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[54] **PRODUCTION OF CARBON FROM WASTE MATERIALS**

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[52] **U.S. Cl.** .....**423/449**, 110/8 P, 201/17, 201/25, 209/12, 209/162, 209/166, 423/461

[51] **Int. Cl.** **C01b 31/02**

[58] **Field of Search**.....23/209.4, 209.1, 209.9, 260, 23/259.1; 201/25, 17; 209/173, 172, 214, 162–165, 166, 12; 241/20, 24, 68; 110/8 P; 71/14; 423/449, 461

[56] **References Cited**

UNITED STATES PATENTS

3,362,887	1/1968	Rodgers	201/25 X
3,275,547	9/1966	Bucksteeg et al.	201/25 X
2,964,184	12/1960	Gillette	241/68 X
1,523,739	1/1925	Vodicka	209/173
506,051	10/1893	Langville	23/209.9
2,998,375	8/1961	Peterson et al.	201/17 X
3,477,649	11/1969	LeRoy	241/24
3,524,594	8/1970	Anderson et al.	241/24 X
1,209,654	12/1916	Anderson	110/8 P
3,597,308	8/1971	Brooks	209/173 X
2,088,624	8/1937	Tschudy	209/164
2,136,074	11/1938	Crawford et al.	209/166
2,144,115	1/1939	Merz	209/166
2,885,078	5/1959	Fenske	209/166

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[57] **ABSTRACT**

A waste materials processing system and method sometimes involving material recycling, which converts solid waste materials, such as household garbage, demolition debris, and so forth, to usable products such as carbon, ash as lightweight aggregate, metals, both ferrous and non-ferrous, and inert fill material. Various methods of separation techniques are applied to separate combustibles from non-combustibles, ferrous materials from non-ferrous materials, lights from heavies, and liquid from solids, to accomplished desired results. Floatation techniques are relied upon to accomplish essential separations as hereinafter described.

2 Claims, 3 Drawing Figures

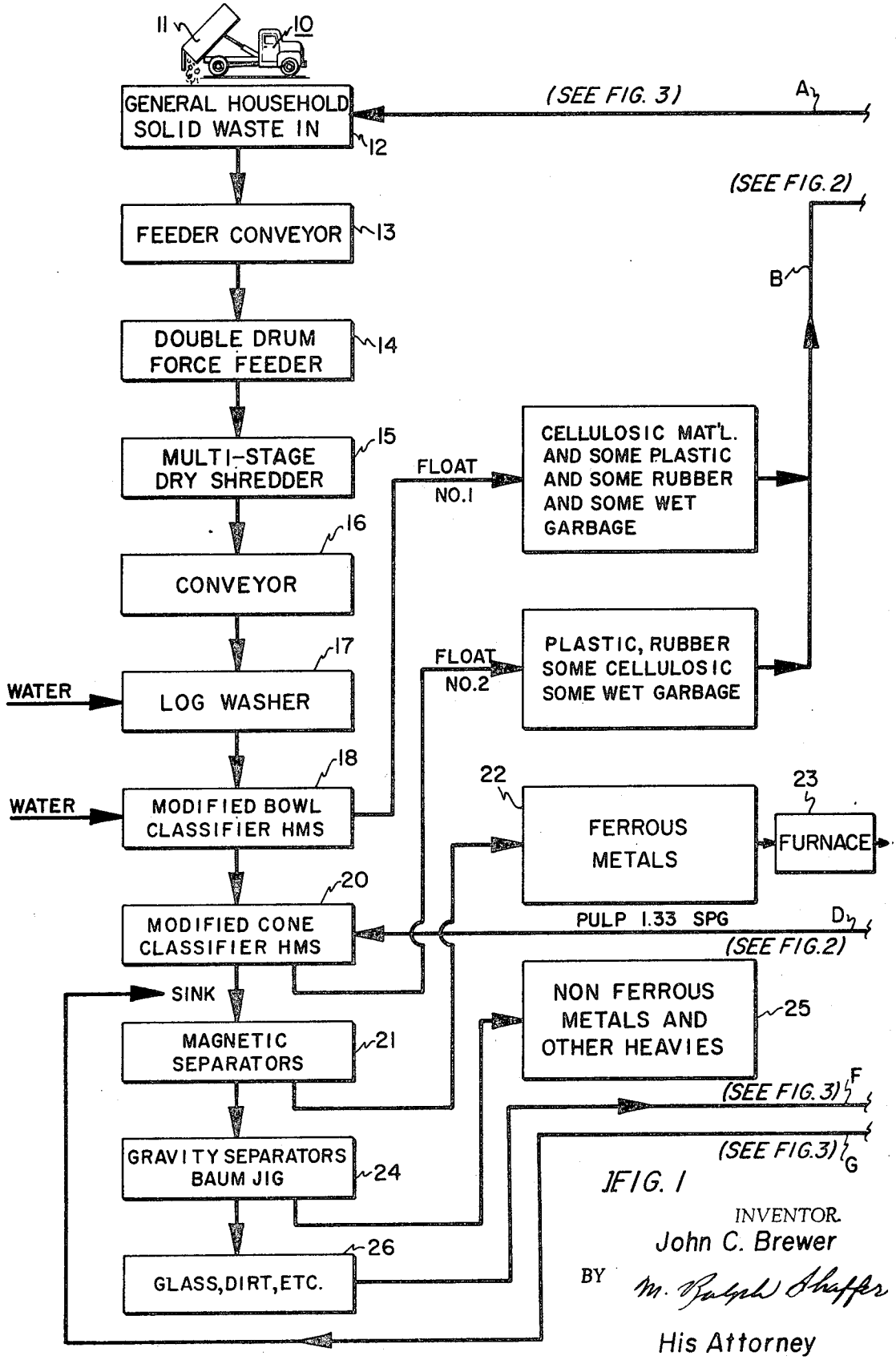

FIG. 1

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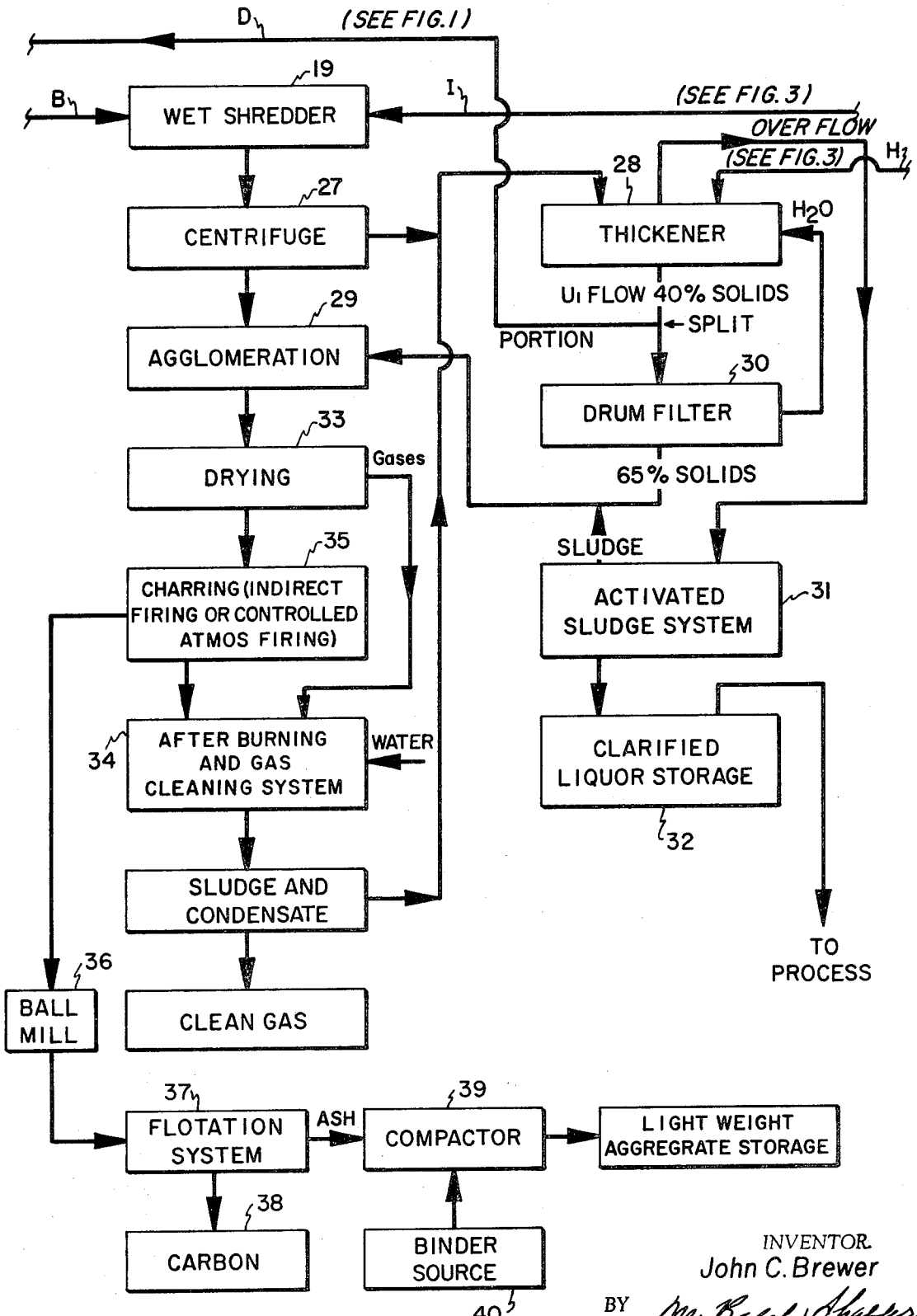

FIG. 2

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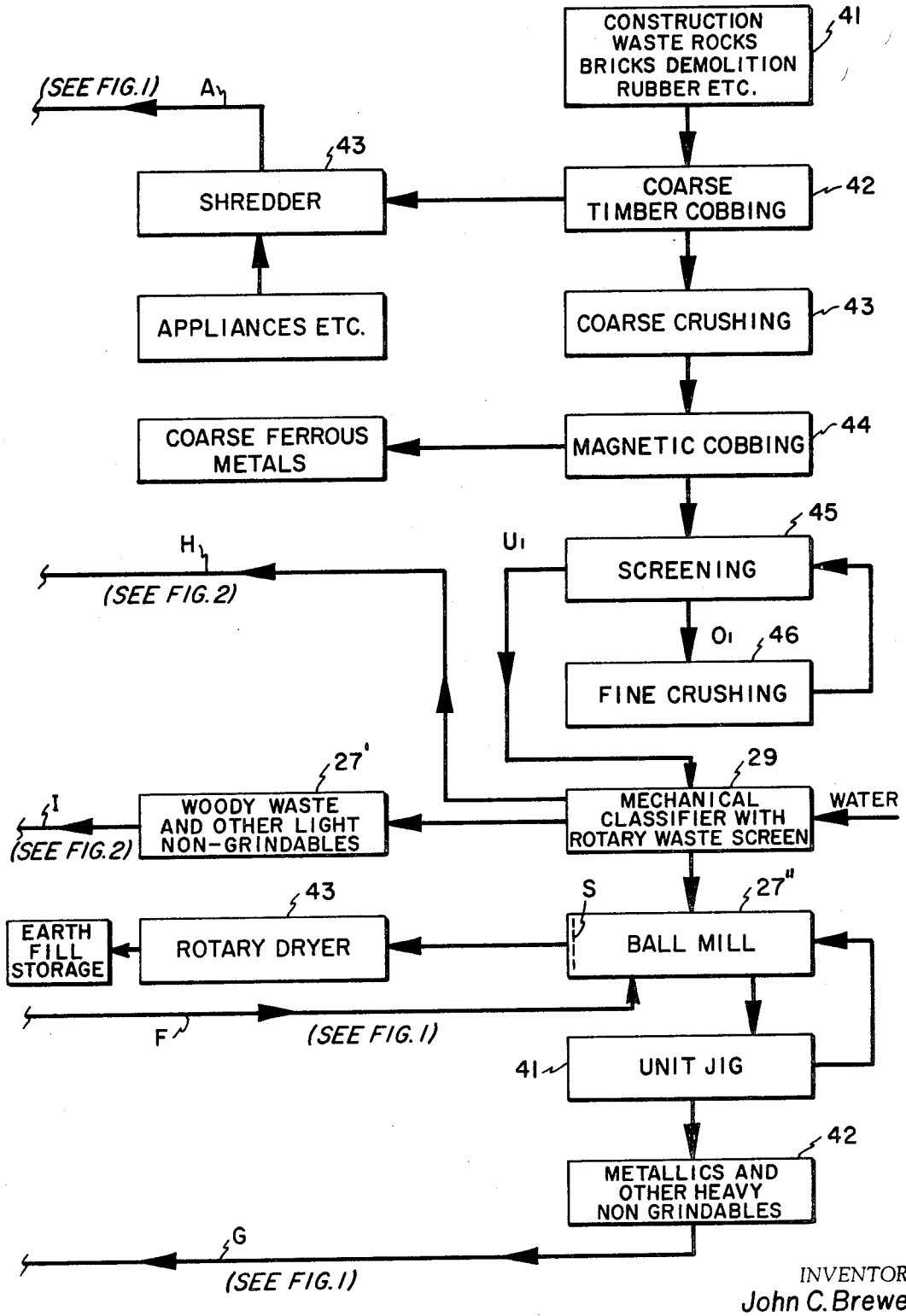

FIG. 3

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PRODUCTION OF CARBON FROM WASTE MATERIALS

The present invention relates to waste materials treatment and, more particularly, provides a system and process for treating waste materials of various types and descriptions in such manner that commercial end products are derived therefrom.

In the invention dry waste materials such as demolition debris is processed through a series of steps, culminating in milling, to produce granule-sized earth-fill material and separation of ferrous and non-ferrous metals. Garbage such as general household waste is processed in a wet environment which, ultimately, through flotation techniques, is separated on the basis of combustibles and non-conbustibles, this for separate processing to produce char (ultimately carbon and ash) and other products.

Recycling is incorporated, particularly as to water requirements, so that a closed aqueous system can be used to supply water at essential points.

Accordingly, a particular object of the present invention is to provide a new and improved process and system for the treatment of garbage and other debris.

An additional object of the invention is to provide a recycling type of waste processing system wherein water and/or other materials are recycled in an advantageous manner to achieve the results desired.

An additional object of the invention is to provide a waste-treatment system wherein flotation techniques are relied upon to achieve desired separations.

An additional object is to provide in a waste-treatment system a flotation system wherein ash and carbon may be separated, as in the presence of a disbursing agent, to produce carbon and light-weight aggregate for storage.

An additional object of a waste system for accommodating a wide variety of disposable debris, including even appliances, ferrous metals, construction debris, and this as well as general household waste.

An additional object is to provide a waste processing system wherein combustibles are separated from non-combustibles and separately processed through permissible application of flotation techniques.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation, together with further object and advantages thereof, may best be understood by reference to the following description, taken in connection with the accompanying drawings in which:

FIGS. 1–3 presents a schematic diagram in block diagram form, and illustrates one embodiment of a preferred system and method of the present invention; certain units thereof are particularized, with flow extensions of the three sheets of drawings being represented by identical letters, references to other drawing sheets being supplied.

In FIG. 1 truck **10** is shown to have an elevated bed **11** which dumps its contents into a first stage generally identified as "General Household Solid Waste In." This may comprise a receiving hopper **12** the contents of which are passed to a feeder conveyor **13**. Feeder conveyor **13** is a standard endless conveyor manufactured by numerous materials handling companies. The conveyor feeds into what is known in the art as a force feeder, see stage **14**, which is of a double-drum or other type.

Feeder **14** feeds into a multi-stage or other type of conventional shredder, preferably of the dry type, which can be identical or similar to the shredder manufactured by the Eidal Company of Albuquerque, N. Mex. The purpose of the shredder, of course, is to shred all of the materials fed to it through stages **12–14**. In particular, shredder **15** is included in the system to reduce in size the materials fed to it, for convenience of handling.

The output from shredder **15** is fed to a conventional endless conveyor **16** of standard design to enter into log washer **17**. Stage **17** generically comprises a re-pulper; any one of a number of types of equipment may be employed herein. It is preferable to use a log washer type re-pulper such as that manufactured by the McLanahan Company (a U.S. company). Water, as shown, is fed into the re-pulper, specifically log washer **17**, so as to mix with the shredded materials disposed therein.

Care should be taken in choosing the time cycle of operation of log washer **17**. It is preferable that the materials be urged speedily through the log washer so that the paper contents that are in the waste material fed through the washer will not tend to disintegrate excessively or otherwise become difficult to handle. Thus, it is preferable to use the log washer or other "re-pulper" at stage **17** in a manner such that there results a mere mixing of the materials therein and a combination thereof with the water fed into the input as indicated, this without permitting the materials to be retained in the log washer long enough so as to cause an awkward disintegration and suspension of paper products in the liquid environment.

The discharge from log washer **17** is fed into a classifier, termed as stage **18** in FIG. **1**, which generically comprises a flotation system. In the system shown in FIG. **1** the classifier takes the form of a modified bowl classifier HMS ("heavy media separation") e.g., the classifier manufactured by the Koppers Company, a domestic manufacturer. This system, classifier **18**, operates as a sink-float system by which there is floated out, via float "No. **1**," the floating combustibles such as cellulosic material, plastics, rubber, and some wet garbage. These materials are subsequently fed via line B (see now FIG. **2**) to a wet shredder **19**. The input to the wet shredder **19** also includes some additional materials the production of which will be hereinafter described.

Relative to classifier **18**, the resulted materials, i.e., that which did not separate and float out via the float No. **1** route in FIG. **1**, will be conducted to a second classifier **20** which can be a modified cone classifier (HMS) such as that manufactured by the Wemco, a division of Envirotech, Inc., a domestic corporation. It is noted that the modified bowl classifier receives not only the residue, that is, the non-floatables, but also such floatables as were not separated out via classifier **18**. It is to be understood that there may be a small portion of paper or other fibrous materials held in suspension in the water and not separated out via the float No. **1** path. Thus, materials such as plastic, rubber, and some cellulosic material with some wet garbage, are picked up and separated out via the modified cone clas-

sifier **20** and subsequently combined via the float route No. **2**, with the materials at float No. **1**, for routing to wet shredder **19**.

It will be seen that dropping out of the classifier at **20** will be the non-floatables such as the metals, rock products, dirt, and glass. These refer to the "sink" portion of classifier **20**, identified as such, and these materials are fed into a magnetic separation stage identified in FIG. **1** as magnetic separators stage **21**. Magnetic or other suitable means separates out the ferrous metals and deposits these suitably at a stage **22**. In practice, the ferrous materials recovered from the magnetic separators' stage **21** will be conveyed, so as to be separated from the magnetic separating stage and, if desired, directed through a furnace **23** so as to kill all bacteria that may be present. Subsequently the ferrous metals may be further processed, if desired, for sale or other desired disposal.

The materials remaining, that is, non-ferrous materials, are directed to a baum jig **24**, identified in the drawing as a "gravity separators' baum jig" that can be supplied by a domestic corporation known as the McNally Company. The purpose of baum jig **24** is to separate out non-ferrous metals and other heavies, see stage **25**, and route glass, dirt, etc. via flow path F, see also FIG. **3**, to ball mill **27''** the operation of which will be described hereinafter. The materials at stage **25**, if desired, may be subjected to further processing, as needed, for proper disposal and/or sale. By way of example, the materials at **25** may be formed as ingots, for supply to industry.

In returning to FIG. **2** at this time, it is seen that the wet shredder **19** utilized in the system may be such as that manufactured by the Bauer Brothers Company, an Ohio company. Feeding into the wet shredder **19** via conveyor line I will be the woody waste and other light non-grindables **27'** in FIG. **3**, the production of the latter of which will be described hereinafter. The purpose of the inclusion of the wet shredder **19** is to further reduce the in-coming material so that such may be adaptable for processing in a centrifuge and small enough for the following agglomeration stage. The materials received by centrifuge **27** (i.e., a centrifuge unit such as that currently manufactured by the Bauer Corporation of Ohio,) from the wet shredder **19** is separated such that the liquid phase enters a thickener **28**, whereas the solids' phase enters the agglomeration stage **29**. The agglomeration stage **29** may take the form of a currently manufactured "agglomerator" as manufactured by the Komerek-Greeves Company of Illinois.

Thickener **28**, such as one manufactured by the Eimco Corporation of Utah, is also fed materials assuming flow-path H, i.e., the thickened liquid phase received from the mechanical classifier **29** of FIG. **3**; a description of the operation of the latter follows. The output from thickener **28** is divided such that a portion thereof is fed to drum filter **30**, whereas a remainder travels via conveyor line D to the modified cone classifier **20** in FIG. **1**. It is noted that this pulp conveyed via line D will approximate 1.33 in specific gravity. Output from drum filter **30** is conveyed as solids to the agglomeration stage **29**, with liquid overflow being routed to thickener **28**. Now the overflow from thickener **28** is routed down to activated sludge system **31** in FIG. **2**. In FIG. **2** it is seen that liquid from the activated sludge system **31** is directed to clarified liquor storage stage **32** for re-use as liquid in the process. Correspondingly, sludge from the activated sludge system **31** is directed back to the agglomeration stage **29**.

We shall now return to the agglomeration stage **29**.

The agglomeration stage **29** has as its purpose a mixing of its inputs, i.e., the solid residue of the centrifuge, the solids from the drum filter **30**, and so forth. Accordingly, the agglomerator at **29** serves as a mixer for feeding the contents thereof to a drying stage **33**. Gases from dryer stage **33** are fed to an after-burning or gas cleaning system **34** such as a so-called gas scrubbing system as manufactured by Western Precipitators, a domestic company. The drying stage **33** may comprise a Ruggles-Coles dryer as manufactured by the Koppers Corporation above referenced, and is employed to further remove liquid and liquids as gases prior to charring. The dried materials are subsequently routed to the charring, indirect firing or controlled "atmospheric firing." Gases coming from the charring stage **35** are fed to the gas scrubbing system stage **34**, and sludge, particulate matter, and condensate from the latter are routed to thickener **28** in a manner shown.

Regarding again to the charring stage **35**, the char therefrom is routed to a ball mill **36** for grinding. The end products of ball mill **36** are routed to flotation system **37** where a reagent is added so that the ash and carbon portions of the char material may be separated. The reagent used operates as a dispersing agent and can comprise any one of a number of chemicals such as sodium silicate, tannic acid, sodium hexametaphosphate, or a chemical going under the trade name Calgon.

After the separation is effected by a flotation system **37**, then the carbon is collected at **38** and the ash is sent to compactor **39**. Introduced into compactor **39** is a binder originating from a binder source **40**. This binder may comprise common cement or any cementicious substance. The result is of course the production of a light weight aggregate or aggregate blocks to be used in the building industry, for example.

In referring now to FIG. **3**, where a sub-system relating construction debris is to be utilized, debris such as waste rocks, bricks, other demolition products, and so forth, at stage **41** is routed, for example, to an area **42** wherein coarse timber cobbing takes place. This is to say, the coarse timber is manually removed. The timber is then sent through a shredder **43** and is routed via conveyor line A to the hopper receiving the general household waste as at **12** in FIG. **1**. Also fed to the shredder are appliance products such as toasters, stoves, refrigerators, so forth which are shredded and also routed back to the input hopper at **12**. After timber cobbing, the remaining materials are fed to a coarse crusher, at **43**, of conventional design, wherein rock and concrete products are reduced in particulate size. The end products of coarse crushing step at **43** are fed to an area or hopper wherein magnetic cobbing as at **44** takes place. The coarse ferrous materials are separated by conventional magnetic means whereas the remaining materials at stage **44** are fed to a screening stage **45**. At the screening stage **45** the fines U_1 are routed to mechanical classifier **29** hereinbefore identified. The coarse materials 0_1 at the screening

stage 45 are fed through a fine crusher as indicated by stage 46 so that the fines may be routed back to screening 45 to appear ultimately as U_1 fines routed to classifier 29.

Mechanical classifier 29 may be provided with a rotary waste screen, an optional, standard classifier item, which will route woody waste and other light non-grindables at 27' via line I to wet shredder 19 in FIG. 2, to proceed through the related sub-system shown in FIG. 2. The balance of the materials at the classifier stage 29 are fed to ball mill stage 27'' and combined with the glass, dirt, and so forth, at stage 26 for further reduction. The products from ball mill 27'', i.e., dirt-type products, glass and so forth, are routed from ball mill 27'' to a rotary dryer to become inert and used as earth fill. The coarse, non-grindables from the ball mill 27'' are routed via unit jig 41 in the conveyor direction G. Such will comprise metallics and other heavy non-grindables, as illustrated in stage 41.

Unit jig 41 can be identical to the baum jib before referenced.

It is noted relative to FIG. 3 that the heat-treated and, hence, inert fines from the rotary dryer 43 are routed to a storage place simply identified as earth fill storage. It is noted that the metallics and other heavy non-grindables at stage 42 are routed via conveyor line G back to the "sink" portion of the modified cone classifier 20, where such drop into the magnetic separator stage 21.

The above description has considered the individual stages, elements and processes in detail in connection with the present invention. A general summary is deemed helpful and now will be made.

Firstly, general household solid waste material is conveyed as by truck to an input hopper at 12 in FIG. 1. The materials to be household solid waste materials are received and processed as indicated to the flotation system 18, preferably a bowl classifier, and in any event which accomplishes a sink-float method of separation. The initial float fraction, i.e., taking the coarse "float No. 1," is combined with a second float fraction produced through by the cone classifier 20, so that these materials can be passed through the wet shredder 19 and ultimate agglomeration, drying, and charring. Gases are cleaned such that clean vapors and/or gases are exhausted to the atomosphere, for example, whereas the char is milled and introduced into a separate and independent flotation system for separating carbon and ash. The carbon and ash are independently collectible and stored for desired uses. It is noted that all of the materials collected at the float No. 1 and the float No. 2 points are conbustibles so as to be directly routed to the carbon-ash sub-system, i.e., the left-hand side of FIG. 2. It is noted that this sub-system also takes cognizance of and processes the coarse timber and other combustibles related to demolition products collection as at 41.

There remain other portions of the over-all system which are important. These include taking cognizance of the possible presence of ferrous or magnetic materials which are separated out at stage 21 in FIG. 1 for subsequent processing and/or storage. It is noted that it is difficult to separate metals where metal fragments are surrounded by combustible materials. In the present invention such difficulty is avoided since the combustible materials are first separated out, i.e., floated out, so that all that remains are the ferrous and non-ferrous materials plus glass, dirt and so forth. This is a much more effective approach in easily removing, by conventional magnetic means, the ferrous materials for stock piling at 22 and possible subsequent treatment as at 23.

Once the magnetic or ferrous materials are removed, gravity separators such as a baum jig 24 can be utilized to separate out non-ferrous metals and other heavies from the glass, dirt and so forth that remains. The latter, of course, is routed to the ball mill 27'' for grinding, and the fines coming therefrom can be dried and stored as earth fill material. Coarse or non-grindable materials at ball mill 27'' can be routed through a unit jig for separation into future grindables or heavy non-grindables as at G.

In any event, the result is a collection of ferrous metals at 23, of non-ferrous metals at 25, and of earth fill storage at the output side of rotary dryer 43.

Note is to be made that the materials to be subjected to a ball mill process include not only the glass, dirt and so forth at stage 26 in FIG. 1, but also includes the materials resulting from the collection and processing, as shown in FIG. 3, of the construction demolition materials.

Note, further, is to be made of the unique closed liquid system of the invention wherein all liquids used are fed into the sub-systems shown in the upper right-hand portion of FIG. 2. Here, by the use of thickener 28, drum filter 30, activated sludge system 31 and liquor storage 32, the water may be continuously reused and fed, for example, into stages 17 and 18 in FIG. 1 as well as into the mechanical classifier 29 in FIG. 3.

Note also is to be made that the processed water at 32 in FIG. 2 is also employed in the cleaning or scrubbing system as at 34.

Reduced to barest essentials, then, in the present invention shredded materials are conveyed to a log washer where a water-mix action takes place. The result is discharged to a bowl classifier wherein cellulose, plastics, rubber, and other combustible materials are separated and sent through a wet shredder to be reduced and agglomerated. This agglomeration is combustible and will be sent to a by-products furnace for coking, see charring stage 35.

While this is being performed relative to the combustibles, the non-floatables, non-combustibles such as dirt, glass, metals, and so forth are sent through a magnetic separation stage 21 wherein the ferrous metals are removed. The balance of non-floatables will be sent through a gravity separation stage, see baum jig 24, wherein the non-ferrous metals and other heavies are removed. The rest of the non-floatables are sent to a ball mill, for example, to be reduced to dirt. The dirt and recovered metals are heat treated to kill all bacteria and to be rendered inert. Referring again to the combustibles as they were derived in the sub-system relating to the charring stage 35, it is noted that charring or char products are fed to ball mill 36 where the ultimate production of separated carbon and ash takes place. In a larger sense, stage 35 may be referred to as a distillation stage, i.e., in the sense that vapors arising from the char may be separately cleaned, collected, derived as condensate and stored as clean gas and/or

condensate. In any event, if simple scrubbing is desired, then suitable water spray will be supplied stage **34** to accomplish the desired effect. It is to be noted at this point that, if desired, gases such as chlorides and florides may be separately collected and stored, even as liquids, relative to the charring or distillation step at **35**.

It is noted that the resultant carbon at **38** may be sold for fuel, water treatment or for other purposes where finely divided absorbative carbon is required. The remaining products can likewise utilizable in various industries for various needs as above described.

It is seen that the above describes a new system and process, incorporating a series of sub-systems and sub-processes, of refuge treatment, for multiple uses and purposes, and incorporates appropriate recycling where necessary to cover the broad spectrum of waste disposal and treatment. Where not needed in specific environs, certain portions of the system, such as the sub-system beginning at **41** in FIG. **3**, may be deleted from the over-all system, where such treatment is not needed; note, for example, the absence of demolition waste.

By way of further explanation relative to flotation system **37**, conventional flotation cell such as that used in the copper industry may be utilized. This time, however, in addition to the dispersing agent utilized aforementioned, kerosine may be introduced in the acqueous cell as a carbon collecting agent. Kerosine has the effect of coating the surfaces of the particulate carbon so that the same will cling to bubbles formed in the froth of the cell. The froth is produced by the addition of a suitable frothing agent such as metholisobutylcarbinol.

In practice, the carbon is drawn off via the froth whereas the ash will tend to settle and/or be suspended as a thick slurry in the lower portion of the flotation cell. Where desired, and depending on the percentage of water used in the cell, the ash may be routed to a thickener and then filtered and dried, as required.

While particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from this invention in its broader aspects, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

I claim:

1. A method of processing municipal non-sewage waste materials comprising various types of mixed, non-floatables and also floatable carbonaceous substances, to obtain carbon from the latter, including the steps of collecting said waste materials, shredding the so-collected waste materials, sink-float classifying and thereby separating said floatable carbonaceous substances from said non-floatables, drying said floatable carbonaceous substances, charring said carbonaceous substances, milling the so-charred carbonaceous substances and subjecting to a froth-flotation step the so-milled substances to separate out carbon therefrom.

2. A method of recovering carbon from non-sewage municipal waste comprising a variety of non-floatables and also floatable carbonaceous substances including the steps of collecting said waste, shredding the so collected waste, sink-float classifying and thereby separating said floatable carbonaceous substances from said non-floatables, wet-shredding said floatable carbonaceous substances, drying said floatable carbonaceous substances, charring said floatable carbonaceous substances to produce a carbon and ash-containing material, milling said material, and then subjecting to froth-flotation the so-milled material to separate carbon from the ash-containing residue thereof.

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