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(54) Title: AN APPARATUS FOR DECOMPOSING RUBBER PRODUCTS THROUGH PYROLYSIS

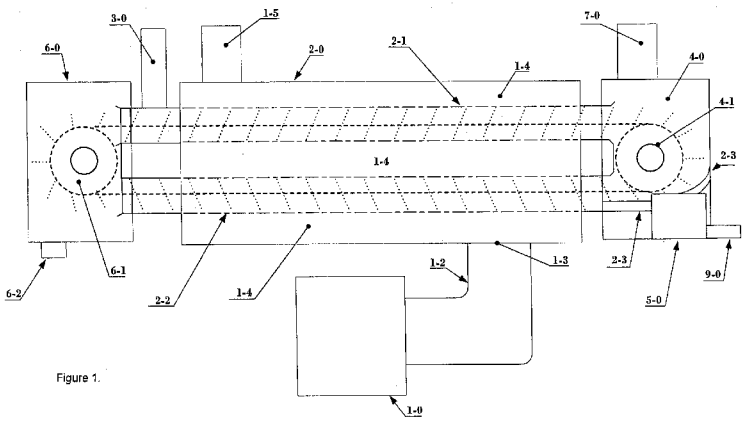

Figure 1.

(57) Abstract: The present invention relates to a carbonization reactor (1 -0) to decompose used rubber products and the like by heating the rubber products under constant high temperature and the reactor comprise a conveyor (2-0) which continuously move and drag the rubber products through cylinders (2-1, 2-2) where the decomposition process takes place to produce recyclable by products such as carbon black, oil vapour and the like.

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AN APPARATUS FOR DECOMPOSING RUBBER PRODUCTS THROUGH PYROLYSIS

FIELD OF INVENTION

The present invention relates to an apparatus for decomposing rubber products through pyrolysis.

BACKGROUND OF INVENTION

In the destruction of rubber products such as used tyres and the like, numerous types of systems have been employed, some with unfavourable results. One of such system is blending shredded used tyres to become surface materials which are experiencing a depleting in demand. Used tyres have and will continue to become a waste hazard that proves difficult to deal with a waste that cannot be combusted without extensive flue gas treatment due to the generation of noxious gases e.g. hydrogen sulfide.

Current systems only process shredded used tyres in batches due to limiting operating capacity such as the time needed to load and unload such used tyres.

Therefore there is a need of a system which is able to destroy used rubber products more effectively and efficiently as the volume of used rubber products is rising at an alarming rate.

SUMMARY OF INVENTION

Accordingly, the present invention provides an apparatus for decomposing rubber products through pyrolysis, (a) a thermal inlet for receiving thermal energy to heat up the apparatus under a controlled temperature, (b) a feed port for receiving inlet products, (c) an outlet port for discharging carbonized products, (d) an outlet duct for extracting oil vapour and synthesis gas after the inlet product is partially composed, (e) a first cylinder to partially decompose the inlet product, (f) a second cylinder to completely decompose the inlet product and (g) a conveyor means to move and drag inlet products through to the first cylinder and the second cylinder wherein in operation, said conveyor means is continuously moving and dragging said inlet products from said feed port through said first cylinder and through said second cylinder and re-enters said feed port to further collect inlet products to be decomposed.

The present invention consists of several novel features and a combination of parts hereinafter fully described and illustrated in the accompanying description and drawing, it being understood that various changes in the details may be made without departing from the scope of the invention or sacrificing any of the advantages of the present invention.

BRIEF DESCRIPTION OF THE DRAWING

The embodiment of the invention will now describe, by way of example only, with reference to the accompanying figure in which:

Fig. 1 illustrates the apparatus for decomposing rubber products according to the preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention relates to an apparatus for decomposing rubber products through pyrolysis. Hereinafter, this specification will describe the present invention according to the preferred embodiments of the present invention. However, it is to be understood that limiting the description to the preferred embodiments of the invention is merely to facilitate discussion of the present invention and it is envisioned that those skilled in the art may devise various modifications and equivalents without departing from the scope of the appended claims.

For a better understanding of the invention, Fig. 1 relates to a carbonization reactor (1-0) for decomposing used rubber products such as used rubber tyres and the like.

Although the description hereinafter refers to used rubber products such as rubber tyres and the like, it is understood that the invention can be used to decompose unused rubber products such as used rubber tyres or unused rubber products such as unused rubber tyres with defects, or a combination of both.

The used rubber products herein referred as the inlet product is fed into the reactor (1-0) at an entry duct or feed port (3-0) from a continuously feeding conveyor and falls by gravity onto a continuously rotating conveyor means or drag chain conveyor (2-0). The inlet product is then dragged by the continually moving drag chain conveyor (2-0) which, at a controlled speed, conveys the inlet product through an upper conveying transfer cylinder or a first cylinder (2-1).

As the inlet product is drawn through the upper conveying cylinder (2-1) its temperature is increased by thermal energy being transferred from high temperature air circulated through the void surrounding the conveying transfer cylinders (2-1, 2-2). The conveying transfer cylinders (2-1, 2-2) are sealed from the void surrounding them and operate under partial vacuum i.e. oxygen is below its stoichiometric level to permit combustion; hence the inlet product chemically decomposes through a pyrolysis process. The pyrolysis process transforms the inlet product

into carbon black, oil vapour and syngas leaving the residual steel wire that was contained in the shredded inlet product as the only original faction.

Transformation of the inlet product is completely achieved in the reactor due to the specified length of the main body (2-0) and the time the inlet product is conveyed by drag chain conveyor (2-4) which loops back on itself in the shape of a 'rounded rectangle' in a controlled high temperature environment.

The looping path of the drag chain conveyor (2-0) is achieved by the drag chain being captured by a drive sprocket (4-1) which is driven by a variable speed motor (5-0). The drive end (4-0) of the reactor is located at one end and the drag chain motion is maintained on a fixed path of travel through the conveying transfer cylinders (2-1, 2-2) by a freewheeling sprocket (6-1) at the opposite end.

The inlet product is fed onto the drag chain conveyor (2-0) at a feed port (3-0) located at the same end as the freewheeling sprocket (6-1). The thermal energy from a heat generator (10-0) enters the reactor void space (1-4) via a purpose designed refractory lined transfer duct (1-2), the thermal energy maintains a heat transfer rate, with a circulating air temperature within the reactor between about 500°C to about 800°C, at the thermal inlet (1-3) to the reactor being located at the opposite end to the inlet product entry (3-0) and in the void space (1-4) of the invention. These opposing entries of the inlet product and the thermal energy provide a contra-flow path which, by adjusting the rate of feeding the inlet product at the inlet product entry (3-0) and the travel rate (rotation) of the drag chain conveyor (2-0) the extraction of oil vapour and syngas from the inlet product by the pyrolysis process is maximised.

As the partially decomposed inlet product enters the drive end (4-0) of the reactor the oil vapour and syngas that have been extracted from the inlet product are drawn out of the invention via the oil vapour/syngas outlet duct (7-0) located at the top of the reactor drive end section (4-0).

The drag chain conveyor (2-0) at the drive end (4-0) exits from the upper conveying cylinder (2-1) into the reactor drive section (4-0), the partially de-composed inlet product will fall from the drag chain conveyor into a catch tray (4-2) fixed at the base of the reactor drive section (4-0). The catch tray (4-2) is designed to capture the partially de-composed inlet product and funnel it to the center of the catch tray (4-2). The diameter of catch tray (2-3) is slightly larger than the plates of the drag chain conveyor (2-0). The drag chain conveyor (2-0) is moved round the drive sprocket (4-1) and in doing so collects the partially de-composed inlet product that fell into the catch tray (2-3) and drags this into a lower conveying cylinder or a second conveying cylinder (2-2).

As the drag chain conveyor (2-0) is a continuously moving conveyor it drags the partially decomposed inlet product through the second conveying transfer cylinder or the lower conveying cylinder (2-2) until it reaches the outlet of the lower conveying cylinder (2-2) located in the drive free wheel section (6-0) at which point, due to the variable speed at which the inlet product was conveyed though the reactor, the control of temperature inside the reactor, the transfer of thermal energy from the thermal energy section (1-3) to the conveying cylinders (2-1, 2-2), and the maintaining of a partial vacuum in the conveying cylinders of the reactor, the inlet product is now completely decomposed into carbon black together with any residual steel wire that remained in the inlet product at the time of being fed into the reactor.

On entering the freewheeling drive section (6-0) the carbon black and residual steel will fall from the drag chain (2-0) into the de-composed product outlet (6-2) at the base of freewheeling drive section (6-0). The drag chain continues to loop over the free-wheeling sprocket (6-1) so that it re-enters the upper conveying cylinder (2-1) and collects further inlet product to be decomposed thus completing and continuing the carbonization process of the inlet product.

The invention incorporates all necessary temperature, pressure, level and flow instrumentation and control for operating the reactor and to provide protection against upset operational conditions. Safety features are also designed into the reactor for prevention and/or reaction to over and under pressure conditions.

It should be understood that various changes, adaptations and modifications may be made thereto without departing from the gist of the invention and the scope of the claim. It should be understood; therefore, that the invention is not limited to details as illustrated and shown in the figures and that it may include variations as will be apparent to one skilled in the art.

CLAIMS

1. An apparatus for decomposing rubber products through pyrolysis, the apparatus includes:

   (a) a thermal inlet (1-3) for receiving thermal energy to heat up the apparatus under a controlled temperature;

   (b) a feed port (3-0) for receiving inlet products;

   (c) an outlet port (6-2) for discharging carbonized products;

   (d) an outlet duct (7-0) for extracting oil vapour and synthesis gas after the inlet product is partially composed;

   (e) a first cylinder (2-1) to partially decompose the inlet product;

   (f) a second cylinder (2-2) to completely decompose the inlet product; and

   (g) a conveyor means (2-0) to move and drag inlet products through to the first cylinder (2-1) and the second cylinder (2-2)

   wherein in operation, said conveyor means (2-0) is continuously moving and dragging said inlet products from said feed port (3-0) through said first cylinder (2-1) and through said second cylinder (2-2) and re-enters said feed port (3-0) to further collect inlet products to be decomposed.

2. The apparatus as claimed in claim 1, wherein the rubber products are used rubber products such as used rubber tyres or unused rubber products such as unused rubber tyres with defects, or a combination of both.

3. The apparatus as claimed in claim 1, wherein the said thermal inlet (1-3) is located opposite said feed port (3-0) to provide a contra-flow path of thermal energy.

4. The apparatus as claimed in claim 1, wherein the inlet product is shredded before entering said feed port (3.0).

5. The apparatus as claimed in claim 1, wherein temperature of circulating air within said reactor is between about 500°C to about 800°C.

6. The apparatus as claimed in claim 1, wherein the first cylinder (2-1) and said second cylinder (2-2) is sealed and operating under partial vacuum to chemically compose said inlet products.

7. The apparatus as claimed in claim 1, wherein the conveyor means (2-0) is continuously moving at a controlled and variable speed to achieve maximum carbonization of said inlet products.

8. The apparatus as claimed in claim 1, wherein the conveyor (2-0) continuously moving in a loop-like motion by moving under a freewheeling sprocket (6-1) which is located at the same end as said feed port (3-0) to continuously collect said inlet product to be decomposed.

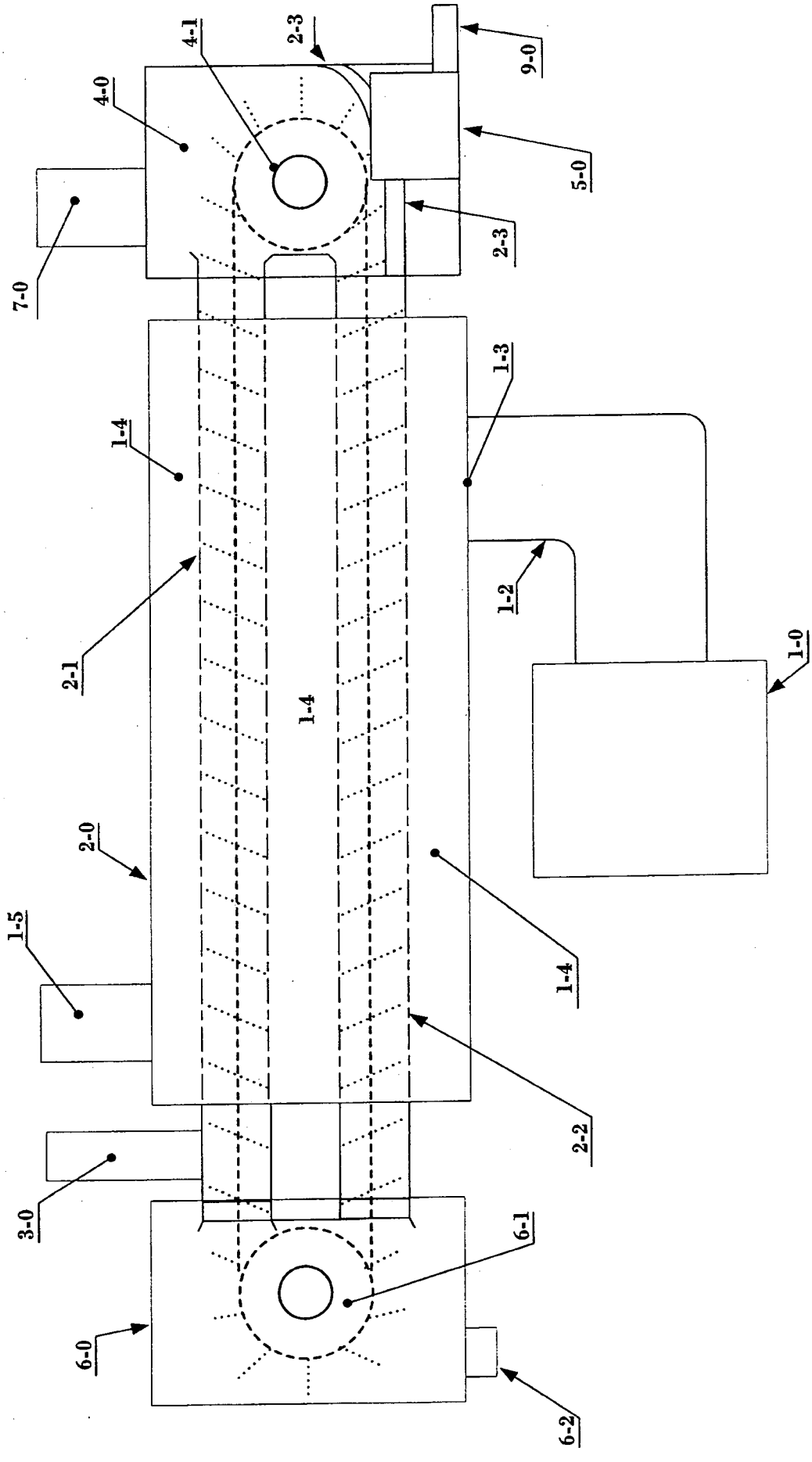

Figure 1.

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

C10B 7/06 (2006.01) ***C10B 53/07*** (2006.01) ***C10G 1/10*** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPODOC, WPI: EC/IPC – C10B; Keywords – convey+, tyre?, rubber+, chain, conveyor and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/142441 A1 (DONG-A E.N.C. CO., LTD.), 13 December 2007 *Abstract; paragraphs [5], [14], [15], [33]-[43]; figures 1,3, 4, 8*	1-4, 8
Y	*Abstract; paragraphs [5], [14], [15], [33]-[43]; figures 1,3, 4, 8*	5-7
Y	US 2007/0227417 A1 (AGUAYO A.L. et al.), 04 October 2007 *Abstract; paragraph [0035], [0048]; figure 3, 4*	5
Y	WO 2006/119594 A1 (KOLEV, D. et al.), 16 November 2006 *Abstract; page 2, lines 47-49; figure 1*	5
Y	US 5082534 A (BREU, F.A.), 21 January 1992 *Abstract; column 1, lines 21-24*	5

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 September 2010	08 SEP 2010
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. +61 2 6283 7999	Authorized officer **MARULI SAPUTRA** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : +61 3 9935 9626

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2010/000122

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4686008 A (GIBSON, H.T.), 11 August 1987 *Abstract; column 4, lines 31-33*	5
Y	US 5167772 A (PARKER, SR., T.H.), 01 December 1992 *Abstract; column 4, lines, 10-11, column 5, lines 30-34, column 6, lines 12-14, 51-55*	6-7

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/MY2010/000122

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
WO	2007142441	NONE					
US	2007227417	EP	2008025	US	2009114519	WO	2007113605
WO	2006119594	AP	1875	AU	2006246242	BG	109150
		CA	2607304	CN	101171323	EA	200701718
		EP	1879978	KR	20080021643	MX	2007013998
		NO	20076313	NZ	563220	US	2008202913
		ZA	200709429				
US	5082534	CA	2038146	EP	0446930	JP	6212163
		US	5225044	US	5258101	US	5342421
		US	5453164				
US	4686008	NONE					
US	5167772	NONE					

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX