



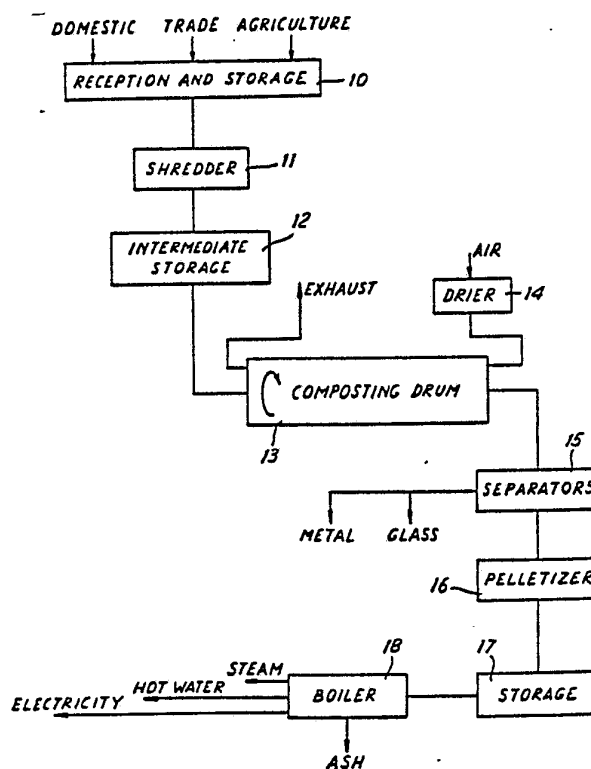
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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**(54) Title:** METHOD FOR THE PRODUCTION OF A FUEL FROM WASTE

**(57) Abstract**

A method and apparatus for the production of fuel from waste materials comprises fermenting the waste materials in a rotating drum (13) so that the heat generated can dry the materials sufficiently to prevent any further organic decomposition and thereafter pelletizing the fermented material to form fuel in a pelletizing machine (16).



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Method for the production of a fuel from waste

This invention relates to the production of a useful fuel, usable for example for steam-raising, from waste materials.

A discussion of the problems of waste disposal, and examples of methods of making use of waste materials as a fuel, are contained in British Patents 1551019 and 1551020.

The invention proposes a method for the production of fuel from waste materials comprising fermenting said waste materials in a rotating drum whereby the heat generated can so dry the materials as to prevent any further organic decomposition and thereafter pelletizing the fermented material to form the fuel.

Such a method requires the use of a pelletizer, which at first sight needs such a heavy energy input that the resultant fuel would be uneconomically expensive. Surprisingly, however, two highly beneficial effects are produced : first, the pelleted fuel is so much easier to handle, store and use that it is more desirable and thus more valuable; second, its water content is further reduced in pelletizing and its calorific value thus substantially enhanced.

Preferably, the process is a continuous one, rather than a batch process, and reduces the moisture content



of the material at the exit from the composting drum to between 23 and 33%, and after the pelletizer to between 18 and 28%. The residence period in the drum is normally less than 12 hours.

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In order that the invention shall be clearly understood, an exemplary embodiment thereof will now be described, with reference to the accompanying drawing which shows a process flow chart of a method according to the invention.

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Waste materials for use in the process are derived from three main sources - houses (domestic waste), trade and agriculture. The proportions of each vary according to the location of the plant. Some of the waste, e.g. metal and glass, has no calorific value for the end fuel and must be removed so far as possible. At the other end of the scale, the more that organic materials, e.g. paper, wood, plastics, packaging or vegetable matter, are present, the higher the eventual calorific value of the fuel. These organic materials are preponderantly present in agricultural wastes, and may also include fibrous material e.g. husks, peelings, etc. from factories operating on agricultural products.

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It can be seen that the method is therefore ideally suited to an area which is considerably agricultural but which also has a substantial urban population.

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In the plant according to the invention, waste materials of all descriptions are delivered by lorry to a reception and storage area 10. It is preferred to be able to marshal the waste to produce an even mixture of all the different kinds, if this is not achieved without intervention. From area 10, the waste is

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passed to a powerful shredder 11, possibly in the form of a hammer mill. In this case, no pre-sorting of the waste is needed; only the very heaviest individual lumps e.g. engine blocks, need to be removed. All other waste will be disintegrated to less than 100 mm particle size, with 98% less than 50mm.

From the shredder the waste passes to a large volume intermediate store 12. This has two major functions. First, it serves as a buffer for smoothing out variations in supply of waste e.g. at weekends, and ensures continuous operation of the fermentation drum. Second, when simply piled, the shredded waste, which may have a total moisture content (i.e. free or surface moisture, plus internal moisture) in the region of 38% (the range may be 30 to 60%), can start anaerobic spontaneous fermentation with a consequent temperature rise. In fact, under suitable ambient conditions, its temperature can rise before it enters the fermentation drum to the operating temperature of the drum, i.e. 70 to 80°C. Thus, no heat and no extra water needs to be injected into the drum.

The shredded waste is moved by conveyor and/or hopper into the drum 13.

The drum may typically have a length of 80m and a diameter of 4.5m. Its function is to ferment and dry the raw shredded waste. The drum will process on a continuous basis a charge of about 300 tonnes. This will represent a charging rate of about 40 tonnes/hour and a discharge rate of about 30 tonnes/hour, the balance being the water removed. The charge will take between 6 and 12 hours to pass through, the average residence time being in the region of 9 hours and being



adjustable according to the charging rate by varying its speed of rotation so as to produce the driest product possible. A forced air draught is passed through a drier 14 and then in countercurrent through the drum. It is important that the air passed through the drum should be dry, since this maximises the amount of water which can be removed and the efficiency of the drying process in the drum. The air both removes the moisture released from the waste material, and assists the aerobic fermentation. The latter serves to both further break down the waste, and to generate the heat necessary to drive off the water. The water content can be reduced from its starting figure to one in the region of 23 to 25% (by weight) at the drum exit. In fact, it cannot go below the lower figure because the conditions for fermentation cease to exist, and thus heat generation and further dewatering cease.

At this stage the waste matter has been reduced to a particle size of less than 50 mm. with 90% less than 20mm. However, it still contains both metal and glass, which must now be removed in one or more separators 15. It is a positive advantage that this mineral waste is present in the drum, since it assists considerably in further reducing the particle size while the fermentation stage is proceeding. these may be magnetic (for ferrous metal) or gravity (for all heavy fractions). The latter type of separator can be very effective in respect of the waste matter now involved, since the really valuable fibrous waste for the fuel is inevitably very much less dense than all the rest. The metal extracted can obviously be baled and sold as scrap. The nature and amount of the remaining mineral solids, will vary enormously dependant upon the plant location, and must be disposed



of as appropriate - possibly as land-fill aggregate.

5 It is important to remove these solid mineral fractions, since they can otherwise cause excessive wear and damage to the pelletizer 16 which follows. This is a conventional piece of apparatus, but its use in the present invention is important and surprisingly advantageous. In a typical application, it is used to produce extruded pellets of largely fibrous matter 75  
10 mm length x 18 mm diameter. A considerable energy input (approximately one third of the process total energy) is required to the pelletizer to produce the compaction, but this process has the additional effect that the friction involved generates considerable heat  
15 and this is sufficient to reduce the water content of the waste by a further 5%, i.e. to between 18 and 23%.

In fact, the waste in the form it leaves the separators  
15 is ideally suited for pelleting, since it has consistent, fibrous characteristics, without abrasive content, and of suitable moisture level. In turn, the pellets are a much more satisfactory fuel product than  
20 the loose waste produced by known processes. They can be burnt in conventional boilers, without admixture of coal, and because they are compacted with a smooth  
25 outer surface they are much less hygroscopic than the loose fuel. Thus, there is less danger of renewed fermentation with production of noxious liquors and smells. Therefore, the pellets can be stored  
30 virtually indefinitely without deterioration (instead of requiring to be burnt immediately), and are easier to handle and require smaller storage space. They are also cheaper to transport.

35 In the integrated plant described, they are passed to



storage 17 and from there as required directly to a boiler 18. This boiler can be used to produce hot water, steam, or electricity, normally without any additional fuel. Its residue of ash is approximately 5 17% of the dry weight of the original fuel, rather less relative to the actual weight. The ash is also saleable as aggregate.

This process and plant is designed for use in an area 10 having a relatively high agricultural/fibrous waste input, and not too high a proportion of dense solids. It also runs at its most economical with a high ambient temperature, such as exists in, for example, African countries. Samples of typical waste in a central 15 African city gave figures of around 23% paper and cardboard, 60% putrescibles (i.e. vegetable and other organic waste), the remainder being plastics, textiles, metal, glass, etc. It is calculated that a plant handling 200 tonnes of this waste can produce a steam 20 output of  $3.633 \times 10^8$  KCal at a heat efficiency overall of about 70%. Such an outcome for what is in fact at the same time and primarily a comprehensive waste disposal system must be regarded as highly satisfactory.

25 In other areas and climates, certain modifications may be required. These would mainly concern the intermediate storage 12, and the separators 15. In colder climates, it may not be sufficient simply to 30 pile the waste to initiate fermentation, so that a second smaller fermentation drum may be required, possibly with some heat input. However, it is believed that otherwise the process could proceed as described. With more heavy industrial waste, more or 35 different separators may be required. Moreover, the



energy input to the shredder is higher the less water is present in the waste materials, so that overall the heat efficiency of the system may be lower. But the system is still capable of operating on unsorted waste and continuously.

In certain circumstances, in order to maintain the throughput of the continuous process, by reducing what would be an uneconomically long residence time in the drum, it may be advisable or necessary to inject heat into the drum. This can be achieved by using the drier 14 to heat the air as well. The aim would be to achieve an optimum 70 to 80°C in the drum.



Claims

1. A method for the production of fuel from waste materials comprising fermenting said waste materials in a rotating drum whereby the heat generated can so dry the materials as to prevent any further organic decomposition, and thereafter pelletizing the fermented material to form the fuel.
2. A method as claimed in claim 1, wherein the water content of the material at the exit from the drum is in the region 23 to 25% by weight.
3. A method as claimed in claim 1 or 2 wherein the method is operated continuously and the residence time in the drum is between 6 and 12 hours.
4. A method as claimed in any preceding claim wherein dry air is fed in countercurrent through the drum.
5. A method as claimed in claim 4 wherein said air is also heated before injection into the drum.
6. A method as claimed in any preceding claim wherein the fermentation is preceded by a shredding operation, and followed by a process for separation of mineral waste.
7. A method as claimed in any preceding claim, wherein the pelletizing is carried out in such a way as to produce a fuel with a water content of between 18 and 23%.



8. A method as claimed in any preceding claim wherein  
5 prior to fermentation, the waste material is piled for  
a period during which anaerobic fermentation is allowed  
to occur and the temperature rises before entry to the  
drum.

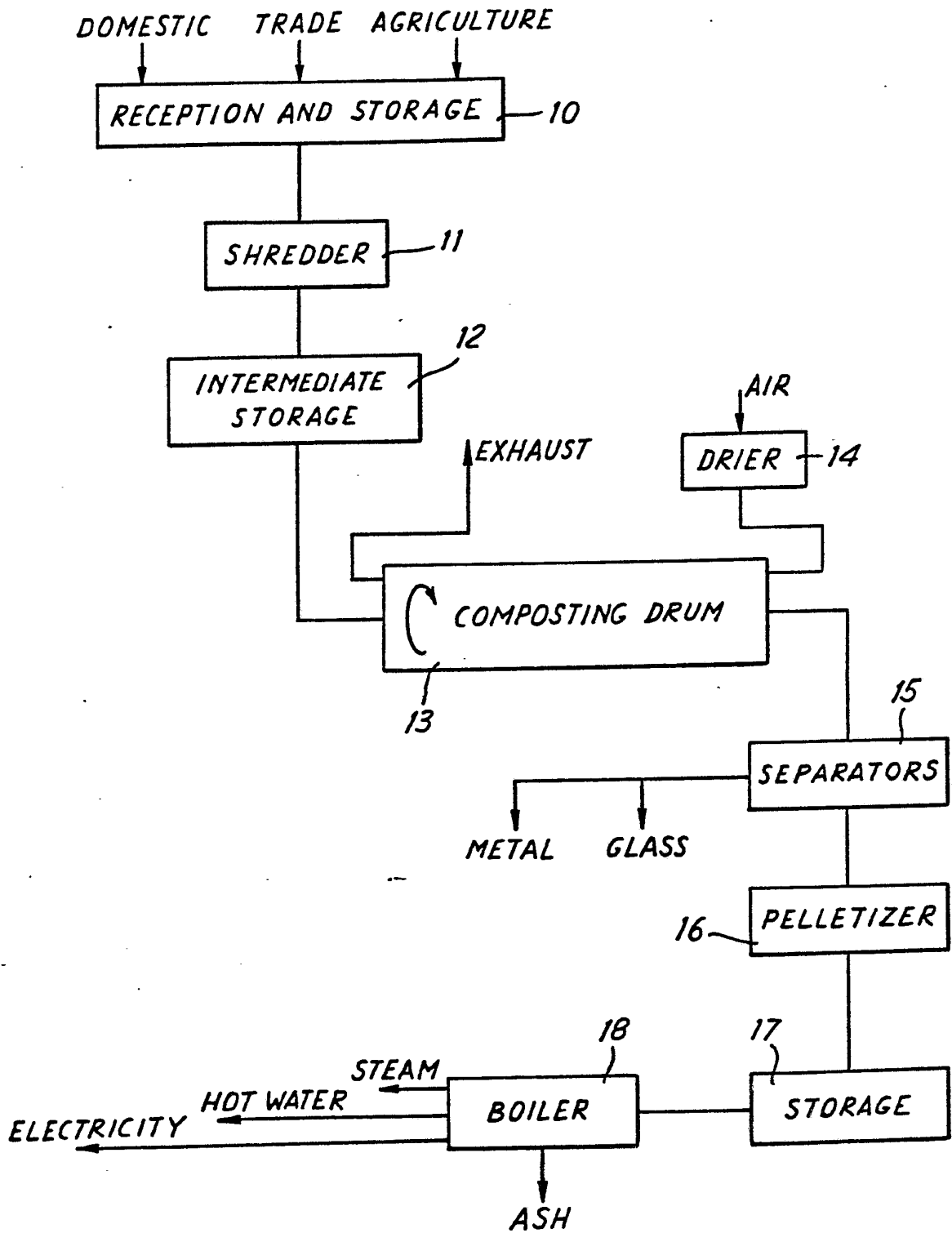
10 9. A method as claimed in any of claims 1 to 7,  
wherein a pre-fermentation is carried out in a second  
drum, prior to the fermentation, with injection of  
heat.

15 10. A method as claimed in any preceding claim,  
followed by direct burning of the fuel to produce power  
in a power generator on-site.

20 11. A method for the production of fuel from waste  
materials substantially as herein described with  
reference to the accompanying drawings.

25 12. Apparatus for manufacturing fuel from waste  
comprising a rotary fermentation drum followed by a  
pelletizing machine which converts the output of the  
drum into fuel pellets having a lower water content  
than said output.





# INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 83/00043

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>3</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC <sup>3</sup> : C 10 L 5/46		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>4</sup>		
Classification System	Classification Symbols	
IPC <sup>3</sup>	C 10 L	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>5</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>14</sup>		
Category <sup>6</sup>	Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>18</sup>
X,Y	FR, A, 1248249 (DELATTRE) 31 October 1960, see abstract --	1-7,10-12
Y	GB, A, 1551020 (REFUSE DERIVED FUELS) 22 August 1979, see claims 1-4 (cited in the application) --	1-7,10-12
Y	WO, A, 81/03029 (KEANE) 29 October 1981, see claims 1,4,5 --	1-7,10-12
X	FR, A, 2307866 (LAOS) 12 November 1976, see claims 1-6 --	1
P	EP, A, 0058128 (ARBED) 18 August 1982, see claims 1-4 ----- --	1
<p><sup>15</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"G" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search <sup>19</sup>	Date of Mailing of this International Search Report <sup>20</sup>	
8th June 1983	28 JUN 1983	
International Searching Authority <sup>1</sup>	Signature of Authorized Officer <sup>20</sup>	
EUROPEAN PATENT OFFICE	G.L.M. Kruydenberg	

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 83/00043 (SA 4829)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 22/06/83

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR-A- 1248249		None	
GB-A- 1551020	22/08/79	None	
WO-A- 8103029	29/10/81	EP-A- 0050153 AU-A- 7171981	28/04/82 10/11/81
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EP-A- 0058128	18/08/82	LU-A- 83114	10/09/82

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