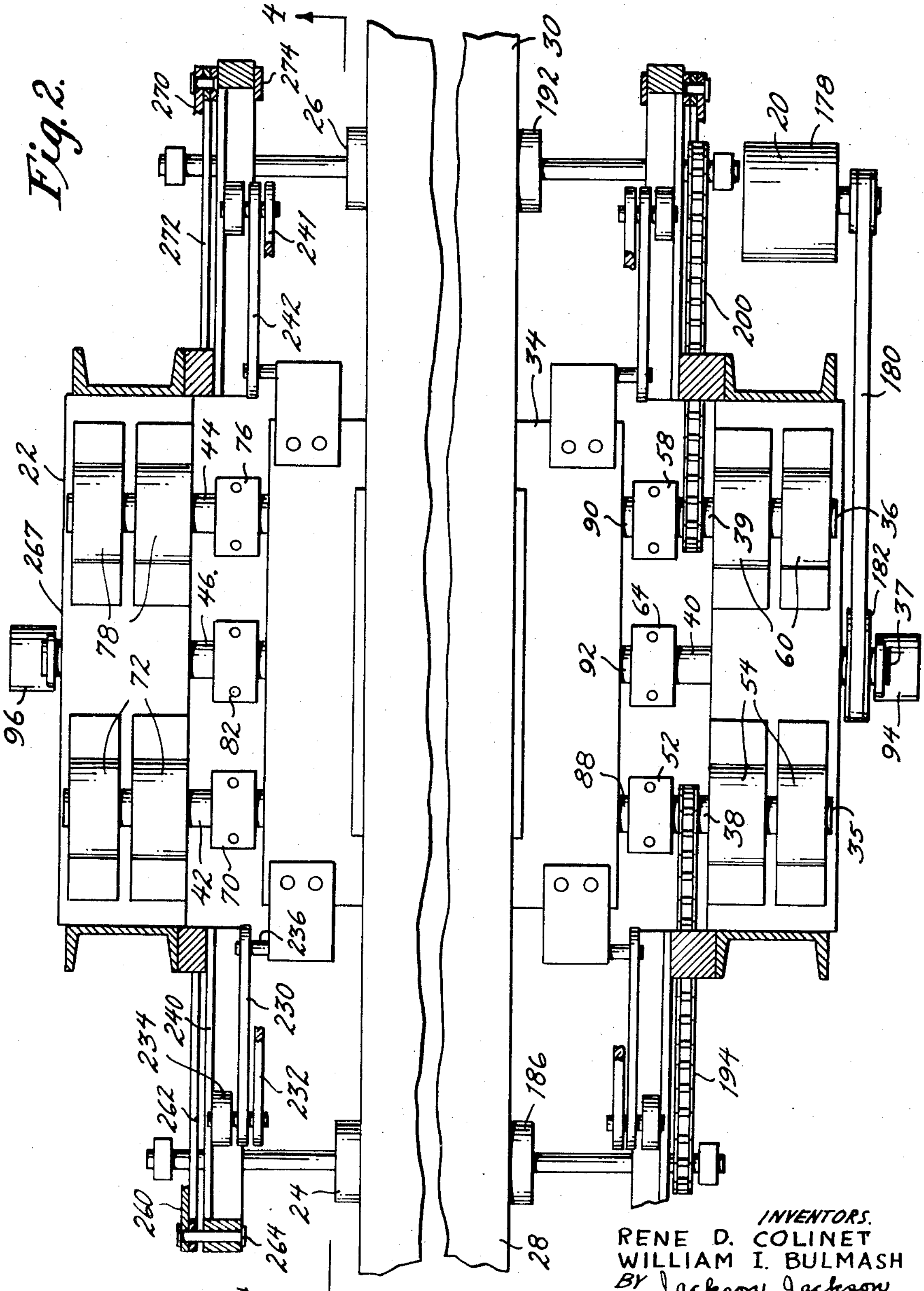


Fig.1

INVENTORS.
RENE D. COLINET
WILLIAM I. BULMASH
BY Jackson, Jackson and Chovanes
ATTORNEYS.

Fig. 2.



INVENTORS.
RENE D. COLINET
WILLIAM I. BULMASH
BY Jackson, Jackson and Chovanes
ATTORNEYS.

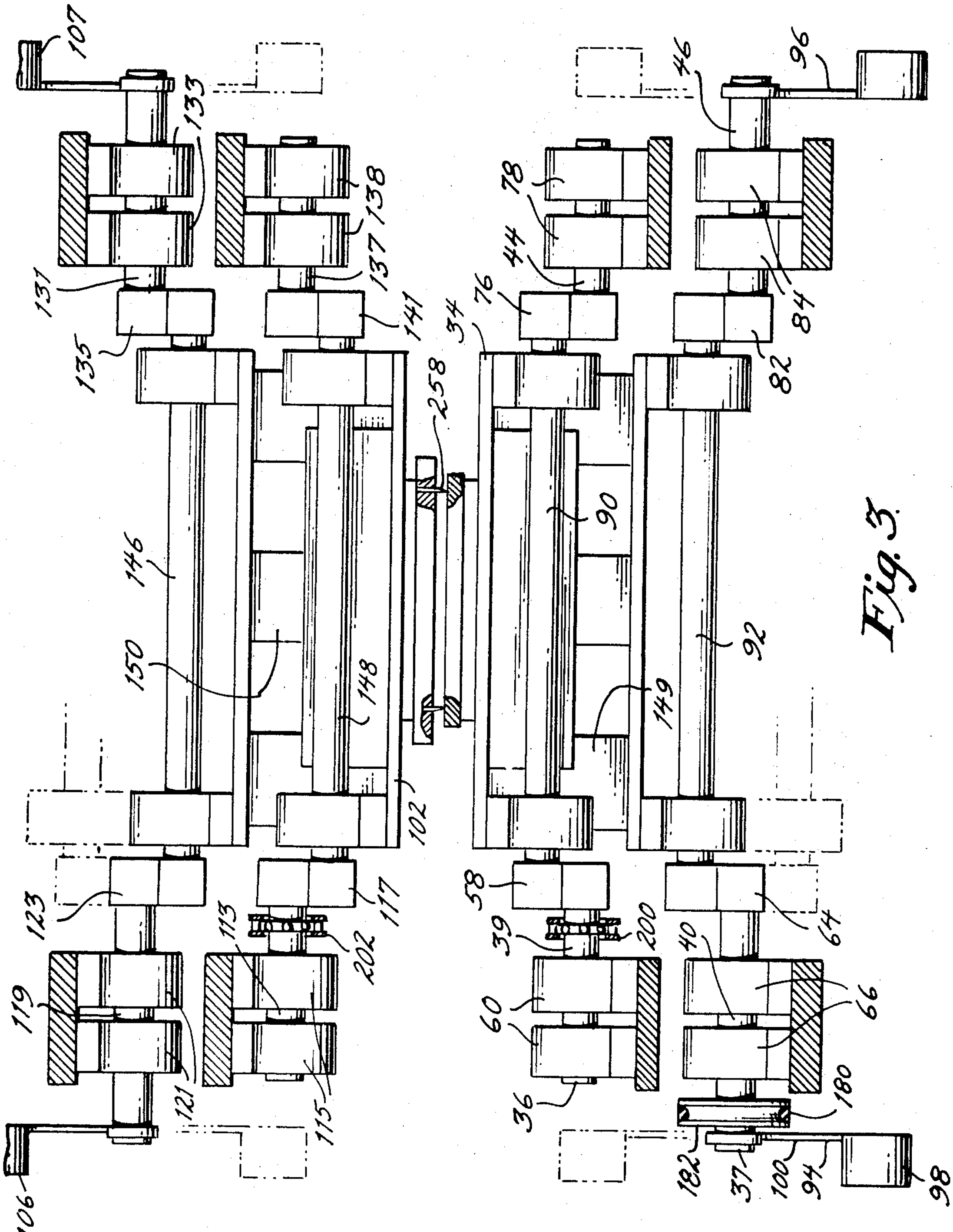


Fig. 3

INVENTORS.
RENE D. COLINET
WILLIAM I. BULMASH
BY Jackson, Jackson and Chovanes
ATTORNEYS.

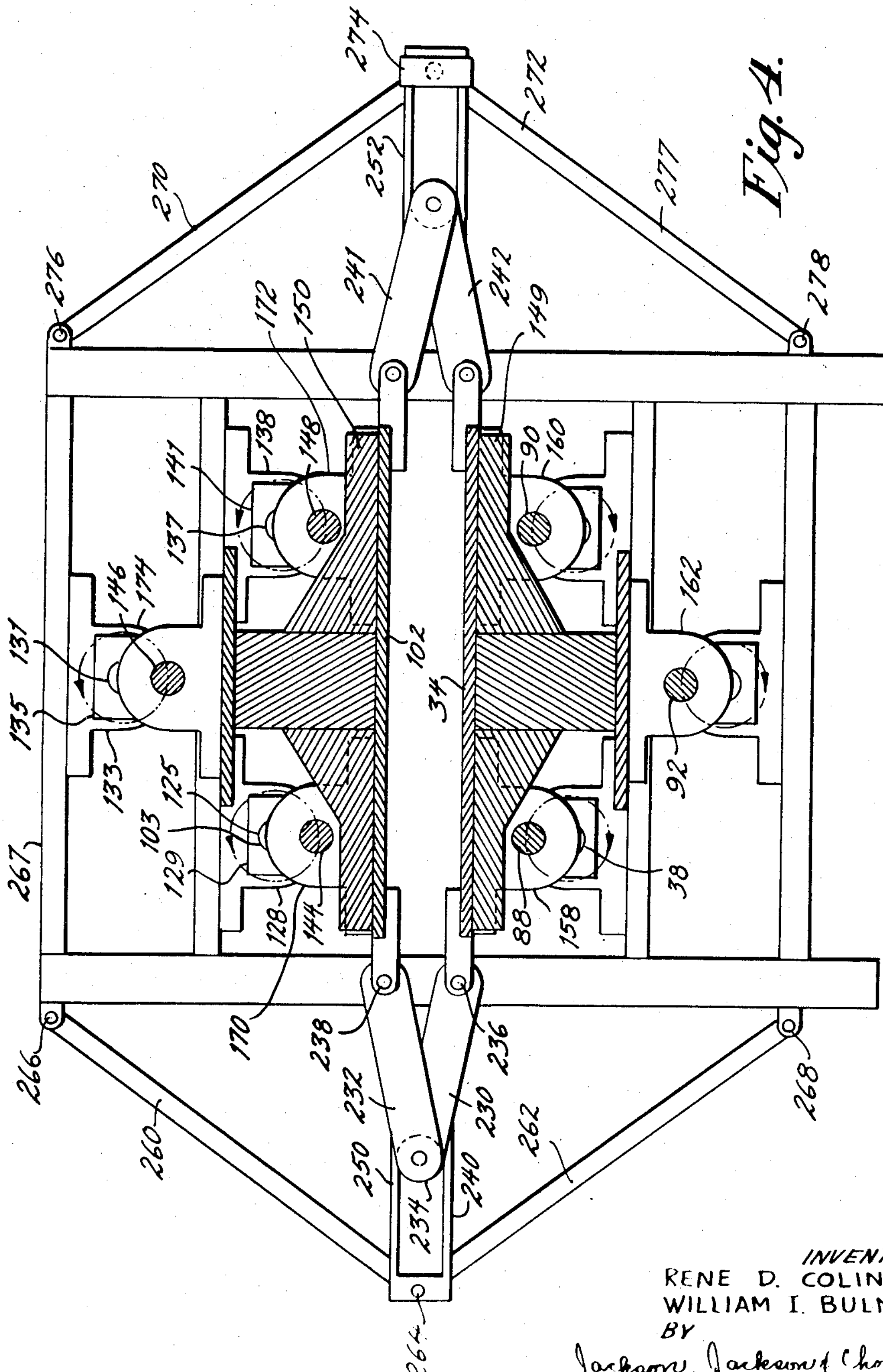


Fig. 4.

INVENTORS.
RENE D. COLINET
WILLIAM I. BULMASH
BY
Jackson, Jackson & Chovanes
ATTORNEYS

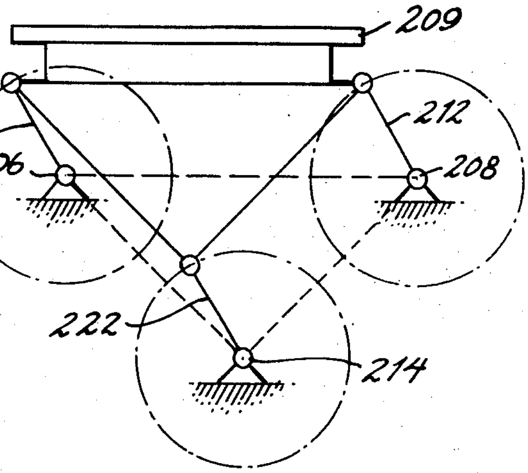


Fig. 5.

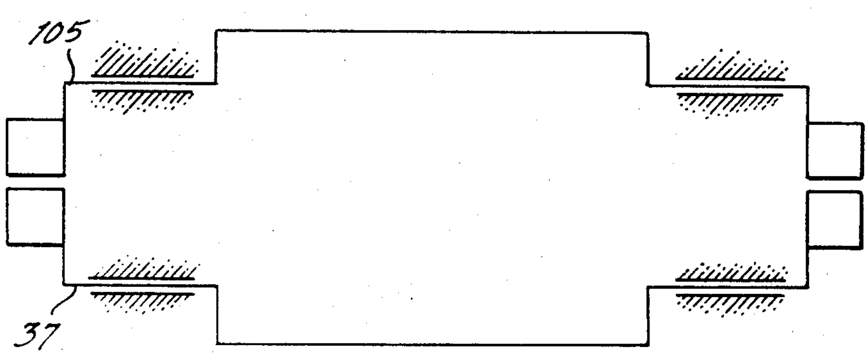


Fig. 6.

INVENTORS.
RENE D. COLINET
WILLIAM I. BULMASH
BY Jackson, Jackson and Chovanes
ATTORNEYS.

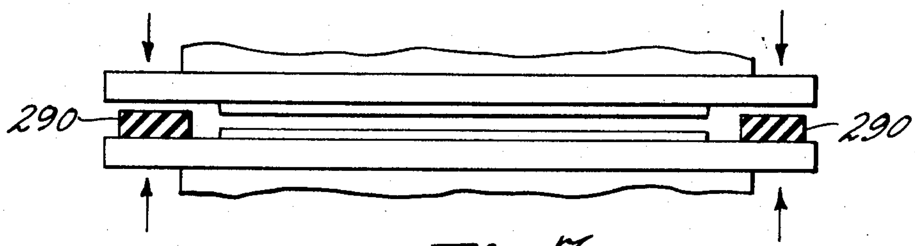


Fig. 7.

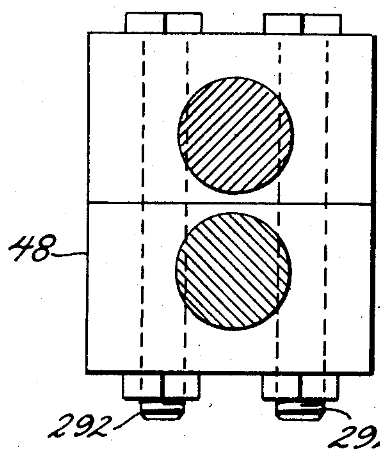


Fig. 8.

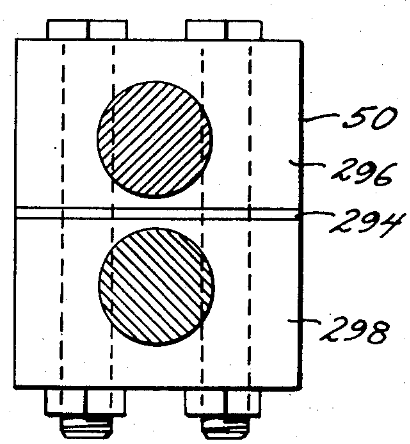


Fig. 9.

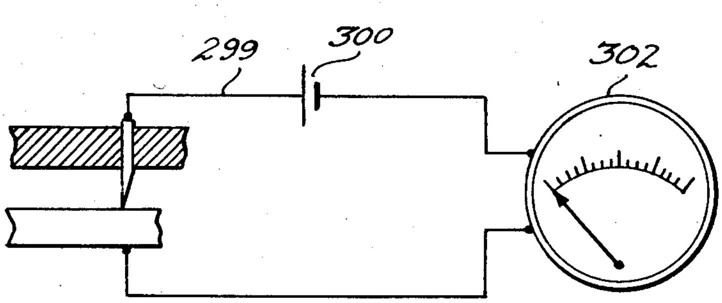


Fig. 10.

INVENTORS.
RENE D. COLINET
WILLIAM I. BULMASH
BY Jackson, Jackson and Chovanes
ATTORNEYS.

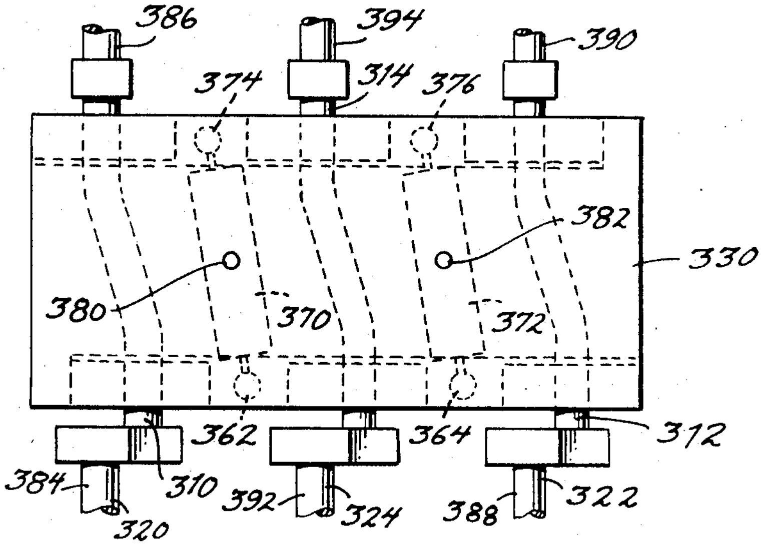


Fig. 12.

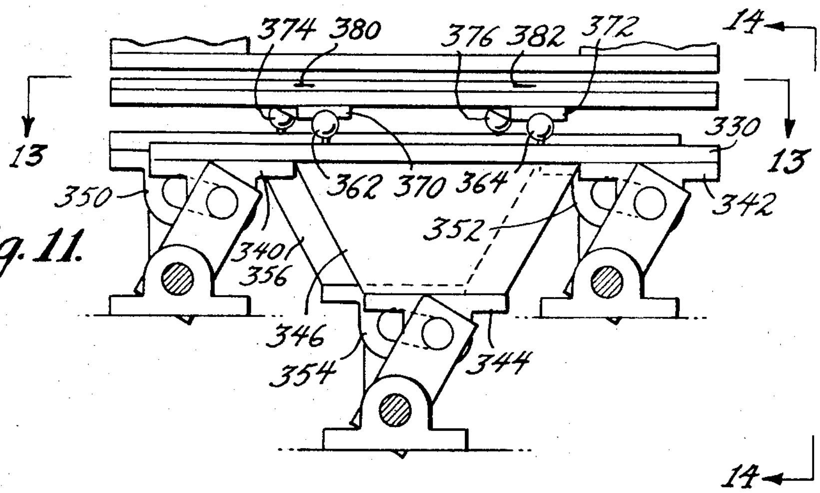
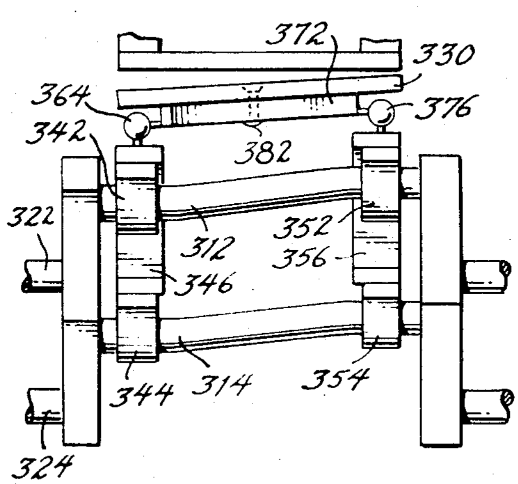


Fig. 11.

Fig. 13.



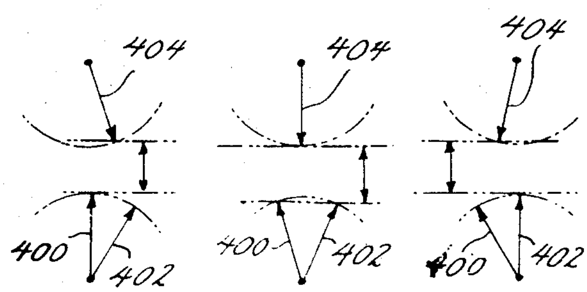


Fig. 14.

INVENTORS.
RENE D. COLINET
WILLIAM I. BULMASH
BY Jackson, Jackson and Chovanes
ATTORNEYS.

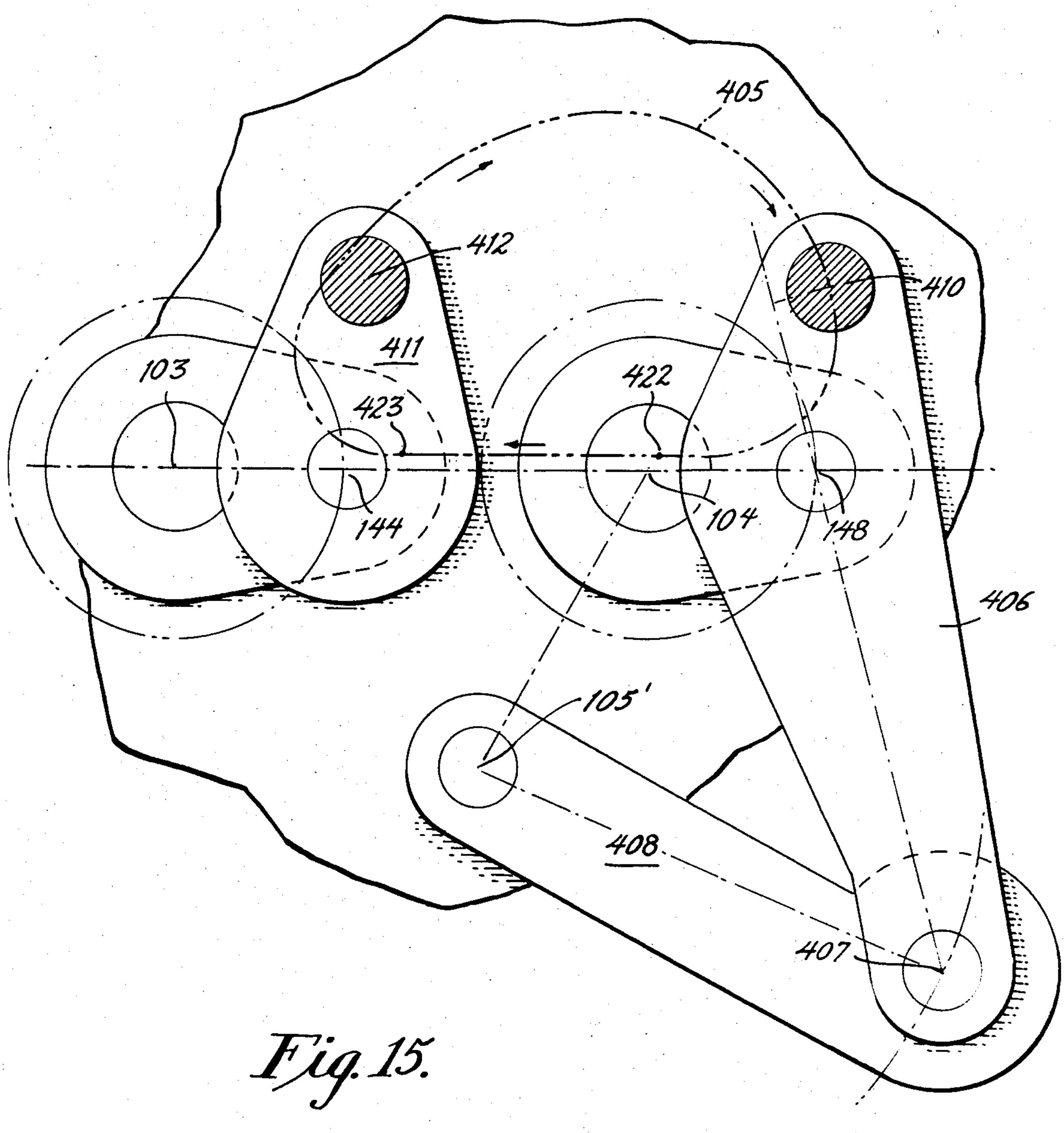


Fig. 15.

INVENTORS.
RENE D. COLINET
WILLIAM I. BULMASH
BY
Jackson, Jackson and Chovanes
ATTORNEYS.

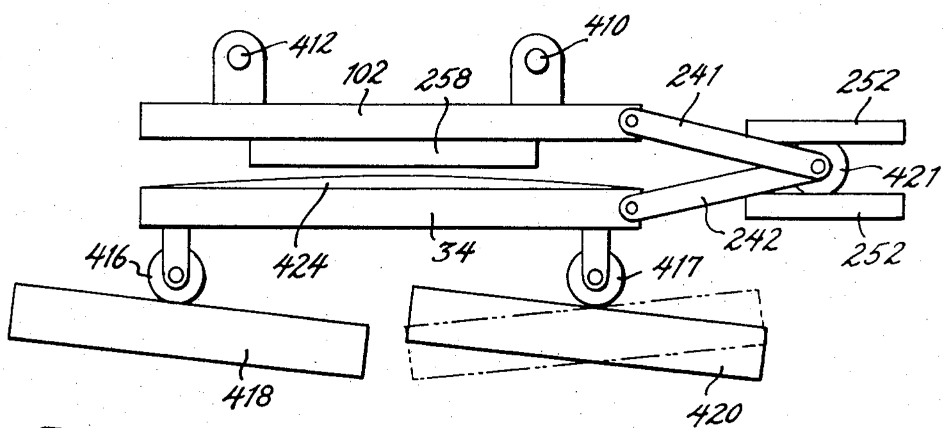


Fig. 16.

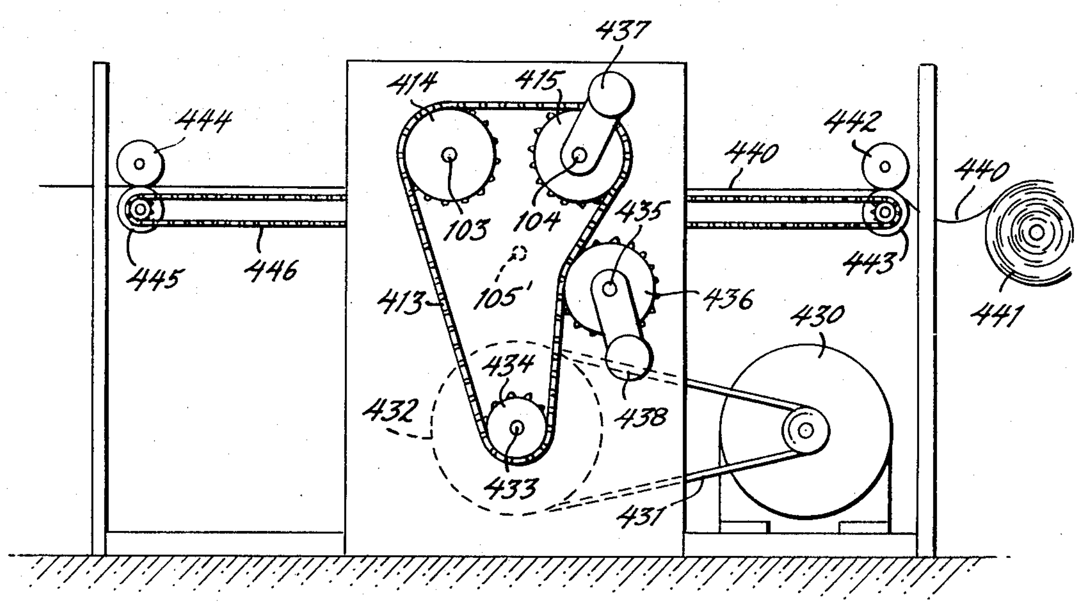


Fig. 17.

INVENTORS.
RENE D. COLINET
WILLIAM I. BULMASH
BY Jackson, Jackson and Chovanes
ATTORNEYS.

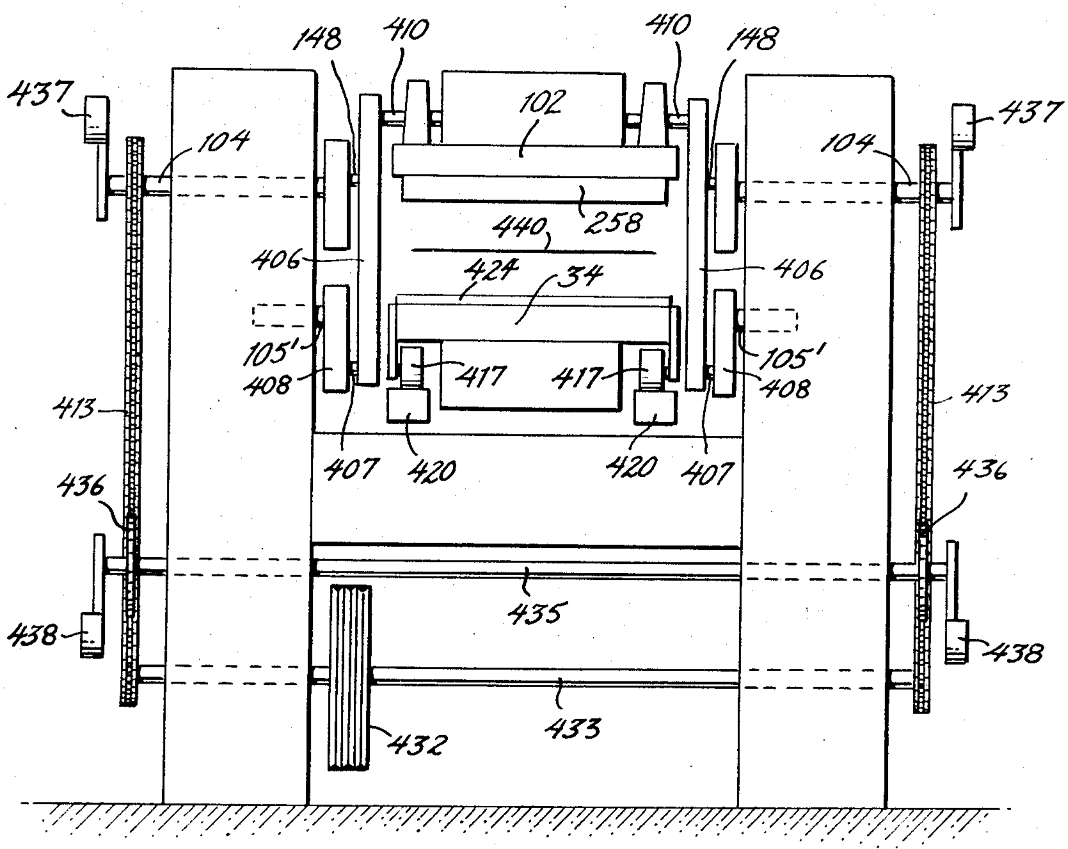


Fig. 18.

INVENTORS.
RENE D. COLINET
WILLIAM I. BULMASH
BY Jackson, Jackson and Chovanes
ATTORNEYS.

MACHINE FOR AND PROCESS OF DIECUTTING

This application is a continuation-in-part of our earlier application, Ser. No. 855,905, filed Sept. 8, 1969, now Pat. No. 3,618,437, for MACHINE FOR AND PROCESS OF DIE-CUTTING.

SUMMARY OF THE INVENTION

This invention relates to machines and processes for cutting of work by means of dies.

The work may for example be some paper-type material in sheet form, especially paper or cardboard.

Present commercial paper die-cutting presses, insofar as we are aware of them, belong to two classes:

1. Reciprocating-motion platen presses, operating in the speed range of 100 to 200 strokes per minute.

2. Purely rotary presses, operating in the speed range of 500 to 1,200 revolutions per minute.

The greater productivity of the rotary presses is due to constant speed of the moving parts, paper included, which are free from acceleration and deceleration inertia effects but this advantage is offset by the high cost of the cylindrical matrices used on the rotary presses with which we are familiar. Such a curved die must be of individual design for the particular occasion, not reusable for a different pattern. The curvature is double and complex, since the contour of the paper cutting must be wrapped around a perfect cylinder. On the contrary the flat dies used with plane platens in the reciprocating machines cost very little because they are made of straight steel cutting rules simply bent sideways to the desired contour of the cut. This curvature is maintained by holding the bent steel strip by a plywood support. The price ratio of a rotary rule edged die compared to a flat die is approximately 100 to 1. Let us now consider rotary presses using flat dies.

Rotary die-cutting presses in which the die platen is supported and moved by two crankshafts or by a similar motion of two shafts are shown by Conner U. S. Pat. No. 2,407,353; Bruker U. S. Pat. No. 2,262,919; Conner U. S. Pat. No. 2,394,534; Grupe U.S. Pat. No. 2,192,707; Haskin et al U. S. Pat. No. 3,296,910; Elineau U.S. Pat. No. 3,269,245; Kramer U. S. Pat. No. 3,121,361; Bates U. S. Pat. No. 2,202,889; Talbot U. S. Pat. No. 1,973,515 and Conner U. S. Pat. No. 2,406,808.

A purpose of the present invention is to provide a particular press useful for such things as die cutting of paper-type products, which press is an improvement over both of the above two particular commercial forms as known to us.

A purpose of the present invention is to combine the advantage of high productivity of the rotary presses with the low cost of the flat rule dies of the reciprocating presses.

A purpose is to do this by a machine which also has:

a. Complete and correct balancing of all moving parts;

b. Silent operation due to the elimination of all toothed gears, which also wear, as a result of friction between the teeth;

c. Absence of the clearances between the teeth such as are normal in the absence of anti back-lash devices.

The proposed invention replaces the gears by rigid linkages having tight-fitting pivots such as pre-stressed ball or roller bearings or similar articulated means.

A purpose of the present invention is to cut material well with a minimum of expense and effort. This purpose is something that can be especially well accomplished in the case where sheet material is being cut, and/or where the cut is a contour type of cut.

Further purposes will be apparent from the remainder of the specification, and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings we have chosen to illustrate certain only of the particular embodiments in which the invention may appear, the forms shown being chosen from the standpoints of convenience of illustration, satisfactory operation and clear demonstration of the principles involved.

FIG. **1** is a side elevational view of a first embodiment of my invention. The view is somewhat fragmentary, with all, or a large part of, the supply and receiving rolls for the sheet material and the adjustment lever arms omitted.

FIG. **2** is a fragmentary horizontal sectional view, looking downward, along the line **2-2** on FIG. **1**, thus constituting mostly in effect a plan view of the lower half of this embodiment of the machine.

FIG. **3** is a somewhat fragmentary cross sectional view along the lines **3—3** on FIG. **1**, with the platens broken away to better show the die.

FIG. **4** is a cross sectional view along the line **4—4** on FIG. **2**.

FIG. **5** is a diagrammatic view to show the operation of one of the platens in this embodiment. FIG. **6** is a diagrammatic view applicable to ether of the above embodiments, to show balancing of the device.

FIG. **7** is a fragmentary side elevational view applicable to all the embodiments herein shown, showing the buffer cushions, but with the die omitted.

FIGS. **8** and **9** are detail views, applicable to all the embodiments herein shown, showing a typical crank arm in elevation, with associated trunnion and pin in section, illustrating the provision for adjustment of its length.

FIG. **8** shows it in its shortest form, without any spacer.

FIG. **9** shows it in an exemplary lengthened form with a particular spacer.

FIG. **10** is a diagrammatic view of an optional feature applicable to all embodiments, namely, a sensing means to determine contact and pressure between die and backer.

FIG. **11** is a fragmentary side elevational view of a third embodiment involving a variation using side-rolling motion.

FIG. **12** is a fragmentary horizontal section, looking downward, along line **12—12** on FIG. **11**.

FIG. **13** is a fragmentary elevational view from line **13—13** on FIG. **11**.

FIG. **14** is a diagrammatic view illustrating the action in this third embodiment.

FIGS. **15** to **18** show an embodiment of the invention in which the die platen moves in a quasi elliptical path.

FIG. **15** is a diagrammatic section in the position of FIGS. **1** or **4**, showing one linkage which produces the semi elliptical motion of the die platen. This linkage is reproduced on both sides of the machine.

FIG. 16 is a diagrammatic section in the position of FIG. 4 showing the interconnections between the die platen and the backer platen, and the rollers and wedges by which the backer platen is operated.

FIG. 17 is a diagrammatic end elevation in the position of FIG. 1 showing the drives for the shafts and the arrangement of the sheet material which is to be cut.

FIG. 18 is a diagrammatic end elevation, partly in section in the position of FIG. 3 showing the duplication of the linkage on the two sides of the machine, and the drive of both parts of the device.

DESCRIPTION OF PARTICULAR EMBODIMENTS AND THE LIKE

Describing in illustration but not in limitation and referring to the drawings:

The press of the invention in its simplest form is shown in FIGS. 1 to 5, together with other figures applicable to maintain one embodiment, as for example, FIG. 6. This press is used for cutting paper and other sheet material which is relatively thin and easy to cut.

This includes driving means **20**, central portion **22**, which is mainly concerned with the die-cutting, supplying end portion **24** and receiving end portion **26**, which in this example are respectively supplying a sheet of paper **28** and receiving what remains of it after the desired cut out has taken place, herein designated as **30**.

The whole machine can, of course, be mounted on some suitable foundation, herein diagrammatically indicated at **32**.

In the central portion **22**, a lower horizontal backing platen **34** translates in a circular path while remaining always perfectly horizontal in the case of the first embodiment, for example. More generally, the platen moves with every one of its particles following an identical trajectory along an endless curve. Geometrically speaking, the platen is a solid body moving by pure translation in a plane, without any angular motion with respect to fixed axes of reference.

The circular motion is obtained from three identical crankshaft setups **35, 36** and **37**. Each crankshaft setup would normally include at least one crank arm, at least one trunnion running in suitable bearings, and at least one pin.

More specifically, we preferably have trunnions **38, 39** and **40** on one side of the machine, together with three other identical trunnions **42, 44** and **46** on opposite side of the machine, each of which respectively has its axis in prolongation of a corresponding different one of the three first-mentioned trunnions **38, 39** and **40**. All the trunnions rotate an equal speed and each corresponding pair of trunnions forming part of the one crankshaft setup is constantly parallel to all the other trunnions.

The rotation is obtained from driving means **20** as explained hereafter, using no gears.

Preferably the crank arms when at their shortest length take the form exhibited by typical crank arm **48** in FIG. **8**, while if adjusted to a longer position their form is that of crank arm **50** in FIG. **9**.

In any case, crank arm **52** is on trunnion **38**, which rides in the pair of bearings **54**. Likewise, crank arm **58** is on trunnion **39**, which rides in bearing pair **60** and crank arm **64** is on trunnion **40**, which rides in bearing pair **66**.

Similarly, on the other side, crank arm **70** is on trunnion **42**, which rides in bearing pair **72**. Also, crank arm **76** is on trunnion **44**, which rides in bearing pair **78**, and crank arm **82** is on trunnion **46** which rides in bearing pair **84**.

Pin **88** interconnects crank arms **52** and **70** on corresponding-axis trunnions **38** and **42**, pin **90** interconnects crank arms **58** and **76** on corresponding-axis trunnions **39** and **44**, and pin **92** interconnects crank arms **64** and **82** on corresponding-axis trunnions **40** and **46**, all together to form crankshaft setups **35, 36** and **37** respectively. The above pins in this embodiment are all straight pins whose axes are parallel to the axes of the two shafts, and thus the respective crank arms which are connected together rotate in unison in this embodiment.

Counterweight devices **94** and **96** are located on corresponding-axis trunnions **40** and **46**, respectively, and may each take the form of a weight adjustably positioned on an arm or arms mounted on the trunnion to turn with the trunnion as in the case of counterweight **94** whose weight **98** and arm **100** are to be seen in FIG. **1**. As will be seen there, the arm for the counterweight extends radially outwardly from the trunnion in a direction opposite to that of the crank arm.

There is also an upper horizontal die-platen **102**, with three crankshaft setups, **103, 104** and **105**, and two counterweight devices **106** and **107**, all of which operate as already mentioned for the backer platen and related items, except that the crankshafts rotate in the reversed direction.

More specifically, on one side of the machine, trunnion **108** running in bearing pair **109** has crank arm **111**, trunnion **113** running in bearing pair **115** has crank arm **117**, and trunnion **119** running in bearing pair **121** has crank arm **123** and counterweight device **106**.

Likewise, on the other side, trunnion **125** running in bearing pair **128** has crank arm **129**, trunnion **137** running in bearing pair **138** has crank arm **141**, and trunnion **131** running in bearing pair **133** has crank arm **135** and counterweight device **107**.

Pin **144** interconnects crank arms **111** and **129** on corresponding-axis trunnions **108** and **125**, pin **148** interconnects crank arms **117** and **141** on corresponding-axis trunnions **113** and **137**,and pin **146** interconnects crank arms **123** and **135** on corresponding-axis trunnions **119** and **131**, all together to form the three crankshaft setups **103, 104** and **105**, respectively.

The structure **149** interrelating the lower crankshaft setups and the backer platen **34**, and the structure **150** interrelating the upper crankshaft setups and the die platen **102** can preferably be opposite counterparts from a vertical standpoint in this embodiment.

Thus, a structure **149** supports backer platen **34**. It is in turn supported on pins **88, 90** and **92**, by means of the structure's bearings **152, 154** and **156** in which the respective pins rotate on one side, and the structure's bearings **158, 160** and **162**, in which the respective pins rotate on the other side.

So likewise, structure **150** supports die platen **102** and is itself supported on pins **144, 148** and **146** by means of the structure's bearings for rotation of the respective pins, bearings **164, 166** and **168** being on one side and bearings **170, 172** and **174** on the other.

A single driving means **20** consists of a variable speed electric motor **178**, a belt **180** and a pulley **182** mounted on one only of the various crankshaft setups mentioned, and more specifically, in the particular example shown, on trunnion **40** in crankshaft setup **37**.

One pair of paper feeding rolls **184** and **186**, having outside diameters equal to those of the six crankshafts, rotate in opposite directions in conjunction with the crankshafts and at the same speed. These rolls do not normally pull the paper band from the coil on the pay-off reel, or in other words supply roll **188**, but retain it from going too fast under the pull of a second pair of rolls **190** and **192** which are slightly oversized or over-speeding. The two pairs of rolls **184**, **186** and **190**, **192** are driven synchronously with the crankshafts.

Specifically, in the example shown, chain **194** driven by sprockets (not shown) on trunnion **38** drives roll **186** by means of sprockets **196**, and a similar chain-and-sprocket setup **198** drives roll **184** from trunnion **108**. Similarly, roll **192** is driven from trunnion **39** by chain-and-sprocket setup **200**, and roll **190** is driven from trunnion **113** by chain-and-sprocket setup **202**.

The reel (not shown) on which supply roll **188** is mounted is externally driven, by known means, preferably maintaining a free loop of paper strip **28**. As a result of this setup the paper strip moves at constant speed through the machine, with known corrective devices to keep the strip well-centered.

The paper speed equals exactly the horizontal speeds of both platens **34** and **102** but only during the short distance when the die and the backer have perforately engaged into the paper thickness for the cutting operation. After the die has separated from the backer and the paper, the die and the backer speeds reduce in their horizontal components, then reverse to come back for the next cut. During that revolution of the crankshafts, the paper strip keeps on going provided that the dies have closed contours and do not destroy the continuity of the strip, to be wound as waste as part of receiving roll **204** on a standard reel (not shown) or to be chopped in small pieces of waste.

For each revolution of all shafts, the paper must move by the length of the die plus a short length of paper waste separating consecutive cut products. It is therefore necessary to increase or to reduce the speed of the rolls during the period when the die is not in contact with the backer, to such an extent as to satisfy the above requirement.

The basic mechanism to translate the platen, applying equally well in principle to both the mechanism translating backer platen **34** and that translating die support **102**, is shown diagrammatically in FIG. **5**. It consists primarily in two identical crankshafts **206** and **208**, connected by their crankpins to the platen **209**, and by their trunnions to the stationary base **32** in the case of the mechanism translating the backer platen, and by their trunnions to structure **267** in the case of the mechanism translating the die support. The crankshafts act as an articulated parallelogram. This arrangement is unstable when the cranks **210** and **212** line up with the platen, at which time the cranks may cease from being parallel. The preferred means to retain the parallelism is to install a third crankshaft **214** out of line with the crankshafts **206** and **208**. The "-dead-center" instability is then fully removed.

The triple crankshaft system assures greater rigidity and precision in the motion of the platens, because pre-stressed ball or roller bearings have no clearances, which is not the case for three gears in tandem. In fact, the system is hyperstatic or over-linked in all but the "-dead-center" positions where the cranks **210** and **212**, or **210** and **222** line up in pairs.

The following conditions are required to build satisfactory platen suspension:

1. the **3** cranks must be identical in radii dimension. In a preferred form of execution, the radius is adjustable up to one inch in range to permit wide changes in the distance from one cut to the next on the paper strip.

2. assuming the stationary ball bearings are all mounted rigid on the base and one swinging ball bearing is bolted tight on the platen, then a second swinging ball bearing may be bolted tight on the platen but only when in its dead center position (lined up with the first swinging crank).

3. similarly, the third swinging ball bearing may be bolted tight to the platen but only when the first and third cranks line up in "dead-center" position. The adjustments are now complete because the second and third ball bearings are automatically lining up in their "dead-center" position.

Mathematical precision in the cranks' radii is not practically possible, but this is not necessary because minute errors (say up to 0.005 inch) are absorbed by small elastic deformation without harm.

FIG. **4**, especially, shows how the platens **34** and **102** (the die support) are interrelated to obtain mutual pressure by toggle-joint action, when all cranks are vertical. The linkages used for this purpose, in accordance with the invention, consist in two equal short levers **230** and **232** joined pivotally with a roller **234**, while the opposite ends pivot at **236** for platen **34** and **238** for platen **102**. As long as roller **234** is guided by a horizontal double track **240** (this roller may be double, if desired), located at mid-level between the pivots **103** and **38**, the angles between each lever, **230** and **232**, and the horizontal are equal and therefore the alignment **236–238** remains vertical as it should be. Only one of the platens **34** and **102** need to be moved by the drive means **20**. The other, undriven, platen will then move by a push and pull effect of the levers **230** and **232**. In this particular example, backer platen **34** receives its drive thru the crankshaft setup **37** from drive means **20** and it is die support **102** that is in turn driven from platen **34** thru the levers, etc.

However, an instability appears by the "dead-center" effect when lever **230** or **232** lines up with the theoretical crank of the travel of pivot **236** or **238**. For this reason, a second linkage **241–242**, similar to the first, is provided at the other end of the platens **34** and **102**. It is evident that their respective "dead-center" positions never occur simultaneously.

The arrangement above discussed, with the two lever arm setups, or in other words motion-transmission sets, **250** and **252**, therein described, is really enough for the transmission of the motion. However, as a practical matter, in addition to the two lever arm setups, therein described, both of which are at one and the same side of the sheet material, there will preferably be two other similar lever setups, **254** and **256** involving double track **259**, in similar locations on the other side of the sheet material, making a grand total of four of these motion-transmission sets. (FIG. 1)

Mounted on die-platen **102** is die **258**, which extends downward from that die platen and is preferably a flat type of contour die, with the die edge all in the one plane that moves with the die platen.

Since the track **240** must remain at mid-distance of pivots **236** and **238** at all times, any adjustment up or down of the die platen **102** should be repeated equally in opposite direction for the backing platen **34** if the track **240** is stationary. This would impose a burdensome task on the operator. To remedy it, provision is made for the track **240**, and in fact also the double track **259** on the other side of the device, to be adjusted automatically when one platen is moved and the other platen is not. New Levers **260** and **262** are added, joined pivotally to one end **264** of the track **240** while the opposite ends of these levers pivot at **266** for the upper structure **267** (not the moving platen **102**) and at **268** for the lower structure (not the moving platen **34**). Two other levers **270** and **272** are linked pivotally to a bracket **274** which slides on track **240**, while the other ends of the levers pivot at **276** and **278** to the upper and lower structures. The track **240** is correctly centered by the above adjustment setup **277**, even when one structure is tilted with respect to the other for any reason.

A similar adjustment setup **279** on the other side keeps double track **259** likewise centered. The entire upper structure **267** rests on the levers of these adjustment setups and is capable of moving up and down as required by their adjustment.

As shown in FIG. **7** is is desirable to cushion the approach of the die to the backer in what is called a "-kissing" contact. The pressure between the sharp edge of the die and the hard platen should be about 200 lbs. per linear inch of edge, but without severe impact. In the press of the invention, this approach is tangential for both trajectories, culminating when the cranks line up vertically in toggle-joint fashion. However, the large centrifugal forces resulting from high speed rotations tend to extend the radii of the cranks. A contact correctly adjusted on an idle machine would therefore be too tight when the machine would have reached high speed. One method to avoid die breakage would be to start with an open gap and then to reduce the gap gradually at high speed, until the proper contact is obtained. A safety may be provided by attaching several springs or preferably rubber cushions **290** to one of the platens. These cushions would be compressed between the platens just before the die contact, and freed just after it. During the cushion compression, the extension of the cranks would be nullified by a change into compression of the cranks, making the machine less sensitive to die damage.

Balancing the press in accordance with the invention is easy and complete by observing the following instructions (FIG. **6**):

a. Ignore any stationary parts and all revolving components having the center of gravity of each cross section located upon the axis of rotation.
b. Parts which rotate eccentrically are arranged symmetrically with respect to the center of the shaft length.
c. Multiply the weight (lbs.) of each eccentrically-moving part by the distance (inches) of its center of gravity to its center of rotation to obtain the torque (inchpounds). Totalize these products for the two structures.
d. Subtract the torque of fur counterweight levers.
e. Divide the difference by the distance selected for the counterweight lever (from the center of the steel cylinder selected for the counterweight to the center of rotation), to obtain the total weight of the four counterweights. Install one counterweight on each end of crankshafts **37** and **105**. Due to their complex motion, the levers of the motion-transmission sets must be handled separately.

Their combined weight should be added to the platens for horizontal inertia but all their other motions cancel each other. No counterweight at all would be needed for vertical balancing since the upper and lower platens move with equal amplitude simultaneously and in opposite directions. However, such is not the case in the horizontal motions. The horizontal resultant inertia force is central to both structures and the same is true for all four counterweights. The resultants are therefore lined together and the accelerations are completely cancelled. The speed of the machine will not be limited by any vibrations but rather by the ability of individual components to resist the various centrifugal forces.

As already mentioned the crank radii are preferably changeable to vary the distance between the consecutive cuts in the paper. FIG. **8** and **9** show for example a crank having a minimum radius of 1½ inches and a maximum radius of 2½ inches. The change is easily accomplished in releasing the bolts **292**, inserting a spacer **294** between the blocks **296** and **298** and installing new, longer bolts. The feed rolls must be modified also, either by replacing them with larger rolls, or by changing the speed ratio of their transmissions.

FIG. **10** illustrates a method for measuring and adjusting the pressure of the die upon the backer while the machine is in operation. In this method, the backer platen is insulated from the rest of the machine and connected to a circuit **299** comprising a low voltage dry battery **300** and a milliammeter **302**. The instrument will detect current passage as soon as the sharp edge of the die touches the backer platen. The current will increase as the pressure gets heavier, even though such pressure cannot be directly estimated while the machine is in operation.

FIGS. **11** thru **14** illustrate a variation in the design of the press, applicable particularly to hard papers or plastics, to thick cardboards, corrugated cartons, etc., which require large forces to produce the cut. In the design described so far, the entire contour of the die produces the cut in one single and instantaneous vertical pressure. In the variation, a side-rolling motion is superimposed and cutting proceeds from one side that is parallel to the paper motion, continues toward the center and is completed by the opposite side. This action is obtained very simply by tilting one crank against the other, in the plane of rotation of the crank, a few degrees in each of at least 3 crankshafts of the upper or lower platen. During the rotation of the cranks, the cranks on one side reach the vertical position first. A few degrees later, the cranks of the other side would reach the vertical position after the platen has rolled like a ship in water. There is no loss of production nor speed, but a great advantage is reduced loading on the machine, due to progressive instead of instantaneous cutting. The crank dephasing could be as great as thirty degrees. All ball bearings should be of the self-aligning type.

FIGS. **11** thru **14** illustrate the mechanism just described. The three crankshafts **35, 36** and **37** of FIG. **1** have been slightly modified by advancing one crank with respect to the other in each crankshaft. This is done by having the pins no longer straight but offset, with their ends parallel to the trunnions of the crankshaft. The offset pins are shown at **310, 312** and **314**, forming part of variant crankshaft setups **320, 322** and **324**.

In FIG. **1**, the platen **34** was bolted to the pillow-blocks of the crank pins but in FIGS. **11** thru **14**, the corresponding platen **330** is no longer connected directly to the pillow-blocks. Instead, on one side the three pillow-blocks **340, 342** and **344** are rigidly related to a triangle frame **346** while on the other side the three pillow-blocks **350, 352** and **354** are rigidly connected to a second triangular frame **356**. The frame **346** is connected pivotally by ball joints **362** and **364** to the two flat bars **370** and **372**. Similarly, the opposite ends of the bars are pivotally connected to the frame **356** by ball joints **374** and **376**.

Finally, the platen **330** rests upon the two flat bars **370** and **372** and is pivotally connected to them by two pins **380** and **382** in the middle of the bars **370** and **372**. The three crankshaft setups **320, 322** and **342** rotate around their respective trunnions which are **384** and **386** for **320**, **388** and **390** for **322** and **392** and **394** for **324**. The three pillow-blocks **340, 342** and **344** translate together in circular trajectory and likewise for the three pillow-blocks **350, 352** and **354**, but one set is dephased circularly to the other. The two flat bars **370** and **372** have identical wobbling motions. The platen **330** has a complex motion which is a rocking or oscillatory motion around the axis **380–382** superimposed on a translation as in FIG. **1** along a circular trajectory.

FIG. **14** shows diagrammatically the interrelation between a given corresponding set of crank arms above and below the work during the cutting operation in this embodiment.

Crank arms **400** and **402** represent the two crank arms forming part of a given crankshaft setup below the work and crank arm **404** represents both crank arms in a given such setup above the work. The leftmost part of the figure shows crank arm **400** in a vertical upward position, with crank arm **402** somewhat behind in phase, and crank arm **404** at an intermediate phase relative to its vertical downward position. In the middle part of the Figure crank arm **404** has reached its vertical downward position, while crank arms **400** and **402** are on opposite sides of their vertical upward positions. In the rightmost part of the figure crankarm **402** has reached its vertical upward position, while crank arm **400** is beyond its vertical position and crank arm **404** intermediately so.

It will be seen from this that the vertical spacing between the respective crankpin ends remains nearly constant during the rocking motion, so that the die never loses contact with the backer platen **34** during the cutting operation.

NON-CIRCULAR MOTION

An improvement of the invention, which is believed to be the preferred embodiment, manipulates the die platen through a quasi elliptical path which has a straight portion, and brings the backer platen in a cooperating path. The die platen is manipulated by a four bar linkage driven by a crank and connected to a rod guided by a rocker lever, the crank and rocker both being pivoted on stationary centers.

Instead of a single point of contact between the two platens, or the tools located thereon, such as is obtained between two circles tangent to each other, the new trajectory for at least one of the platens (or both if desired) comprises a straight portion which provides a longer contact (10 to 20 percent of the cycle) as well as a smooth landing of one platen upon the other. The initial contact is obtained with no appreciable pressure of the die upon the material to be cut, and therefore no noise. Immediately after this contact, the two trajectories are no longer tangential, but they cross each other at a slight angle (1° to 3°) creating an interference which tends to force one platen into the other and, consequently, the die into the material. This second phase of the approach is also a silent one. Thus the cooperative motion between the die platen and the backer platen provides a first contact between one end of the die platen and the material at the beginning of the straight motion of the die platen, later changing gradually to a contact traveling across the surface of the die as the latter moves along its straight run, and finally becoming a last contact between the opposite end of the die and the material at the termination of the straight motion of the die platen.

The preferred cycle may be divided as follows:

1. A gradual approach to contact at a final angle of 0°, which occupies about 10 percent of the total cycle duration.
2. A light contact followed by continuing pressure which occupies about 20 percent of the cycle.
3. Separation of the platens and return which occupies about 70 percent of the cycle.

Since the actual cutting operation is no longer instantaneous as it was when the platens were moving in circular trajectory, it becomes possible to divide the cutting time into a plurality of short cuts spread end-to-end all over the length of the die, one after the other. Pressure between the platens is considerably reduced as compared to what would be required for a single full cut, and the operation becomes similar to a cut obtained with shears or scissors, gradual rather than sudden, soft rather than hard. The strain on all the parts of the machine is much reduced as a consequence, as will be described more in detail below.

In the form of FIG. **15**, which shows the mechanism for moving the upper platen or die platen, the trajectory **405** is elliptical with a straight portion at the bottom, obtained by modifying Curve No. 282 of "Analysis of the Four Bar Linkage" by Hrones & Nelson (Copyright 1951 Massachusetts Institute of Technology) modified by changing the tracing point to coordinates −5¼ and 2½. Crankshafts are provided at **103** and **104** mounting identical cranks thereon which move crankpins **144** and **148** through circular paths. The third fixed shaft in this machine, **105'**, is no longer a crankshaft as in the form of FIG. **1**.

It will be understood that shafts **103**, **104** and **105'** provide fixed pivots. The crank on shaft **104** is the main crank rotating clockwise at constant speed. It carries a rod **406** guided in pivot **407** by an arm **408** extends between a fixed pivot on shaft **105'** and the pivot **407**. A pivot **410** at the opposite end of rod **406** supports one end of the die platen and the pivot shaft **410** desirably extends from one side to the other of the die platen, where there is another mechanism similar to that shown. The die platen is supported at the opposite end by an arm **411** equal to the distance between pivots **148** and **410** which pivots on the crankpin of crank **103** and which pivotally connects by pivot **412** to the die platen, the pivot **412** desirably going through the die platen and turning on similar mechanism at the other end. The die platen is therefore held horizontal at all times by the linkage, pivots **410** and **412** suspending the die platen. The crankshafts **104** and **103** revolve synchronously by a common chain drive shown at **413** in FIG. **17** and driving a sprocket **414** on crankshaft **103** and a sprocket **415** on crankshaft **104**.

Assuming in a particular example that the tracing point coordinates are −5¼ and 2½ in FIG. **15**, the dimensions on the same basis may be as follows: distance from axis **104** to axis **148** is equal to 5; distance from axis **104** to axis **105'** is equal to 10; distance from axis **105'** to axis **407** is equal to 15; distance from axis **407** to axis **148** is equal to 15. Various construction lines are put on FIG. **15** to aid in determining these distances.

The backer platen **34** shows in FIG. **16** is supported by four caster wheels **416** and **417**, it being understood that each is duplicated at the opposite side of the machine. These roll on four straight tracks **418** and **420** which are slightly tilted upward to the left to increase pressure between the die platen **102** and the material while both platens move from right to left. The movement of the platens is synchronous and the die platen is driven by rollers **421** joined by levers **241** and **242** to the respective platens and moving on horizontal straight tracks **252** as already described. It will be understood that the rollers **421** and the levers **241** and **242** and the tracks **252** will be repeated at the other side of the platens in the preferred form.

While the tracks **418** and **420** will preferably be inclined in the same direction, it is possible to reverse the inclination of the track **420** to replace the simultaneous contact of die **258** by the following succession of contacts:

1. At the initial contact between the die and the material being cut, when pivot shaft **410** reaches the position **422** in FIG. **15**, the roll **417** of the backer platen **34** is higher than the roll **416**, and cutting is limited to the right side of the die **258**.

2. As both platens move to the left roller **417** goes down while roller **416** goes up, thereby tilting the backer platen toward horizontality, at which time the cut extends toward the left and center of the die **258**.

3. Near the end of the platen's straight motion when pivot **410** reaches the point **423** of FIG. **15**, the roll **417** is fully down and the roll **416** is fully up, tilting the backer platen **34** to maximum inclination and cutting material at the left of the die **258**.

As explained previously, this succession of cutting operations reduces the total pressure on the platens and the strain on the machine.

This advantage is further developed by inserting between the die **258** and the backer platen **34** a solid curved wedge **424** about 0.040 inch thick at the center and thinning down to nothing at each end.

When the tracks **418** and **420** are inclined in opposite directions, the linkage shown in FIG. **16** no longer keeps the platens perfectly facing one another, and this is corrected for by tilting the tracks **252** slightly in the direction to correct the linkage.

Referring to FIGS. **17** and **18** endless roller chains **413** drive the cranks, from an electric motor **430** driving a belt **431** to a fly-wheel **432** on a shaft **433** which carries sprockets **434** meshing with the chains. The shafts **104** and **435**, which have sprockets **436** meshing with the chain, carry arms and counterweights **437** and **438** to balance the platen and their levers horizontally and vertically.

The material **440** is supplied from a coil **441** which is pulled by the platens from right to left and also assures rotation of rubber rolls **442** and **443** to drive rolls **444** and **445** at the output side by sprocket and chain **446**. These left rolls pull the waste material out of the machine while the cut products fall off during the return stroke of the platens toward the right.

FIG. **18** shows the platens occupying the center of the machine frame while the drives are twins front and back.

While the above description of our device has been specific to a machine in which the work is a single sheet coming from a single roll, it is possible also to feed multiple sheets from multiple rolls, or in packed form, into a position where they will be passing through together between the upper and lower part of the machine and to cut the multiple sheet in the one single cut by die against backer platen. In such a case, the die will be active as a cutter in a greater portion of its motion, part of which will therefore have a slower horizontal component of the velocity. As a result, a free loop will tend to form in the sheet material between the feeding rolls and the cutting portion of the machine while the cutting is going on, which free loop will tend to disappear after the cutting part of the cycle is over for that particular cycle, until a new cutting portion begins.

It will be evident that when cutting of materials in sheet form is mentioned, this includes cutting of multiple sheets as well as a mere single sheet.

The machine of our invention is intended generally for use on paper-type material, by which is meant paper, cardboard and other forms of material made from paper pulp, and can also be used on metal foil or plastic having comparable cutting characteristics.

In view of our invention and disclosure, variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art to obtain all or part of the benefits of our invention without copying the process and apparatus shown, and we, therefore, claim all such insofar as they fall within the reasonable spirit and scope of the claims.

Having thus described our invention what we claim as new and desire to secure by Letters Patent are:

1. A rotary die-cutting press for materials in sheet form, operating by pure translation of a die platen and cooperation of a backer platen, comprising a die platen, two parallel crankshafts having identical cranks, turning in unison, means supporting the die platen from the cranks, a third shaft out of the line

between the two crankshafts, means for operatively connecting said third shaft to the die platen to stabilize its motion, a backer platen and means for operatively manipulating the backer platen in cooperation with the die platen.

2. A rotary die-cutting press of claim 1, in combination with means for moving the die platen in a non-circular path.

3. A rotary die-cutting press of claim 2, in combination with means for moving the die platen in a quasi elliptical path having a straight portion.

4. A rotary die-cutting press of claim 3, in combination with means for moving the die platen and the backer platen to impinge by a first contact between one end of the die platen and the material at the beginning of the straight motion of the die platen, later changing it gradually to a contact traveling across the surface of the die as the latter moves along its straight run, and finally becoming a last contact between the opposite end of the die and the material to be cut at the termination of the straight motion of the die platen.

5. A rotary die-cutting press of claim 1, in which, the motion of the die platen is accomplished by a four bar linkage connected to a rod and guided by a rocker arm.

6. A rotary die-cutting press of claim 1, comprising a rod pivoted on the crankpin of one of the cranks intermediate between the ends of the rod and having a pivot at one of its ends which pivotally supports one end of the die platen, an arm pivoted on a fixed pivot on the third shaft on one end and pivotally connected at the other end to the other end of said rod and a rod pivoted on the crank of the other crankshaft and supporting the other end of the die platen.

7. A rotary die-cutting press of claim 1, in combination with rollers supporting the ends of the backer platen and tracks guiding the rollers and the backer platen as it comes together with the die platen.

8. A rotary die-cutting press of claim 7, in combination with rollers at each end of the platens, horizontal tracks supporting the rollers and levers connecting each roller to an end of the backer platen and an end of the die platen.

9. A rotary die-cutting press of claim 7, in which the tracks are sloped in the same direction.

10. A rotary-die cutting press of claim 7, in which the tracks are sloped in opposite directions.

11. A rotary die-cutting press of claim 1, in combination with means including a surface on the backer platen which is high at the middle and lower at each end to produce a rocking contact at the time of cut.

12. A rotary die-cutting press of claim 1, in which the means supporting the die platen from the crankshafts constitutes bearings for the cranks, the third shaft is a crankshaft having a crank equal to the other cranks, and the means for connecting the third shaft to the die platen is a crank bearing.

13. A rotary die-cutting press of claim 1, in which all particles of the die platen go through a circular trajectory at a constant peripheral speed.

14. A rotary die-cutting press of claim 1, in which the die platen and the backer platen are synchronized by two pairs of identical levers pivotally connected each to one end of a platen, connected together to the other end by pairs, and in which rollers guide the other ends of the levers in motion parallel to the platen.

15. A rotary die-cutting press of claim 1, in which the die platen and the backer platen have a rocking motion from end to end as they come together.

16. A rotary die-cutting press of claim 1, in which the cranks are out of phase with respect to one another, said dephasing being fixed and not exceeding 30°.

17. A rotary die-cutting press of claim 1, including means for keeping the cutting edge of the die and the backer in planes that keep more or less parallel to each other but have a relative rocking motion between the planes, which rocking motion goes from side to side as the work travels and causes one side of the die and backer platen to go through their cutting travel at least slightly in advance of the cutting travel of the other side of the die and backer platen.

18. A rotary die-cutting press of claim 1, having a set of cranks at both sides of the die platen, and having crankpins connecting the cranks together and to the die platen, in which the crankpins are straight.

19. A rotary die-cutting press of claim 1, having cranks at opposite sides of the die platen and pins connecting the cranks together and to the die platen in which the pins are curved and impart a rocking motion to the die platen.

20. A rotary die-cutting press of claim 1, in which the means for manipulating the backer platen comprises two parallel crankshafts, cranks supporting the backer platen and a third crank located outside the straight alignment of the first two cranks, and connected to the backer platen, all three cranks being identical.

21. A rotary die-cutting press of claim 1, comprising a resilient cushion between the platens engaging one another to reverse the stresses in the drive mechanism before and after contact has been obtained brtween the die and the backer platens.

22. A rotary die-cutting press of claim 1, having balancing of the moving parts to reduce vibration.

23. A rotary die-cutting press of claim 1, in combination with means for measuring the variation in electrical resistance between the die platen and its associated tools and the backer platen as a function of pressure when the cut takes place.

* * * * *

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,686,987 Dated August 29, 1972

Inventor(s) Rene D. Colinet and William I. Bulmash

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 57, change "The" to - This - .
Column 6, line 7, after "222" ', insert -or 212 and 222 - .
Column 7, line 33, "is" first occurrence, should be - it - .
Column 8, line 4, "fur" should be - four - .
Column 8, line 29, "the" second occurrence, should be - two - .
Column 9, line 32, change "342" to - 324 - .
Column 11, line 4, insert - which - after "408".
Column 11, line 31, change "shows" to - shown - .
Column 14, line 21, insert - as - after "motion".

Signed and sealed this 3rd day of April 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents