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U.S. DEPARTMENT OF COMMERCE

PATENTS ONLY

Patent and Trademark Office

Tab se

100999546

To the Honorable Commissioner of Patents and Trademarks: Please record the attached original documents or copy thereof.

1. Name of conveying party(ies):

Irwin Research & Development, Inc

MAR 16 AM 9:34

OPR/FINANCE

2. Name and address of receiving party(ies):

Name: Jere F. Irwin

Internal Address: P.O. Box 10668

Additional name(s) of conveying party(ies) attached? Yes No

3. Nature of conveyance:

- Assignment Merger
- Security Agreement Change of Name
- Other

Street Address:

City: Yakima State: WA ZIP: 98909

Execution Date: December 31, 1998

Additional name(s) & address(es) attached? Yes No

3-16-99

4. Application number(s) or patent number(s):

If this document is being filed together with a new application, the execution date of the application is:

A. Patent Application No.(s)

B. Patent No.(s)

4,687,144

Additional numbers attached? Yes No

5. Name and address of party to whom correspondence concerning document should be mailed:

Name: Mark W. Hendricksen

Internal Address: Wells, St. John, Roberts, Gregory & Matkin, PS

Street Address: 601 West First Avenue, Suite 1300

City: Spokane State: WA ZIP: 99201-3828

6. Total number of applications and patents involved:

7. Total fee (37 CFR 3.41) \$ 40

- Enclosed
- Authorized to be charged to deposit account

8. Deposit account number:

(Attach duplicate copy of this page if paying by deposit account)

03/31/1999 JSHABAZZ 00000130 4687144

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9. Statement and signature.

To the best of my knowledge and belief, the foregoing information is true and correct and any attached copy is a true copy of the original document.

Mark W. Hendricksen

Name of Person Signing

Mark W Hendricksen

Signature

2/7/99

Date

Total number of pages including cover sheet, attachments, and document:

Mail documents to be recorded with required cover sheet information to:
Commissioner of Patents & Trademarks, Box Assignments
Washington, D.C. 20231

(Form PTO--1595--Recordation Form Cover Sheet - page 1 of 3)

PATENT
REEL: 9866 FRAME: 0572

PATENT ASSIGNMENT

Parties to the Assignment

Assignor:

Irwin Research & Development, Inc.
("Irwin Research")
P.O. Box 10668
Yakima, WA 98909

Assignee:

Jere F. Irwin
("Irwin")
P.O. Box 10668
Yakima, WA 98909

Background of This Assignment

Irwin and Irwin Research entered an agreement wherein it was agreed that all inventions made by Jere F. Irwin would be owned solely by Jere F. Irwin and that the corporation would receive a license to those inventions (the "Patent Licensing Agreement"). A copy of the Patent Licensing Agreement is attached hereto as Exhibit 1.

Furthermore, it was the intent of the parties in entering the Patent Licensing Agreement, that since Irwin is the primary inventor of all the inventions, that Irwin was to own 100% of the patents he was involved in, pursuant to the terms of the Patent Licensing Agreement.

Therefore, Irwin Research is assigning its interest in each of the patents in which there were co-inventors with Irwin, and this patent/patent application is one such patent/patent application.

1 Each of the persons who are co-inventors with Irwin have assigned their
2 interest to Irwin Research, and this assignment is to reflect and accomplish
3 the intent of the parties as expressed in the Patent Licensing Agreement, i.e.
4 that Irwin would own the patents/patent applications.

5 The invention/patent/patent application is described as follows:

6 Patent No.: 4,687,144

7 Patent Application No.: 874,151

8 Inventors: Jere F. Irwin
9 John R. Doornink
Clive J. Roberts

10 Title/Description: Apparatus for Comminuting Waste Materials

11 A copy of the patent/patent application/invention disclosure is attached
12 as Exhibit 2.

13 **The Parties Therefore Agree as Follows:**

14 In consideration of good and valuable consideration, Irwin Research
15 does hereby sell, assign and transfer to Irwin, the entire right, title and
16 interest in the above-identified patent/patent application, and to any reissues,
17 divisions or continuations thereof, and hereby authorizes the Commissioner of
18 Patents and Trademarks to issue such Letters Patent to Irwin, if applicable,
19 for the sole use of Irwin, his successors or assigns.

20 Irwin Research further agrees to execute, at the request of Irwin, such
21 other formal documents as may be required to fully convey the interest
22 transferred herein and will similarly execute any applications papers required

1 for the filing of any division, continuation or reissue of the patent application
2 or resulting Letters Patent, if necessary; and will generally do everything
3 necessary or desirable to obtain and enforce proper protection for the
4 invention assigned hereby.

5 Irwin Research further assigns to Irwin, the whole right, title and
6 interest in the invention disclosed in the application throughout all countries
7 foreign to the United States. Irwin, if applicable, is hereby authorized to
8 apply for patents relating to the inventions in his own name in countries
9 where such procedure is proper; to claim the benefit of the International
10 Convention; to file and prosecute International Applications relating to the
11 inventions under the Patent Cooperation Treaty; and to file and prosecute
12 applications relating to the inventions under the European Patent Convention.

13 Irwin Research agrees to execute applications relating to the inventions
14 in those countries and under those conventions where it is necessary that the
15 same be executed by the inventor, and to execute assignments of such
16 applications and the resulting Letters Patent to Irwin, as well as all other
17 necessary papers in relation to such applications and Letters Patent.

18
19
20
21
22

1 Signed at Yakima, Wa on 12-31, 1998.

2 IRWIN RESEARCH & DEVELOPMENT, INC.

3
4 12-31-98

5 Date

6
7 Jere F. Irwin

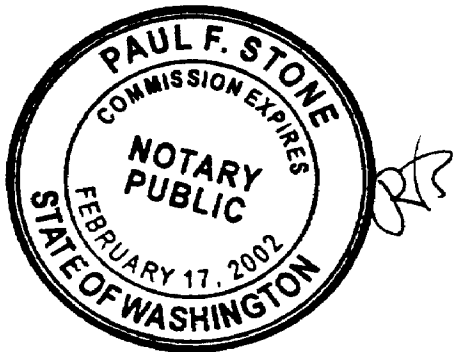
8 By: Jere F. Irwin

9 Its: President

10 State of Washington

11 County of Yakima

12 On 12/31, 1998 before me, a Notary Public, personally
13 appeared Jere F. Irwin, who is known to me to be the President of Irwin
14 Research & Development, Inc., the corporation described in the foregoing
15 assignment, who executed it and acknowledged such execution to be a
16 voluntary act of the corporation, and for the purposes set forth therein.



23 Paul F. Stone

24 Notary Public for the State of

25 Washington residing at

26 Yakima

IRWIN

12-31-98

Date

Jere F. Irwin
Jere F. Irwin, An Individual

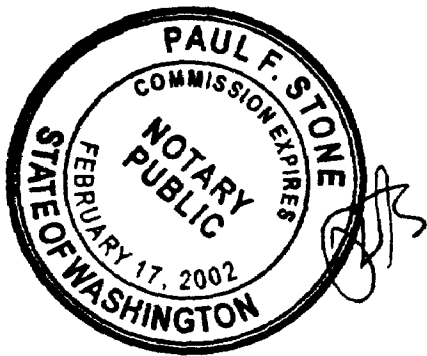
State of Washington

County of Yakima

On 12/31, 1998 before me, a Notary Public, personally appeared Jere F. Irwin, who is known to me to be the person described in the foregoing assignment, who executed it and acknowledged such execution to be voluntary and for the purposes set forth therein.

Paul F. Stone

Notary Public for the State of
Washington residing at
Yakima



PATENT LICENSING AGREEMENT

THIS AGREEMENT made and entered into this 1st day of July, by and between JERE IRWIN, hereinafter termed "Licensor", and IRWIN RESEARCH AND DEVELOPMENT, INC., hereinafter termed "Licensee",

W I T N E S S E T H:

WHEREAS, the Licensor, Jere F. Irwin, is the sole owner of all of the right, title and interest in, to, and under the following Letters Patent of the United States, namely,

(1) Letters Patent of the United States No. 3876361 granted April 8, 1975 to the Licensor for an Apparatus For An Automatic Press; and

(2) Letters Patent of the United States No. 3830611 granted the 20th day of August, 1974 to the last Licensor for an Apparatus For Matched-Mold Thermo-Forming; and,

(3) Letters Patent of the United States No. 4142848 granted the 6th day of March, 1979, to the Licensor for an Apparatus For Manufacturing a Lockable Carton; and,

(4) Letters Patent of the United States No. 4143111 granted the 6th day of March, 1979, to the Licensor for an apparatus or Method of Matched-Mold Forming From a Hot Sheet of Polystyrene Foam, An Open Vessel Having an Outward Sloping Flat Side Wall With At Least One Hole in Said Side Wall; and,

WHEREAS, the Licensor has, since the issuance of said patents, permitted the Licensee to manufacture, use, and sell under said patents under an oral and informal arrangement with the Licensor; and,

WHEREAS, the Licensor and Licensee are desirous of formalizing said arrangement and granting to the Licensee an exclusive license to manufacture, use and sell under said patents; now, therefore,

PATENT LICENSING AGREEMENT

1

LAW OFFICES OF
WILSON & MIKESSELL
SUITE 2, YAKIMA LEGAL CENTER
303 EAST "D" STREET
YAKIMA, WASHINGTON 98901
(509) 248-6423

EXHIBIT 1
PATENT
REEL: 9866 FRAME: 0578

FOR AND IN CONSIDERATION of One Dollar, for each of said patents for a total of Four Dollars, and of other considerations, the receipt whereof is hereby acknowledged, the parties hereby agree as follows:

1) The Licensor does hereby grant to the Licensee and to its successors and assigns and under the terms and conditions and with the limitations hereinafter set forth, an exclusive license for the remainder of the term of the aforesaid Letters Patent, or any reissue, division, or extension thereof, to make, use, and sell, under the aforesaid Letters Patents and under any reissues, divisions, or extensions thereof.

2) The Licensee agrees to pay to the Licensor, or his successors or assigns, a license fee royalty upon each and every apparatus, appurtenance or method, utilized, made, sold, leased or put into use (except such as are used directly by the Licensee for demonstration purposes), during the term of this license agreement, Two (2) percent of the net bonafide wholesale selling price thereof on sales made by the Licensee at wholesale and Two (2) percent of the actual bonafide net selling price thereof on sales made by Licensee at retail to purchasers; royalty to be paid annually within Thirty (30) days after each fiscal period with the first fiscal period to commence on July 1, 1987, and terminate on June 30, 1988.

3) The Licensee agrees to render statements duly verified by its proper officer at the time of submitting each royalty payment, or in any event, within Thirty (30) days after the end of each fiscal year, showing all apparatuses or other articles above enumerated or included, which the Licensee has made, sold, leased or put into use, (except as are used directly by the Licensee for demonstration purposes) within the year which the statement covers, and to keep full, accurate and complete books of account respecting the business, and to give the Licensor, or his duly authorized representative, the privilege of inspecting or examining said books of the Licensee at all

PATENT LICENSING AGREEMENT

2

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YAKIMA, WASHINGTON 98901
(509) 248-6423

PATENT
REEL: 9866 FRAME: 0579

reasonable times for the purpose of verifying said statements and determining the correctness of the annual payment, if any.

4) The Licensee hereby covenants and agrees that during the life of this license it will diligently and continually manufacture, sell, and market the apparatuses and methods under said licenses, and will exert its best efforts to create a demand therefore and to increase and extend its business and supply the demand for their output.

5) In the event that the Licensee, or its successors, discontinue their business relating to the use of said licenses, the licenses shall cease and terminate, at the option of the Licensor.

6) The Licensee hereby covenants and agrees that wherever the same is required under the business and trade, each apparatus made, sold, leased, or put into use by it, will be marked with the word "patented" and the date of said patent and the dates of other patents to which said license is granted and as are lawfully applicable to said apparatus or appurtenances.

7) These licenses shall continue during the remainder of the term of the said patents as above set forth, or any reissue, division or extension thereof. In the event that any patent shall be declared invalid by the final judgment of any court of last resort, the license in respect thereto shall cease and determine.

8) Licensor, his successors and assigns shall not engage in the manufacture and sale of the apparatus or methods covered under said patents in competition with the Licensee, except by a written agreement between Licensor and Licensee.

9) Upon the failure of the Licensee to perform any or all of the conditions of this agreement, after Thirty (30) days written notice from the Licensor of the failure of the Licensee to do so, the Licensor may, at his option, by notice in writing, cancel any one or all of the licenses affected by said failure of performance, without prejudice to the right of the Licensor to

recover thereunder any royalties which may have accrued at the time of cancellation, or any damage that may have been suffered.

10) These licenses are not assignable by the Licensee, in whole or in part, except to a successor of its whole business, or without the written consent of the Licensor.

11) The Licensor waives all claims heretofore arising against the Licensee, if any, and all users of apparatuses purchased from the Licensee, prior to July 1, 1987 arising out of use of, sale of, or infringement of the aforesaid Letters Patents.

12) Licensor hereby warrants that he has good title to the aforesaid patents and the right to grant the license hereby granted to the Licensee.

13) This contract shall be interpreted according to the laws of the State of Washington and any venue shall lie in the State of Washington. This license agreement shall be binding upon the parties hereto, their legal representatives, successors or assigns.


The Licensor, while in the employment of the Licensee, is presently working on and developing further patents, methods and processes. Said patents, methods and processes shall be the property of Jere F. Irwin, as sole owner, but the Licensor does hereby grant to the Licensee the first option to include said further patents, methods and processes within this patent licensing agreement.

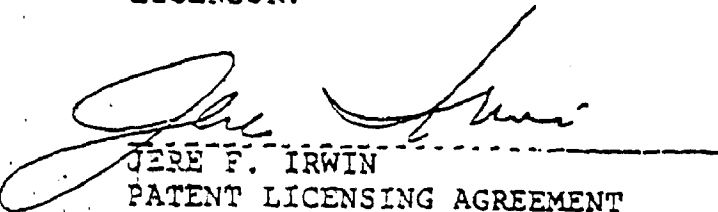
EXECUTED by the parties this 14 day of August, 1987.

JERE F. IRWIN, Individually and as Representative of the Community of JERE F. IRWIN and DIANE IRWIN, husband and wife, LICENSOR:

IRWIN RESEARCH AND DEVELOPMENT INC., LICENSEE:

By: 
President

Attest: 
Secretary


JERE F. IRWIN
PATENT LICENSING AGREEMENT

4


LAW OFFICES OF
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YAKIMA, WASHINGTON 98901
(509) 244-4443

PATENT
REEL: 9866 FRAME: 0581

STATE OF WASHINGTON)
 : ss.
County of Yakima)

THIS IS TO CERTIFY that on this 14 day of August, 1987, before me, the undersigned, a duly commissioned Notary Public in and for said county and state, personally appeared JERE F. IRWIN, to me personally known to be the individual described in and who executed the within and foregoing instrument and who personally acknowledged to me that he signed the same as and for his own free and voluntary act and deed, for the uses and purposes therein mentioned.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal the day and year in this certificate first above written.


NOTARY PUBLIC in and for the State
of Washington, residing at Yakima.

[54] APPARATUS FOR COMMUNUTING WASTE MATERIALS

[75] Inventors: Jere F. Irwin, Yakima; John R. Doornink, Wapato, both of Wash.; Clive J. Roberts, Wincham, United Kingdom

[73] Assignee: Irwin Research & Development, Inc., Yakima, Wash.

[21] Appl. No.: 874,151

[22] Filed: Jun. 13, 1986

[51] Int. Cl.⁴ B02L 23/32

[52] U.S. Cl. 241/49; 241/80; 241/97; 241/167; 241/236

[58] Field of Search 241/49, 52, 73, 79, 241/80, 97, 98, 101.7, 166, 167, 236, 235

[56] References Cited

U.S. PATENT DOCUMENTS

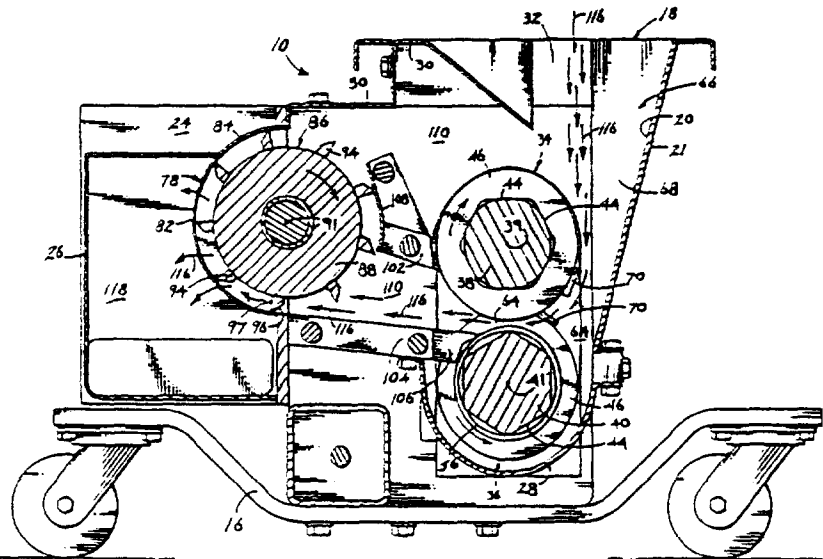
4,134,556 1/1979 Ehrlich et al. 241/236 X

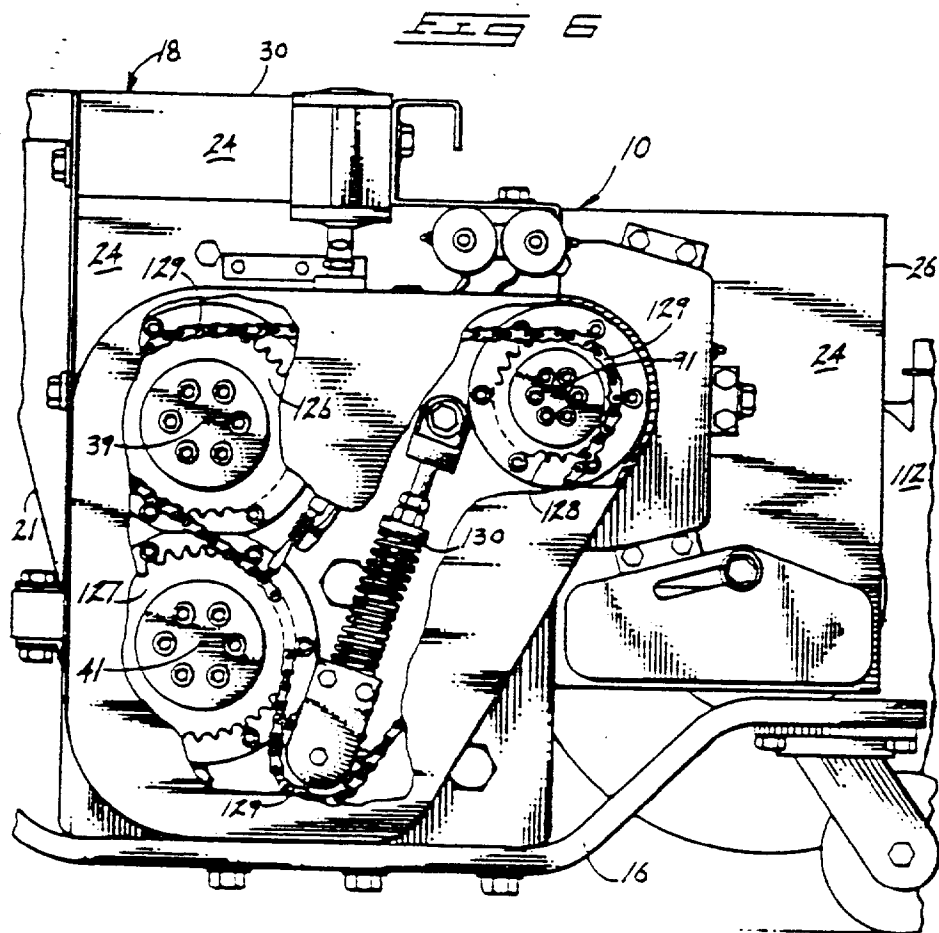
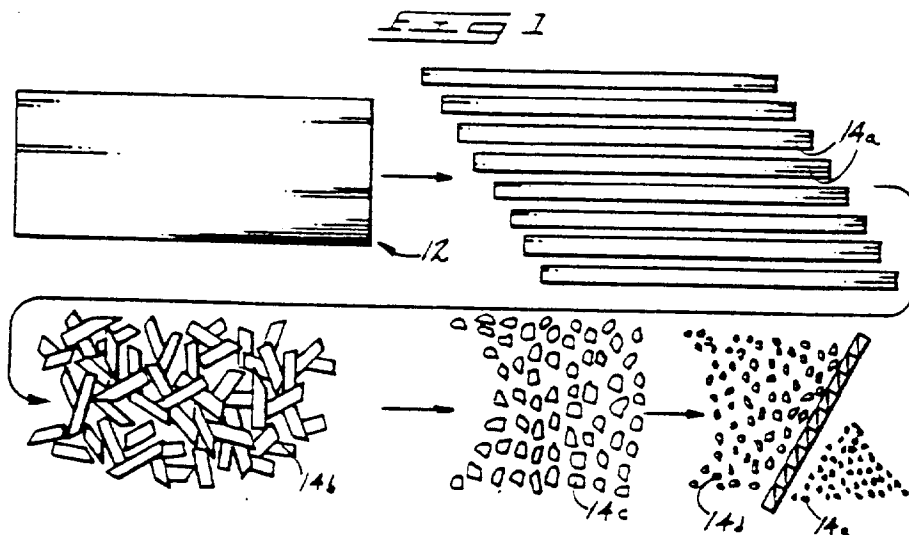
Primary Examiner—Timothy V. Eley
Attorney, Agent, or Firm—Wells, St. John & Roberts

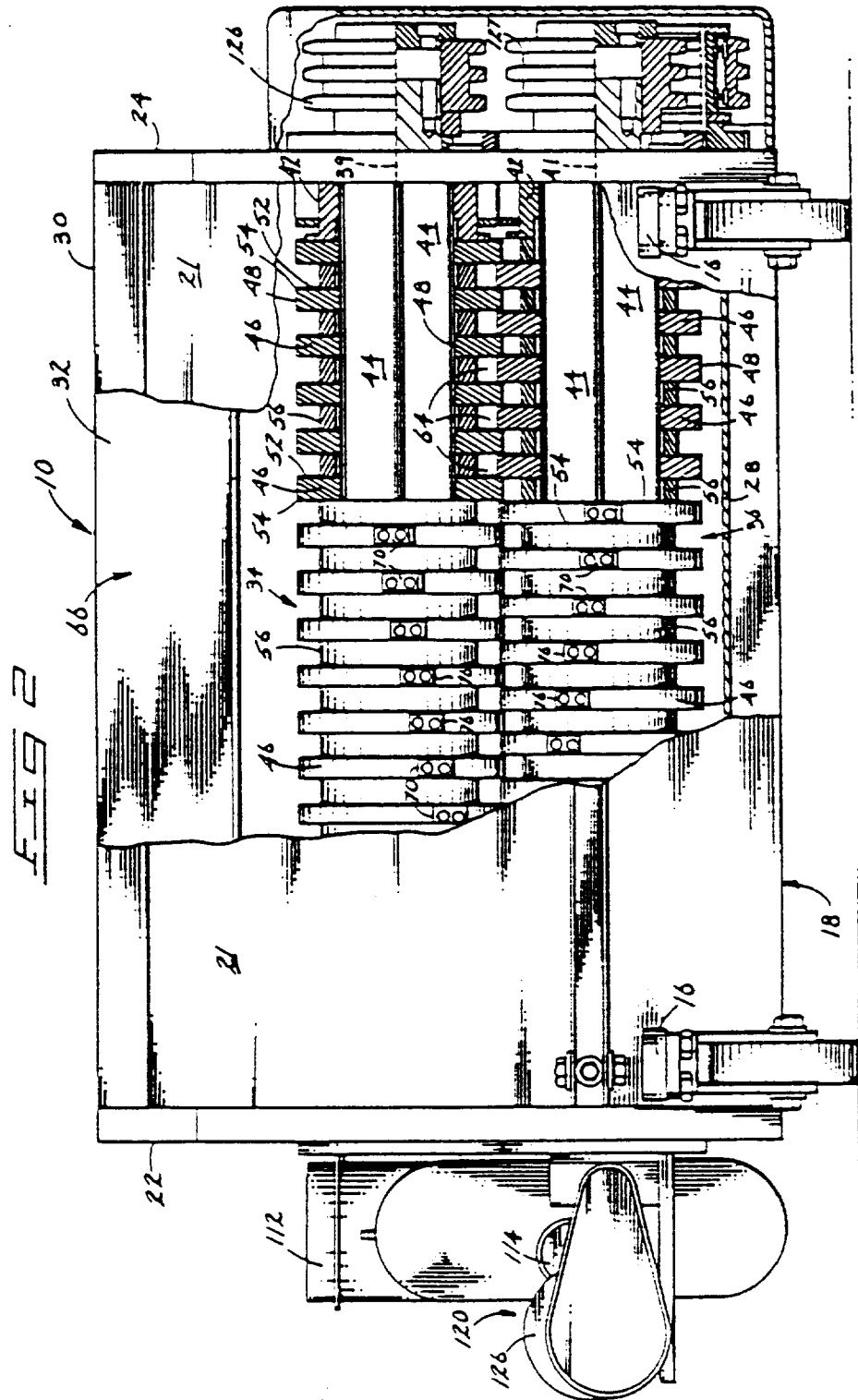
[57] ABSTRACT

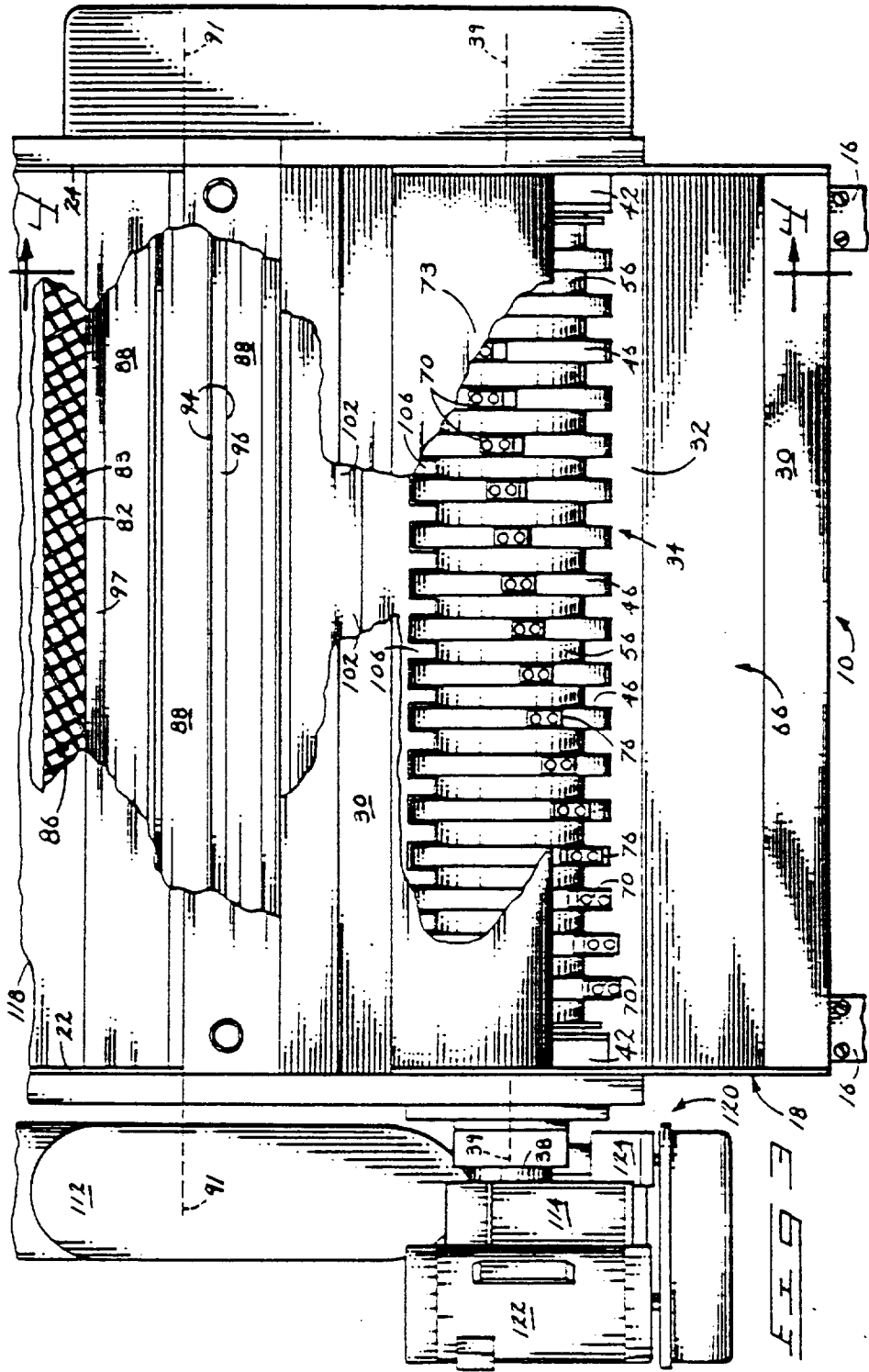
An apparatus for comminuting waste material such as waste plastic sheet material, into progressively smaller pieces until a desired size is reached that may be recycled. The apparatus has a set of slowly rotating, intermeshing scissor rolls for receiving the waste material and shearing the material into smaller pieces. A paddle wheel conveyor receives the smaller pieces from the scissor rolls and moves the smaller pieces over a screen with the undersized smaller pieces passing through the screen defining the desired reduced size. The oversized smaller pieces that do not pass through the screen are reprocessed back to the scissor rolls by the paddle wheel conveyor. A vacuum pump draws air through the apparatus and the screen to facilitate the separation on the screen and entrains the undersized pieces in an air stream to convey the pieces from the apparatus.

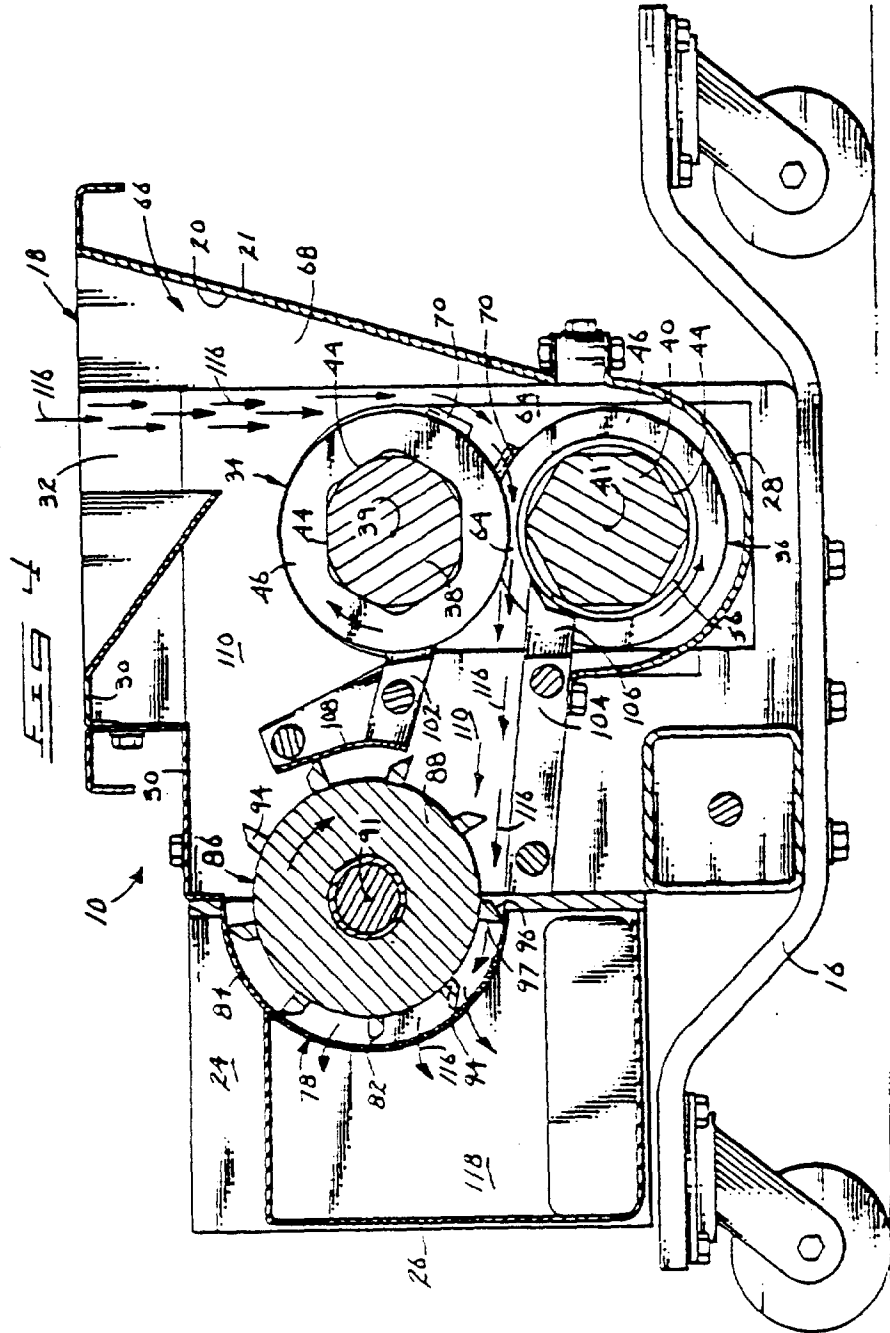
12 Claims, 6 Drawing Figures

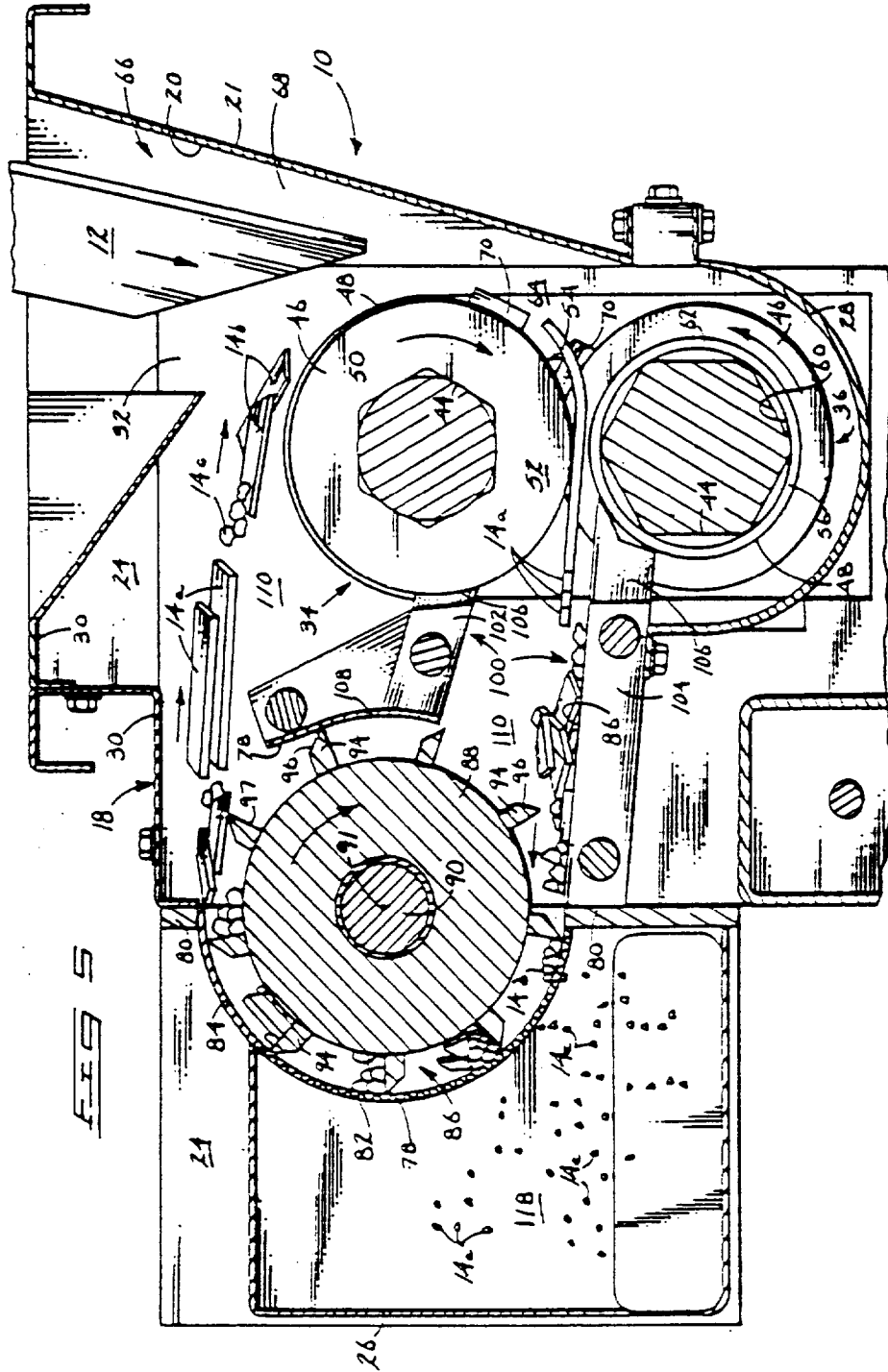












APPARATUS FOR COMMINUTING WASTE MATERIALS

TECHNICAL FIELD

This invention relates to apparatus for comminuting waste material such as plastic sheet material.

BACKGROUND OF THE INVENTION

During the manufacture and forming of many products from plastic, significant amounts of plastic waste material is frequently produced. In the past, various types of hammermills have been utilized to receive the waste material and to reduce the waste material to a particle size sufficient so that material can be recycled and reused. However, such machines are bulky, extremely noisy, and prone to substantial damage should the apparatus become jammed or receive foreign material that cannot be reduced by the apparatus.

The objective of this invention is to overcome many of the problems and to provide a unique apparatus for comminuting waste material particularly plastic waste material produced during thermal forming or injection molding of plastic products.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of this invention is illustrated in the accompanying drawings, in which:

FIG. 1 is a series of illustration views of the waste material and the reduction of the waste material into smaller particles as the material is progressively recycled and reduced to a desired particulate size;

FIG. 2 is a front view of the apparatus with a portion of the front wall cut away to illustrate a frontal view of a set of scissor rolls;

FIG. 3 is a top view of the apparatus with a portion of enclosure cut away to illustrate a paddle wheel in conjunction with a scissor roll;

FIG. 4 is a vertical cross-sectional view taken along line 4—4 in FIG. 3 illustrating the flow of air through the apparatus to assist in the progression of the material through the apparatus; and

FIG. 5 is a cross-sectional view similar to FIG. 4 except showing the material flowing through the apparatus and being recycled to progressively reduce the material to the desired particulate size.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In compliance with the constitutional purpose of the Patent Laws "to promote the progress of science and useful arts" (Article I, Section 8), applicant submits the following disclosure of the invention.

A preferred embodiment of the invention is illustrated in the accompanying drawings particularly showing a waste comminuting apparatus generally designated with the numeral 10 in FIGS. 2 and 3 for receiving waste material 12 and for reducing waste material progressively to smaller and smaller sizes until a desired particulate size is obtained as illustrated in FIG. 1. It should be noted that the apparatus is very compact even though the material is progressively reduced in size in several stages. The waste material illustrated in FIG. 1, is progressively reduced to smaller pieces 14a-e. When the smaller pieces are finally reduced to the size of 14e, they are removed from the apparatus and are referred to as undersize smaller pieces. The smaller pieces that have

not been sufficiently reduced to the desired size are referred to as oversized smaller pieces.

The apparatus 10 has a general frame 16 that may be self-supported or affixed to other apparatus such as the discharge of a thermal forming machine for receiving the waste material 12 directly from the thermal forming machine and reducing the material for reuse. The frame 16 generally includes a general enclosure 18 that includes a front wall 21, two side walls 22, 24, a back wall 26, a bottom wall 28 and a top wall 30. The top wall 30 has a material entrance 32 (FIG. 5) through which the waste material is fed into the apparatus.

Within the enclosure 18 is mounted two scissor rolls 34 and 36 that are mounted in an intermeshing relationship for rotation in opposite directions in coordination with each other to receive the waste material and to shear the waste material as the material passes through the scissor rolls 34 and 36. The scissor roll 34 is mounted on a shaft 38 that rotates about an upper axis 39 (FIG. 4). The scissor roll 36 is mounted on a shaft 40 that rotates about a lower axis 41 that is vertically positioned parallel with and vertically below the axis 39. The axes 39, 41 are positioned so that the scissor rolls 34 and 36 have sufficient overlap to shear the material between the scissor rolls as the material passes between the rolls. Each of the shafts 38 and 40 are supported for rotation by respective bearings 42 (FIG. 2).

Each of the shafts 38 and 40 have hexagonal cross-sectional profiles, providing angular surfaces 44.

Each of the scissor rolls 34 and 36 include a plurality of scissor rings 46 in which each of the rings 46 has a circular outer peripheral surface 48 and in an inner hexagonal bearing surface 50 (FIG. 5). The inner hexagonal bearing surface 50 is complementary to the profile of the shafts 38 and 40 and are engaged by the surfaces 44 so that the scissor rings 46 rotate in response to the rotation of the shafts 38, 40. Each of the scissor rings 46 include side surfaces 52 that form shearing edges 54 in conjunction with the circular outer peripheral surface 48.

Each of the scissor rolls 34 and 36 further include a plurality of ring spacers 56. Each spacer 56 has a circular outer peripheral surface 58 and an inner circular space 60 (FIG. 5). Each of the ring spacers 56 include side surfaces in which the width of the ring spacers is slightly greater than the width of the spacer rings 46. Each of the scissor rings 46 and the ring spacers 56 are alternately positioned on the shafts 38 and 40 so that a scissor ring 46 on one scissor roll opposes a corresponding ring spacer 56 on the other scissor roll creating a circular material cavity 64 (FIG. 2) between the adjacent scissor rings and outward of the intermediate ring spacer 56. Once the material is cut or sheared, it is received in the material cavity 64 and passes between the rolls. The axes 39 and 41 are sufficiently spaced so that there is a slight overlap of approximately an eighth of an inch in the profile of the scissor rings so that as they are rotated the material is sheared by the shearing edges 54 as the profile of the scissor ring 46 moves into the circular material cavity 64 of the opposing ring spacer 56.

The apparatus 10 further includes feeding means (FIGS. 4 and 5) generally designated with the numeral 66 and includes a chute 68 that communicates with material entrance 32 for receiving the material and directing the material between the scissor rolls 34, 36. The chute 68 is defined, in part, by the front wall 20. Additionally, the feeding means include teeth mounted on the scissor rolls 34 and 36 for directing material between

scissor rolls 34 and 36. Preferably the feeding means includes a tooth 70 mounted on each of the scissor rings 46 at angularly located positions about the periphery of the scissor rolls 34, 36 to progressively direct material between the rolls. Preferably each tooth 70 is evenly spaced about the axis of the scissor roll. Each tooth 70 is formed by a curved bar that is complementary to the peripheral surface 48 of the scissor ring. Each curved bar is mounted by releasable bolts to respective scissor ring 46. Each tooth 70 has a leading abutment surface 76 for engaging and directing material between the scissor rolls. The thickness of the curved bar is less than the depth of the material cavity 64 so that the curved bar passes through the respective material cavity 64 of the complementary ring spacer 56. The depth of the material cavity 64 accommodates the curved bar 72 so that there is no interference.

The apparatus 10 further includes a concave screen plate 78 (FIGS. 4 and 5) that is supported between the side walls 22 and 24 by plate supports 80. The concave plate has a radius of curvature with an axis that is parallel with the axes 39 and 41. The screen plate 78 includes a screen section 82 that has a large number of holes formed therein of a desired diameter defining the size of the undersize small pieces that pass through the screen. The pattern and size of the holes may vary considerably depending upon the waste material and the resultant size desired. The concave plate 78 further has an air baffle section 84 that is downstream of the screen section 82 for preventing or minimizing the flow of air countercurrent to the flow of the material.

The apparatus 10 further includes a conveying means 86 for receiving the smaller pieces from the scissor rolls 34, 36 and for directing the smaller pieces over the screen section 82. The oversized small pieces are directed past the baffle section 84 and back to the feeding means 66 for recycling. Specifically in the preferred embodiment shown, the conveying means 86 includes a paddle wheel 88 (FIG. 4 and 5) that rotates on a shaft 90 about an axis 91 that is parallel with the axes 39 and 41. Preferably, the axis 91 is coincident with the axis for the radius of curvature of the concave plate 78. The paddle wheel 88 has a plurality of paddle blades 94 that extend across the wheel 88 between the side walls 22 and 24 for engaging the smaller pieces and moving the smaller pieces over the concave plate 78 permitting the undersized pieces to pass through the holes in the screen section 82 and for propelling the oversized particles with sufficient velocity to direct the oversized particles back to the feeding means 66 and more specifically into the chute 68 as illustrated in FIG. 5. There is a sufficient number of blades 94 so that there is always one of the blades 94 in registration with the air baffle section 84 to prevent an air current from flowing between the paddle wheel and the air baffle section 84 countercurrent to the propulsion of the oversized pieces as they are being recycled from the screen section 82 back to the chute 68 for further reduction in size by the scissor rolls 34, 36. In a preferred embodiment, each of the paddle blades 94 has a beveled outer surface 96 with an engaging front edge 97 for engaging the material and moving the material in a forward and upward direction along the screen section 82. Preferably there is a tolerance of approximately one-eighth inch between the engaging edge 97 and the concave plate 78 to facilitate efficient separation of the undersized and oversized particles over the screen section and to prevent countercurrent air flows between the air baffle section 84.

The apparatus 10 further includes a guide 100 for guiding the smaller pieces 14 from the scissor rolls 34, 36 to the conveying means 86. The guide preferably is constructed of plates 102 and 104 that extend between the side walls 22 and 24 respectively, above and below the flow of the material from the scissor rolls 34 and 36 to direct the material from the rolls to the conveying means 86. The plates 102 and 104 diverge from each other to provide a progressively increasing throat for the flow of small pieces as they emerge from the scissor rolls 34, 36. Each of the plates 102 and 104 has a plurality of fingers 106 that are formed thereon and extend into the material cavity 64 of the respective scissor rolls 34 and 36 to clean and direct the smaller pieces from the material cavity 64 toward the conveying means 86.

An air baffle 108 (FIGS. 4 and 5) is mounted intermediate the scissor rolls 34 and 36 and paddle wheel 88 to act in conjunction with the plate 102 to prevent formation of an air current counter to the flow of the propelled smaller pieces between the scissor roller 34 and the paddle wheel 88. The air baffle 108 has a surface of sufficient size so that at least one of the paddle blades 94 is in registration with the air baffle 108 to prevent air current flow therebetween. The air baffle 108 and plate 102 in addition with the scissor roll 36 provides a recycle passageway 110 in communication with the paddle wheel 88 for permitting the propulsion of the oversized smaller pieces in a recycled path from the paddle wheel 88 back to the chute 68 for recycling and reducing the oversize smaller pieces even further.

The apparatus further includes a vacuum means generally designated with the numeral 112 and includes a vacuum blower 114 for generating a vacuum on the downstream side of the screen section 82 to create an air current 116 through the apparatus as illustrated in FIG. 4. The air current 116 is directed through the material entrance 32 and then between the scissor rolls 34, 36 through the material cavities 64. The air current 116 then is directed and bounded by the plates 102 and 104 to the paddle wheel 88. The vacuum causes the air current 116 to flow through the screen section 82 to draw the undersized smaller pieces 14e therethrough to increase the efficiency of the separation on the screen section 82 and entrain the separated undersized smaller pieces 14e in the air current. The undersize small pieces are drawn through the screen section 82 into a vacuum duct 118 that communicates with the vacuum blower 114 for directing the entrained smaller particles 14e from the apparatus.

As previously noted, it is important that the air current 116 is directed in the specific path indicated and is not permitted to flow countercurrent in the recycle passageway 110 which would hinder the recycle trajectory of the material, as the pieces are propelled by the paddle wheel 88 back to the chute 68. The air baffle section 84 and the air baffle 108 minimize the creation of the extraneous air currents that would interfere with the proper flow of material while still at the same time encouraging and permitting the efficient separation of the undersized smaller pieces from the oversized smaller pieces and in assisting in cleansing the apparatus from dust and other small particulate material.

The apparatus further includes a drive means 120 that includes a motor 122 that is preferably mounted outside the enclosure 18 as illustrated in FIG. 3. The motor 122 is connected to a speed reduction transmission 124 which in turn is connected to the shaft 38. Preferably the speed reduction transmission 124 reduces the speed

of the shaft 38 to a speed of less than 500 rpm and more preferably to a speed of less than 200 rpm. In one specific example the motor 122 is driven at 1,300 rpm and the speed reduction transmission is a 10 to 1 reduction with the shaft 38 being driven at 180 rpm. The direction of the rotation of the shaft 38 is illustrated in FIGS. 4 and 5 and is in an opposite direction to the rotation of the shaft 40. The shaft 38 (FIG. 6) is operatively connected through sprockets 126, 127 and 128 via a chain 129 so as to coordinate the speeds of the shaft 38, 39 and 90. Preferably the sprockets 126 and 127 are the same size whereas the sprocket 128 is of a smaller size to rotate the paddle wheel 88 at a faster rpm than the rotation of the scissor rolls 34 and 36. It is important that the speed of the paddle wheel 88 be sufficient to move the oversized smaller particles at a sufficient velocity to propel the particles unsupported through the recycle passageway and over the scissor roll 34 back to the chute 68 to recycle the oversized smaller pieces. It has been found that for a particular size paddle wheel 88 that a speed of 240 rpm was sufficient to provide a proper relationship between the peripheral velocities of scissor rolls 34 and 36 and the peripheral velocity of the paddle wheel 88. A chain tensioner 130 is provided to provide a constant tension on the chain 129. The tension may be adjusted as desired.

During the operation of the apparatus, waste material is directed into the apparatus through the material entrance 32 into the chute 68. The chute 68 in conjunction with the teeth 70 mounted on the scissor rolls 34, 36 engage and direct the material between the scissor rolls 34 and 36 wherein the material is sheared into smaller pieces in a progression as illustrated in FIG. 1. Material then is directed by the guide plates 102 and 104 from the scissor rolls 34, 36 to the screen section 82. The paddle wheel 88 engages the material and conveys the material over the screen section 82 to enable the undersized small particles to pass through the holes in the screen section 82 and into the duct 118. The air current created by the vacuum means 112 assist in the separation and in conveying of the material on the screen section 82. Additionally, the vacuum means entrains the undersized smaller particles in the air current and conveys the particles from the apparatus. The oversized small pieces are then propelled by the paddle wheel upward and forward through the recycle passageway 110 as illustrated in FIG. 5 in a trajectory sufficient to cause the recycled small pieces to pass into the chute 68. The material will be continuously recycled until the size of the material is reduced to an undersized small piece that pass through the screen. In this manner the apparatus is made very compact and provides a single shearing station that is very efficient to progressively reduce the size of the material to the desired particulate size dictated by the size of the holes in the screen section 82.

It should be further noted that the apparatus is operated at a very slow speed even though the apparatus is very efficient in reducing the material in an expeditious manner. Should any foreign material enter into the apparatus, it will not damage the equipment as the scissor rolls 34 and 36 can, if jammed, stop the motor 122 without damaging the rolls particularly the shearing edges 54. Additionally should any of the parts come loose they will not materially damage the apparatus as the scissor rolls and the paddle wheel for operating at relatively slow speeds and can be stopped by foreign material without damaging the parts. Very importantly the machine operates very quietly even though substan-

tial shearing action is taking place. It is not unusual for the apparatus 10 to be operating at a decibel level far below what would normally be expected from a hammermill or the like. Thus the apparatus is very conducive to working conditions by employees even through there is a significant size reduction in the waste material. Other types of equipment require acoustical enclosures and noise reduction materials to protect the operators.

In compliance with the statute, the invention has been described in language more or less specific as to structural features. It is to be understood, however, that the invention is not limited to the specific features shown, since the means and construction herein disclosed comprise a preferred form of putting the invention into effect. The invention is, therefore, claimed in any of its forms or modifications within the proper scope of the appended claims, appropriately interpreted in accordance with the doctrine of equivalents.

What is claimed is:

1. Apparatus for comminuting waste material into pieces having a size less than a predetermined size, comprising:

a frame having an enclosure with an entrance opening for receiving the waste material;

a set of overlapping scissor rolls rotatably mounted on the frame for shearing the waste material into smaller pieces as the material is passed between the scissor rolls;

feed means for receiving the material from the entrance and directing the material between the scissor rolls;

a screen mounted on the frame within the enclosure downstream of the scissor rolls for permitting undersized smaller pieces of a size less than the predetermined size to pass therethrough and for preventing oversized smaller pieces of a size greater than the predetermined size from passing therethrough;

a recycle conveying means movably mounted on the frame within the enclosure for directing the smaller pieces over the screen and for recycling the oversized smaller pieces back to the feed means;

drive means operatively connected to the scissor rolls and the conveying means for rotating the scissor rolls to shear the material into progressively smaller pieces during each pass of the material between the scissor rolls and for moving the conveying means to direct the smaller pieces over the screen to permit the undersized smaller pieces to pass through the screen and to continually recycle the oversized smaller pieces back to the feed means until the smaller pieces are reduced to undersized small pieces; and

vacuum means for drawing air into the enclosure to form an air current and drawing the air current through the screen to entrain the undersized pieces passing through the screen therein and conveying the undersized pieces from the enclosure.

2. The apparatus as defined in claim 1 wherein the screen is concave shaped and the recycle conveying means includes a paddle wheel for receiving the smaller pieces from the scissor rolls and moving the smaller pieces over the screen to permit the undersized small pieces to be drawn through the screen and entrained in the air current and to propel the oversized small pieces from the screen to the feed means to recycle the oversized small pieces to the scissor rolls.

3. The apparatus as defined in claim 2 further comprising air baffles in the enclosure for directing the air

current between the scissor rolls and through the screen without impeding the propulsion of the oversized smaller pieces from the screen back to the feed means.

4. The apparatus as defined in claim 3 wherein the drive means rotates the paddle wheel at an angular velocity sufficient to propel the oversized smaller pieces in a desired trajectory to carry the oversized smaller pieces to the feed means for recycling back to the scissor rolls.

5. The apparatus as defined in claim 1 further comprising guide means between the scissor rolls and the screen for guiding the smaller pieces from the scissor rolls to the screen.

6. The apparatus as defined in claim 5 wherein the guide has finger elements projecting into the scissor rolls to clean the smaller pieces from the scissor rolls to prevent a build-up of the small pieces on the scissor rolls as the scissor rolls are rotated.

7. The apparatus as defined in claim 1 wherein each of the scissor rolls includes a plurality of scissor rings evenly spaced by sleeve spacers.

8. The apparatus as defined in claim 1 wherein each scissor roll includes a plurality of intermeshing scissor rings interspaced by sleeve spaces that are correspondingly offset to permit the scissor rings of one scissor roll to overlap scissor rings of a second scissor roll to shear the material as the material passes between the scissor rolls.

9. The apparatus as defined in claim 1 wherein the feed means include teeth affixed on the scissor rolls for engaging the waste material and directing the material between the scissor rolls as the rolls are rotated.

10. The apparatus as defined in claim 9 wherein the feed means further includes a chute for directing waste material from the entrance and oversized smaller pieces from the recycle conveying means to the teeth on the scissor rolls.

11. The apparatus as defined by claim 1 wherein the drive means rotates the scissor rolls at a speed of less than 500 rpm.

12. The apparatus as defined in claim 11 wherein the drive means rotates the scissor rolls at a speed of less than 200 rpm.

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