

Jan. 11, 1966

G. CAGEN

3,228,274

SIZE REDUCTION OF SHEET MATERIAL

Filed Aug. 17, 1962

3 Sheets-Sheet 1

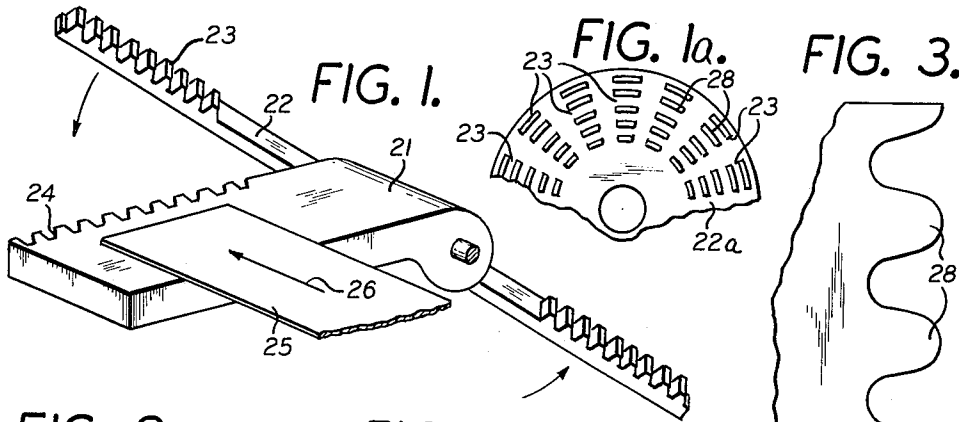


FIG. 2.

FIG. 2a.

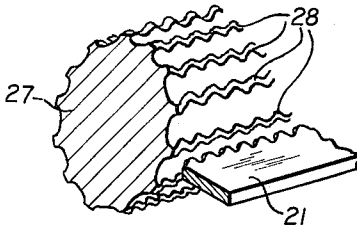
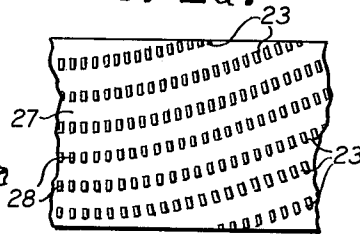


FIG. 4.

FIG. 5.

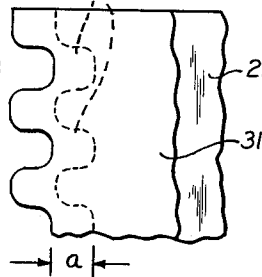


FIG. 6.

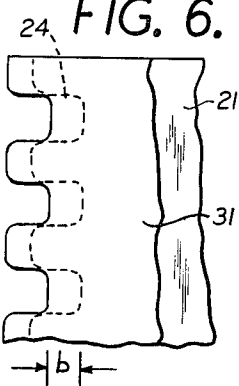
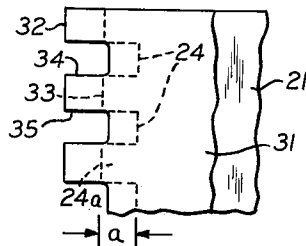


FIG. 7.

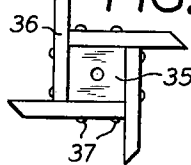


FIG. 9.

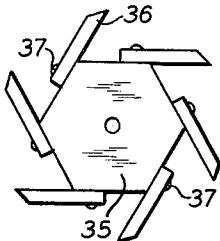


FIG. 10.

FIG. 8.

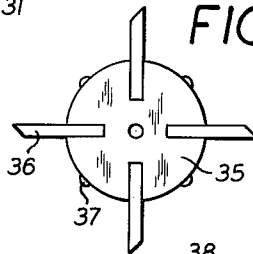
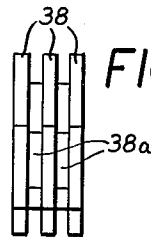


FIG. 11.



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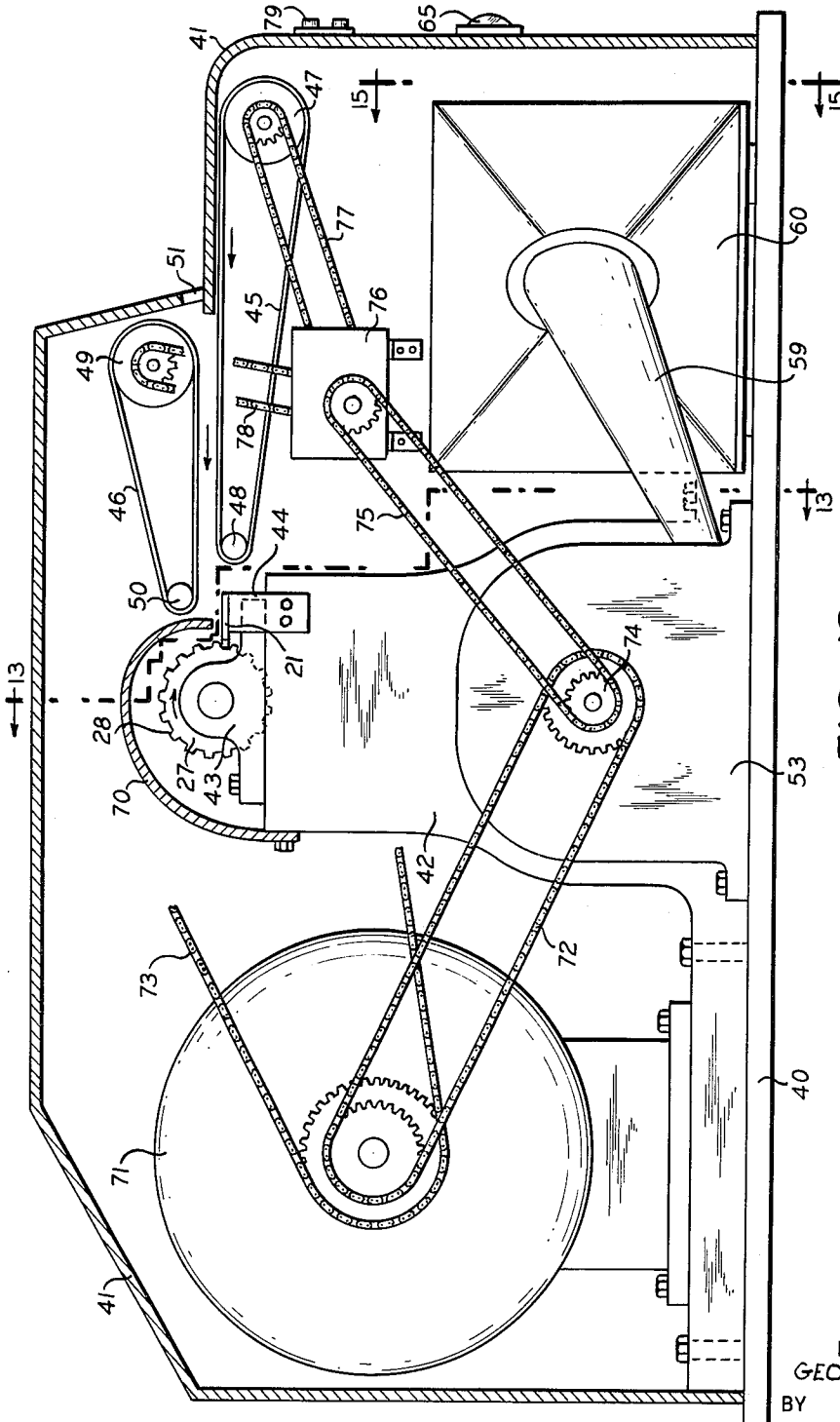


FIG. 12.

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FIG. 13.

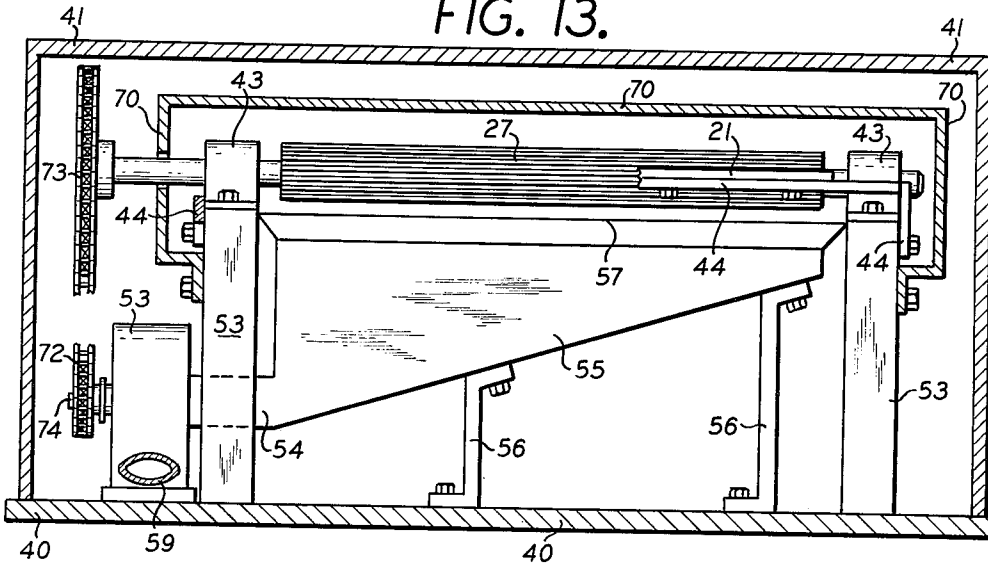


FIG. 14.

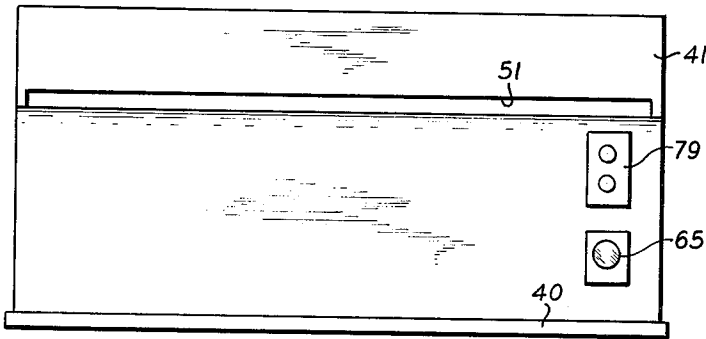
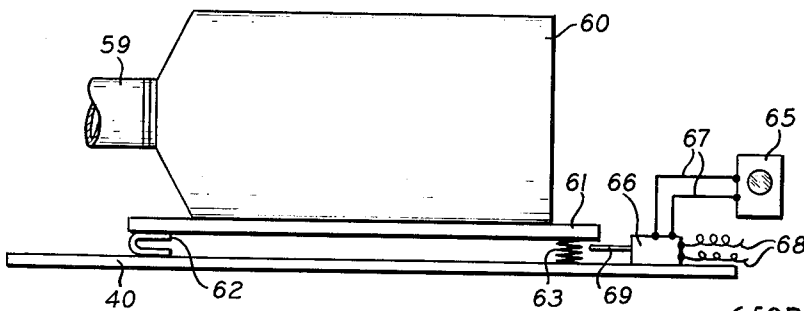


FIG. 15.



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SIZE REDUCTION OF SHEET MATERIAL
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1 Claim. (Cl. 83—100)

This invention relates to the size reduction of sheet material. The invention was occasioned by the need for means to size reduce paper bearing written matter to the point that reassembly of the particles in the manner of a jig-saw puzzle, is virtually an impossibility.

Where it is desired to destroy paper bearing written or printed matter, it is of course possible to burn the paper. This, however, is not always a practical solution to the problem since burning cannot normally be effected as soon as it is desired to destroy the paper, but rather destruction by burning must await collection and cartage to a suitable burning site.

It has been proposed heretofore to solve this problem of destroying paper by providing machines which will destroy the paper by size reducing it to the point that assembly of the particles is impossible. The machines proposed for this purpose, commonly, have the disadvantage of cutting the paper in but one direction and, hence, the size reduction of the paper is effective merely to produce very narrow elongated strips. While the strips can be cut transversely so that two-directional cutting of the paper is realized, this must be done in a second step, and hence, results in complication of the machinery.

It is a principal object of the invention to provide a device and a procedure for size reduction of paper characterized in that the size reduction occurs simultaneously in both directions, i.e. longitudinally and transversely of the paper.

Another principal object of the invention is to provide a machine characterized as aforesaid, and of such weight and size that it can be used as office equipment. Thus, a size reducing machine according to the invention can be installed in individual offices in the manner that reproducing machines, typewriters, and other office equipment is commonplace in individual offices.

According to the invention, sheet material such as paper, is fed over a ledger plate and a toothed cutter is moved into intermittent cutting relation with the ledger plate for corresponding cutting of the material to form a serrated edge along the advancing end of the material upon each cutting thereof. The material is fed to the cutter in synchronism with movement of the cutter so that the material advances over the ledger plate a distance up to the depth, or, more accurately, the effective depth, of the teeth of the cutter for each cutting engagement of the cutter and ledger plate. Further, the cutter is shaped to form upon cutting engagement with the paper, transverse cuts to intersection with the formed longitudinally extending edges of each of the material serrations, while at the same time cutting the advancing end of the material, to form a new serrated edge thereat. The observance of the synchronous movement and the shaping of the cutter result in the desired cutting of the paper, whereby it is cut transversely as well as longitudinally.

The invention provides apparatus which includes a ledger plate, means for automatically feeding the material to be size reduced over the ledger plate, and a toothed cutter mounted for movement in cutting cooperation with the ledger plate. Further, means are provided for moving the cutter in synchronism with the feeding of material over the ledger plate so that the cutter engages the mate-

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rial for cutting intermittently, and at least once for feeding of material equal to up to the depth, more accurately, effective depth, of the cutter teeth. In operation of the apparatus, upon each cutting engagement, a serrated edge is formed along the advancing end of the material. The cutter teeth are formed so that by interaction of the cutter teeth and the formed serrated edge, the desired two-directional cutting of the material can be realized. Thus, the cutter teeth are shaped to form upon cutting engagement with the material, transverse cuts which extend to intersection with formed longitudinally extending edges of each of the material serrations, while at the same time cutting the advancing end of the material to form a new serrated edge thereat. In this manner, the material is cut transversely as well as longitudinally in the size reduction thereof.

Further to the foregoing description of the apparatus, in a preferred embodiment, the ledger plate has teeth for meshing with the teeth of the cutter. Also as a preferred embodiment, the movement of the cutter is rotational. Such rotational movement can be rotation of the cutter, in the form of a blade or toothed disc about an axis perpendicular to the cutting edge of the ledger plate. In a highly preferred embodiment, the cutter is a cylinder having radially outwardly extending projections forming the teeth, and the cylinder is disposed with its axis parallel to the ledger plate and is mounted for rotation.

The invention is further described in the accompanying drawings, wherein:

FIG. 1 is an isometric view of a device according to the invention, and wherein the cutter is in the form of a blade mounted for rotation on an axis parallel to the direction of paper feed to the ledger plate;

FIG. 1a is a partial, elevation view in which the cutter is in the form of a disc;

FIG. 2 is an isometric view showing a ledger plate and cutter, wherein the cutter is in the form of a cylinder mounted on an axis parallel to the ledger plate;

FIG. 2a is a partial elevation view in which the cutter is in the form of a cylinder, the teeth being disposed along spaced helical lines;

FIG. 3 is a schematic showing which depicts a preferred shape for the cutter;

FIGS. 4, 5 and 6 are schematic showings which indicate the manner of operation of the apparatus of the invention whereby transverse, as well as longitudinal cutting is obtained;

FIGS. 7, 8 and 9 are representations of various alternative constructions for a cutter in the form of a cylinder provided with a radially extending projection;

FIG. 10 is an end elevation of a cylindrical cutter and ledger plate, wherein the cutter is made up by stacking cutter plates;

FIG. 11 is taken along line 11—11 in FIG. 10;

FIG. 12 is a side elevation of a device according to the invention, including a motor drive therefor and a housing, a part of the housing being broken away so as to better disclose the construction;

FIGS. 13, 14 and 15 are taken respectively along lines 13—13, 14—14 and 15—15 in FIG. 12.

In the various views, like reference characters indicate corresponding parts.

Referring to the drawings, in FIG. 1, the device includes a ledger plate mounted in stationary manner, and a cutter in the form of the blade 22. The cutter is mounted for rotation on an axis perpendicular to the cutting edge of the ledger plate. The ends of the blade

22 are provided with toothed cutting edges 23, and the ledger plate is provided with teeth 24 which are disposed for receiving the teeth of the cutter in mesh relation. Whereas the meshing relation is not essential and the ledger plate can be merely a straight edge providing support for the end of the paper, yet, the use of a toothed ledger plate is highly preferred and greatly facilitates the cutting.

In the operation of the device shown in FIG. 1, paper 25 is moved over the ledger plate in the direction indicated by the arrow 26 and so that it is engaged in cutting relation between the cutter 22 and the ledger plate.

In the embodiment shown in FIG. 1a, the cutter is in the form of a disc having circumferentially spaced cutting edges 23 made up of teeth 28. The cutting edges are disposed along disc radii and are spaced from the center of the disc. The disc can be rotatably mounted and is for use with a ledger plate, as is shown in FIG. 1.

A preferred form of the cutter is shown in FIG. 2. Here, the cutter 27 is a cylinder having radially outwardly extending projections 28 forming the teeth of the cutter. The cylinder 27 is disposed with its axis parallel to the ledger plate 21, and means (not shown in FIG. 2) are provided for rotating the cutter to effect the cutting action. The cylindrical cutter 27 is formed from a single piece of steel. This manner of providing the cutter is highly preferred, as it permits economy in production and provides a more dependable tool. A close fit between the cutter 27 and the ledger 26 is highly desirable. To this end, it has been found that the cutter after being worked to provide the teeth 28 therein, and after being hardened, can be used to mill the teeth in the ledger 26. This milling would be performed before hardening of the ledger plate 26 and, after the milling, the ledger plate would be hardened. By forming the ledger plate in this way, a matched fit is obtained and the cutter and ledger plate are a pair custom constructed one for the other. It will be appreciated that this procedure permits obtaining a better fit of cutter and ledger plate, whereby to improve the cutting action of the tool.

In the embodiment shown in FIG. 2a, the cutter is generally as in the case of the cutter of FIG. 2, except that the cutting edges 23 are disposed along helical lines. This embodiment has several advantages. It permits a progressive or continuous cutting action and thus makes possible avoiding an intermittent action as would be obtained with a cutter as is shown in FIG. 2. For the FIG. 2a construction less power is required and the machine will make less noise.

A distinctive feature of the device of the invention is that it cuts paper in two directions, i.e. it can cut paper longitudinally and simultaneously can cut the paper transversely. Such operation is the result of observance of particular conditions in the design and operation of the device. These conditions will be described in detail with respect to FIG. 4, FIG. 5 and FIG. 6. In these figures, there is shown a portion of a ledger plate 21 including the toothed cutting edge thereof 24, and overlying the ledger plate is paper 31 which is being subjected to size reduction. The paper 31 is moved continuously toward the teeth 24 of the ledger plate and is engaged at the cutting edge of the ledger plate by the cutter (not shown in FIGS. 4-6). The cutter engages the paper at time intervals and thus provides for the intermittent cutting of the paper. It will be appreciated that the rate of movement of the paper to the cutter must be coordinated with the frequency with which the cutter comes into cutting engagement with the paper. Thus, if the paper is moved too fast, it will result that the cut occasioned by the cutter coming into cutting engagement with the ledger plate will cut from side edge of the paper to the other side edge of the paper forming a continuous cut, and thus, the paper will be cut in the transverse direction only; there would be no longitudinal cut. To make longi-

tudinal cutting possible, it is necessary that the cutter and paper movement be synchronized so that the cutter engages the material for cutting intermittently and at least once for feeding of material equal to up to the depth of the cutter teeth. Thus, referring to FIG. 4, in the interval between cutting engagements, the paper should not advance more than about the distance a . If just before engagement by the cutter, the paper is in the position shown in FIG. 4, satisfactory (two-directional) cutting can be obtained.

A further necessary condition to the two-directional cutting provided according to the invention, is with respect to the shape of the cutter teeth. The cutter is formed so that upon each cutting engagement with the paper, a serrated edge is formed along the advancing end of the material. Now, the cutter teeth must be shaped to form, upon cutting engagement with the material, transverse cuts to intersection with formed longitudinally extending edges of each of the material serrations, while at the same time cutting the advancing end of the material to form a new serrated edge thereat. Referring to FIG. 4, the cutter is of such shape as to form upon its cutting action, and further, the cutter is of such shape that it will form transverse cuts, such as a cut along the face 33 of the tooth 24a of the ledger plate, to intersection with formed longitudinally extending edges, such as the edges 34, 35, of each of the material serrations. It will be observed, that by operation in such manner, the device operates to cut the paper not only longitudinally, but, as well, transversely. In FIGS. 4-6, the cutter is not shown, but it will be appreciated that the cutter is complementary with the toothed ledger plate, and, accordingly, the figures do indicate the cutter and its shape.

For the embodiment shown in FIG. 4, the upper limit to the amount of movement of the paper toward the cutter, between engagements by the cutter, would be the depth a of the teeth 24, and the amount of movement could be any amount less than a (in this manner, the extent of size reduction can be controlled). It is, however, highly desirable to round the corners of the teeth of the cutter and ledger plate. Better cutting can be obtained with rounded corners, and the rounded corners are not as susceptible to injury by hard objects such as paper clips, staples, and the like, as might accidentally be fed into the machine. Thus, the teeth are preferably provided with rounded corners, as shown in FIG. 5. When, however, rounded corners are provided, the extent of advance of the paper between engagements by the cutter cannot be the depth a but must be not more than a lesser amount, namely, not more than the dimension b , shown in FIG. 6. Thus, devices having rounded teeth have an effective depth b which the movement of the paper between cutting engagements should not exceed. It will be observed that where teeth having rounded corners are used and the advance of the paper is equal to the true depth of the teeth, upon cutting engagement a transverse continuous cut would be made and the paper would be cut thereby from one edge thereof to the other edge thereof, but no through longitudinal cut would be made (see FIG. 5).

A preferred shape of the cutter teeth is indicated in FIG. 3. This shape is that of a sine wave. Preferably, the shape is that of an approximate sine wave, differing from a sine wave in that the plus side does not equal the minus side. Such deviation from a sine wave form makes the manufacture of the cutter easier.

As has been explained hereinbefore, a preferred form of the cutter is a cylinder having radially outwardly extending projections forming the teeth. Whereas the preferred form of such a cutter is shown in FIG. 2, various other forms are possible. Some alternatives are shown in FIGS. 7-10. In FIGS. 7-9, the cutter comprises an axially extending block 35 to which blades 36 are secured by screws 37. The blades provide a radially outwardly extending tooth and terminate in a cutting end.

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In FIG. 7, the block 35 is rectangular in cross section; in FIG. 8, the block is circular in cross section; and in FIG. 9, the block is of hexagonal form in cross section.

In FIG. 10, there is indicated a construction of a cylindrical cutter wherein the cylinder is built up by stacking plates. Large plates 38 are spaced from each other by small plates 38a, and the plates 38 are provided with cutting teeth 39, and the small plates 38a are provided with cutting teeth 39a. The large and small plates can be provided with a bore such as the bore 40 in the small plates 38a, whereby to permit assembly of the plates by a bolt extending axially through the plates.

The stack plates 38 and 38a will form a series of toothed edges. Each such cutter edge is continuous or substantially continuous and is disposed or substantially disposed in a plane, all as may be occasioned by suitable sizing and positioning of the plates, and as is the case for the cutter shown in FIG. 2. The radial dimensions of the teeth are preferably constant, as is the case for the cutter of FIG. 2.

As indicated, the teeth of the cutter, and the corresponding teeth of the ledger plate, can be of rectangular form, and are preferably provided with rounded corners. In the preferred embodiment of the invention, wherein the cutter is in the form of a cylinder, the teeth are axially spaced along a line parallel to the axis of the cylinder, and are circumferentially spaced about the cylinder, as is generally indicated in FIG. 2. The teeth can, however, be arranged in a staggered array such as might be obtained by a random orientation of the plates 38 and 38a (see FIG. 10), with respect to the relative circumferential location of the teeth 39 and 39a.

A condition found to be desirable in order to obtain accurate and consistent cutting of the sheet material processed by the machine is indicated in FIG. 10, in particular by the relative positioning of the ledger plate 21 and the cutter 27. Thus, the teeth of the cutter are formed and the cylinder 27 is disposed so that the cutting plane of the teeth 39, 39a is substantially parallel to the ledger plate 21 when the teeth come into cutting engagement with the ledger plate.

Coming now to FIGS. 12-15, in these figures, there is shown an embodiment of the apparatus of the invention suited for office use. That is, the machine depicted here is of such size that it can be installed in individual offices for the size reduction of paper, as and when is convenient, for example, individual sheets can be subjected to size reduction at such times as is desirable from the standpoint of disposing of the paper in a manner such that it is size reduced to the point of defying reassembly. The apparatus includes a base 40 on which is mounted the operating elements of the apparatus, and a housing 41 for such operating elements. The apparatus includes a frame 42 secured to the base 40 and having mounted atop thereof the journal blocks 43 which have journaled therein the cylindrical cutter 27. The ledger plate 21 is secured to the frame 42 by the brackets 44. Means are provided for feeding paper to the cutter. Thus, endless belts 45 and 46 are disposed, respectively, about the lower course pulleys 47 and 48, and the upper course pulleys 49 and 50, and the adjacent courses of these belts are spaced from each other so that paper or other material to be subjected to size reduction can be frictionally engaged by the belts and advanced forward to the cutter. The housing 41 is provided with an opening 51 through which paper may be introduced so as to be placed between the adjacent courses of the belts 45 and 46 for frictional engagement by such belts and delivery by the belts to the cutter.

The machine is provided with vacuum creating means operatively communicated with the cutter and ledger plate for providing a draft to withdraw cuttings from the cutter and ledger plate. Thus, the device includes a fan 53 having its intake 54 (see FIG. 13) communicated with a funnel 55 supported by brackets 56 on the frame 40 and

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having its inlet 57 disposed for receiving the cuttings. The discharge 59 of the fan communicates with a vacuum bag 60 (FIG. 12). The vacuum bag 60 rests on a rest plate 61 which is mounted on the base 40 by spring hinge 62 and spring 63 so that the rest plate is provided with a weight yielding mounting. The purpose of this weight yielding mounting is to permit utilization of means for indicating when the vacuum bag 60 is full. Thus, the device is provided with a signal light 65 electrically connected to a switch 66 by leads 67. The switch 66 is powered by the leads 68 and includes a switch finger 69 positioned for engagement by the rest plate 61 upon the rest plate being loaded, by reason of accumulation of paper in the vacuum bag, to the extent that the plate is lowered to the point of engagement with the switch finger 69. Upon such engagement, the switch is closed so as to activate the signal light 65 and indicate that the vacuum bag 60 is full.

To further facilitate the drawing of vacuum in the vicinity of the cutter and ledger plate, a shield 70 (FIG. 12) is provided and surrounds the cutter in a manner directed to increasing draft from the cutter and ledger plate.

For driving the various elements of the apparatus, a motor 71 is provided and the motor is connected to the blower 53 by belt 72, and is connected to the cutter 27 by belt 73. Further, the blower shaft 74 has mounted thereon a pulley for driving the belt 75 which is operatively connected with the speed adjuster 76, the said speed adjuster being operatively connected with the paper feeding means belts 45 and 46, respectively, by belts 77 and 78. A start-stop switch 79 is provided for controlling the operation of the apparatus.

A device such as is represented in FIGS. 12-15, and adapted to size reduce paper to particles about $\frac{1}{64}$ inch x 0.1 inch, or less, can have a cutter $1\frac{3}{4}$ inches O.D. having 12 rows of teeth, the said rows being at equally spaced intervals about the periphery of the cylindrical cutter 27. The width of the teeth can be about 0.1 inch and the depth of the teeth (or effective depth) can be about $\frac{1}{64}$ inch. The cutter can be operated at about 1000 r.p.m. to provide 12000 engagements per minute of the cutter and the paper. In this manner, size reduction to particles of size about $\frac{1}{64}$ inch x 0.1 inch (or smaller) can be obtained and a paper feed rate to the cutter of about 200 inches per minute can be obtained. As has been explained hereinbefore, size reduction to a smaller particle size can be obtained by suitably varying the rate of paper feed to the cutter. Thus, the invention provides means for feeding paper over the ledger plate at a rate synchronized with the rate of rotation of the cutter to cut pieces of up to the size of the intermeshing area of the cutter teeth and ledger teeth. The intermeshing area is less than about .0016 square inch and the greatest linear dimensions of the pieces is about 0.1 inch.

Whereas the invention has been described with particular reference to the use thereof for size reduction of paper, the invention can be used for size reduction of other materials. It can be used for size reduction of sheet material of various composition, such as metal, plastic, etc. as well as being particularly well suited for size reduction of the usual pulp or rag paper, the invention works well in size reduction of carbon paper, and other papers as are in use in offices.

What is claimed is:

Apparatus for disposing of paper bearing written matter to destroy the information contained thereon, comprising a cylindrical cutter having radially outwardly extending projections forming cutter teeth axially spaced along spaced helical lines, means for rotating the cutter, a ledger plate disposed parallel to the axis of the cutter and having teeth intermeshing with the cutter teeth upon rotation of the cylindrical cutter, means for feeding paper over the ledger plate at a feed rate synchronized with the rate of rotation of the cutter to cut from said paper pieces of

size of up to the intermeshing area of the cutter teeth and ledger teeth, said intermeshing area being less than about .0016 square inch and being up to about 0.1 inch in greatest linear dimension, and vacuum creating means operatively communicated with the cutter and ledger plate for providing a draft withdrawing cuttings from the cutter, and conduit means communicating the discharge of the vacuum creating means with a vacuum bag for receiving material particles discharged by the vacuum creating means, a rest plate and a weight yielding mounting for the rest plate, the vacuum bag resting on the rest plate, and signal means operatively connected with a switch means disposed for response to loading of the rest plate in accordance with material collected in the bag, whereby the signal means is provided to indicate the full condition of the vacuum bag.

References Cited by the Examiner

UNITED STATES PATENTS

864,552	8/1907	Perkins et al.	83—355
1,542,872	6/1925	Gruman	83—100
1,874,902	8/1932	Clyne	83—43
2,335,515	11/1943	Jehle	83—43 X
2,529,750	11/1950	Weingart	83—61 X
2,635,693	4/1953	Gibby	83—355
2,768,689	10/1956	Ewing	83—355 X
2,798,550	7/1957	Hisayoshi Kubodera ...	83—356
2,812,815	11/1957	Quinsey et al.	83—43
2,846,879	8/1958	Kauffman et al.	222—58
2,978,942	4/1961	Casino	83—355

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