PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification [4] :		(11) International Publication Number:	WO 85/ 02007
F23K 3/00, F23J 1/02	A1	(43) International Publication Date:	9 May 1985 (09.05.85)

(21) International Application Number: PCT/SE84/00342

(22) International Filing Date: 17 October 1984 (17.10.84)

(31) Priority Application Number: 8302684-9

(32) Priority Date: 24 October 1983 (24.10.83)

(33) Priority Country: SE

(71) Applicant *(for all designated States except US):* SCANDIACONSULT AB [SE/SE]; Kapellgränd 7, S-102 65 Stockholm (SE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only) :* ASPLUND, Frank, Eskil, William [SE/SE]; Dalbovägen 15, S-191 45 Sollentuna (SE). JANTZE, Ulrika, Margareta [SE/SE]; Gotlandsgatan 74, S-116 38 Stockholm (SE).

(74) Agent: DELMAR, John-Åke; Östermalmsgatan 45, S-114 26 Stockholm (SE).

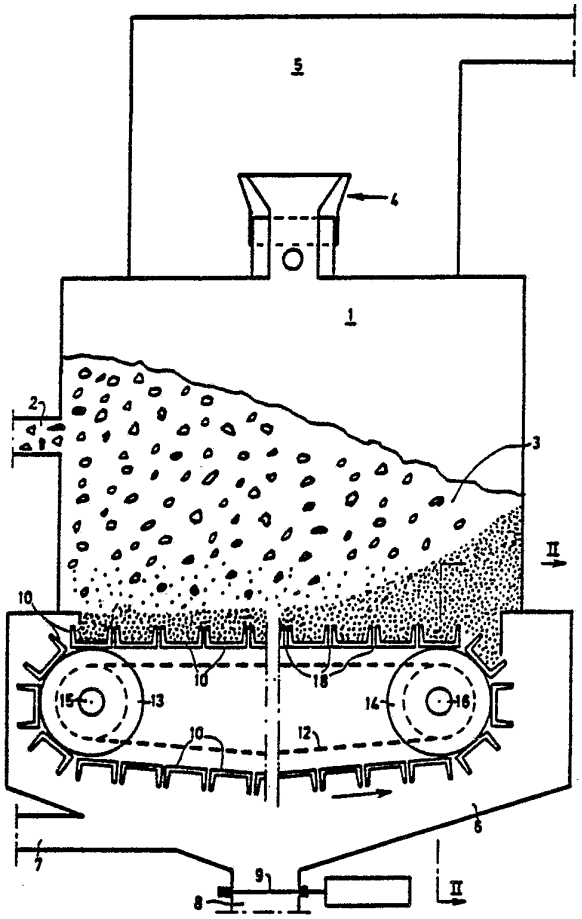
(81) Designated States: DE (European patent), DK, FI, FR (European patent), JP, US.

Published
With international search report.

(54) Title: A METHOD AND DEVICE FOR FIRING SOLID FUELS, MAINLY IN THE FORM OF LUMPS OR PIECES

(57) Abstract

Method and device for firing solid fuels, substantially in the form of lumps or pieces, in a furnace having a combustion chamber (1) with a sustantially horizontal bottom (10), upon which is maintained a fuel bed (3) with relatively great thickness while supplying fuel within the very bed (3), through which bed primary combustion air is fed from below through mutually spaced primary air passages (18) in the combustion chamber bottom (10), the combustion gas which leaves said chamber (1) furthermore being subjected to a subsequent secondary combustion in a secondary combustion chamber after addition of secondary combustion air. In order to provide for a mechanical removal of ash the invention suggests that the fuel is supplied into the bed positively and intermittently at a position on an end wall of said combustion chamber (1) at a vertical height spaced above the bottom (10) of the latter but below the upper surface of the fuel bed during operation of the furnace and substantially in horizontal direction, whereby at each occasion newly supplied fuel provides an an agitation of the bed (3) such that a concentrated combustion zone is obtained at the upper portion of the bed, while finally combusted fuel in the form of ash is progressively moved towards the opposite end wall of the combustion chamber (1) and downwards and along the combustion chamber bottom (10), wherefrom the ash is removed in horizontal direction during furnace operation.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	**GA**	Gabon	**MR**	Mauritania
AU	Australia	**GB**	United Kingdom	**MW**	Malawi
BB	Barbados	**HU**	Hungary	**NL**	Netherlands
BE	Belgium	**IT**	Italy	**NO**	Norway
BG	Bulgaria	**JP**	Japan	**RO**	Romania
BR	Brazil	**KP**	Democratic People's Republic of Korea	**SD**	Sudan
CF	Central African Republic			**SE**	Sweden
CG	Congo	**KR**	Republic of Korea	**SN**	Senegal
CH	Switzerland	**LI**	Liechtenstein	**SU**	Soviet Union
CM	Cameroon	**LK**	Sri Lanka	**TD**	Chad
DE	Germany, Federal Republic of	**LU**	Luxembourg	**TG**	Togo
DK	Denmark	**MC**	Monaco	**US**	United States of America
FI	Finland	**MG**	Madagascar		
FR	France	**ML**	Mali		

A METHOD AND DEVICE FOR FIRING SOLID FUELS, MAINLY IN THE FORM OF LUMPS OR PIECES

The present invention refers to a method and a device for firing solid fuels, substantially in the form of lumps or pieces, in a furnace having a combustion chamber with a substantially horizontal bottom, upon which is maintained a fuel bed with relatively great thickness while supplying fuel within the very bed, through which bed primary combustion air is fed from below through mutually spaced primary air passages in the combustion chamber bottom, the combustion gas which leaves said chamber furthermore being subjected to a subsequent secondary combustion in a secondary combustion chamber after addition of secondary combustion air.

Combustion methods and devices of this kind are previously known and it is also known to fire such furnaces with insufficient supply of primary air, which implies that above the fuel bed is formed an energy-rich gas which after admixing with secondary air is burnt in a secondary combustion chamber. A problem in connection with firing methods and devices of this kind resides in the removal of ash and slag from the combustion chamber. Conventionally, the bottom of the combustion chamber is constituted by a grid-like grate through which primary air is supplied. Ash and slag have to be removed by hand after stopping the fuel supply and complete down-burning of the fuel bed.

Another problem in connection with previously known firing methods and furnaces of the above-stated kind is that it is extremely difficult to obtain a uniform distribution of the primary air flow over the entire cross section of the combustion chamber. This leads to a non-uniform combustion and impaired efficiency.

Partly, said above-stated problems are dependent on each other since the formation of slag within one area of the combustion chamber cross section causes an impaired

air flow within said area such that the air distribution becomes non-uniform which in its turn causes an unsuitable combustion temperature and slag formation caused thereby.

The main object of the present invention is to eliminate the above-stated problems and to provide for an effective removal of ash and other combustion residues and to provide a uniform distribution of the primary air flow of the entire cross section of the combustion chamber. According to the present invention this is obtained by a method which distinguishes in that the fuel is supplied into the bed positively and intermittently at a position on an end wall of said combustion chamber at a vertical height spaced above the bottom of the latter but below the upper surface of the fuel bed during operation of the furnace and substantially in horizontal direction, whereby at each occasion newly supplied fuel provides an agitation of the bed such that a concentrated combustion zone is obtained at the upper portion of the bed while finally combusted fuel in the form of ash is progressively moved towards the opposite end wall of the combustion chamber and downwards and along the combustion chamber bottom, wherefrom the ash is moved in horizontal direction during furnace operation.

The invention also provides for a device for carrying out said inventive firing method in a furnace having a substantially horizontal bottom, upon which is maintained a fuel bed with relatively great thickness while supplying fuel within the very bed, through which fuel bed primary combustion air is fed from below through the combustion chamber bottom, which consists of a plurality of mutually substantially parallel beams, which extend over the whole width of the combustion chamber and which are mutually spaced so as to form gaps therebetween, said combustion chamber in its upper portion furthermore having an orifice

for admixing secondary air to the combustion gas leaving the combustion chamber in order to carry out a subsequent secondary combustion in a secondary combustion chamber. According to the present invention said device is distinguished in that the fuel supply inlet is located at a position on an end wall of the combustion chamber at a vertical height spaced above the bottom of the latter but below the upper surface of the fuel bed during the furnace operation and adapted to supply fuel positively and intermittently and substantially in horizontal direction and in that the beams are arranged horizontally movable in parallel by associated endless conveying means driven by a drive device in order to provide for a mechanical ash removal during the operation of the furnace.

By way of example, the invention will be further described below with reference to the accompanying drawings, in which Fig. 1 is a diagrammatical cross section of a furnace with a device according to an embodiment of the invention and Fig. 2 is a section along the line II-II in Fig. 1.

In Fig. 1 is illustrated a furnace for firing solid fuels, substantially in the form of lumps or pieces. The furnace comprises a combustion chamber 1 which at one of its end walls is provided with an inlet 2 for supplying fuel at a relatively high level in the chamber 1. Owing thereto there might be provided a fuel bed 3 of relatively great thickness, the combustion being adapted to take place in the upper portion of said fuel bed 3 while the lower portion of said bed serves to provide a good distribution of the primary air to the upper portion. At the upper end of the combustion chamber 1 there is an orifice 4 in which secondary air is mixed with the gas from the combustion chamber 1, the secondary combustion being carried out in a secondary combustion chamber 5, into which the orifice 4 opens.

At its lower end the combustion chamber 1 merges into a primary air box 6, to which primary air is fed through a primary air duct 7. The lower portion of the air box 6 simultaneously serves as ash discharge hopper and an ash outlet 8 with a valve 9 is arranged at the lower end of the box.

At the position of merger between the combustion chamber 1 and the air box 6 is located a device for discharging ash and distributing the primary air. Said device which also is illustrated in Fig. 2, comprises in the embodiment illustrated a plurality of mutual parallel U-beams 10, which have a length such that they extend over the whole width of the combustion chamber 1. As is evident from Fig.2 the ends of said U-beams 10 are supported from support beams 11 which are mounted along the sides of the combustion chamber 1. In a suitable way such as by welding the U-beams 10 are connected with two endless conveyor chains 12 of which only one has been illustrated in the drawings. Said chains 12 run over sprockets 13 and 14 which are supported on shafts 15 and 16, respectively. The shaft 16 is driveable by means of a drive device 17 which comprises a drive motor and a suitable reduction gear. The dimensions of the U-beams 10 and their mutual spacing are selected such that the gaps 18 between the beams have a width and mutual spacing that the distribution of primary air supplied through the duct 7 becomes uniform over the entire cross section of the combustion chamber 1.

When firing solid fuels in a furnace according to the present invention fuel is intermittently fed into the fuel bed 3 through the substantially horizontal fuel inlet 2 and primary air is supplied through the duct 7 and distributed through the gaps 18 between the U-beams 10.

Hence, the fuel will move progressively from left to right in Fig. 1 of the drawings and will then firstly be pre-heated and dried such that moisture present in the

fuel, particularly as far as coal is concerned, is evaporated. The steam thus evaporated will be carried obliquely upwardly to the right by the primary air towards a concentrated intense combustion zone in the upper portion of the fuel bed 3 and substantially in the middle or slightly to the right of the middle in Fig. 1 of the drawings, where said steam contributes to the improvement of the gasifying of the fuel. The positive feeding of the solid fuel through the inlet 2 at a relatively high level but still below the upper surface of the fuel while the operation of the furnace as is evident from Fig. 1 of the drawings also implies an agitation and raising of the fuel bed closest to the inlet. By the intense combustion more forwardly or to the right within the upper portion of the bed the upper surface of the bed will progressively sink in said direction, however, at the same time as the amount of ash of course increases rapidly in the same direction. The slope of the upper surface of the bed implies that when supplying new fuel through the inlet 2 burning fuel will carry out an orbiting or rolling motion progressively towards the right end of the furnace.

In the ash removal the drive device 17 drives the chains 12 and thus also the U-beams 10 which then move in an endless path, the upper portion of which is arranged such that in this location the beams form the bottom of the combustion chamber 1. During their movement the beams will progressively scrape away the lowermost layer of the fuel bed which has been burnt to ash. When the beams 10 pass over the sprocket 13 the ash and combustion residues will fall down into the ash discharge hopper in the air box 6.

The surprisingly good operation of the firing method and furnace according to the invention thus resides both in the uniform primary air distribution owing to the last-mentioned design of the combustion chamber bottom in the form of mutually parallel beams 10 and in the particular

feeding of the solid fuel through a horizontally directed fuel inlet 2 located at one of the end walls of the combustion chamber 1 at a vertical level spaced above the combustion chamber bottom 10 but below the upper surface of the fuel bed during furnace operation.

The firing method and the device according to the invention might be automatized as known per se by means of level transducers which detect a predetermined uppermost and/or lowermost level of e.g. the upper said surface at the middle of the length of the combustion chamber 1, i.e. such that at too low a level the fuel feed through the inlet 2 is started but stopped when a predetermined uppermost fuel bed level is detected. In its turn, the ash removal might be automatized by means of a detection of the primary air pressure drop through the bed 3, i.e. such that when the pressure drop from the primary air inlet through the bed and to a point above said bed 3 in the combustion chamber 1 exceeds a predetermined value a control signal is formed by means of well-known equipments for bringing the ash removal device with the parallel U-beams 10 to start for removing ash. Then the combustion has led to the forming of so much ash that has been compressed to such an extent that the throughflow of primary air is obstructed too much.

The invention is not limited to the above-described embodiment but changes might be made within the scope of the accompanying claims.

CLAIMS

1. A method for firing solid fuels, substantially in the form of lumps or pieces, in a furnace having a combustion chamber with a substantially horizontal bottom, upon which is maintained a fuel bed with relatively great thickness while supplying fuel within the very bed, through which bed primary combustion air is fed from below through mutually spaced primary air passages in the combustion chamber bottom, the combustion gas which leaves said chamber furthermore being subjected to a subsequent secondary combustion in a secondary combustion chamber after addition of secondary combustion air, characterized in that the fuel is supplied into the bed positively and intermittently at a position on an end wall of said combustion chamber at a vertical height spaced above the bottom of the latter but below the upper surface of the fuel bed during operation of the furnace and substantially in horizontal direction, whereby at each occasion newly supplied fuel provides an agitation of the bed such that a concentrated combustion zone is obtained at the upper portion of the bed, while finally combusted fuel in the form of ash is progressively moved towards the opposite end wall of the combustion chamber and downwards and along the combustion chamber bottom, wherefrom the ash is removed in horizontal direction during furnace operation.

2. A device for carrying out the method according to claim 1 for firing solid fuels, substantially in the form of lumps or pieces, in a furnace (1) having a substantially horizontal bottom (10), upon which is maintained a fuel bed with relatively great thickness while supplying fuel within the very bed, through which fuel bed primary combustion air is fed from below through the combustion chamber bottom, which consists of a plurality of mutually substantially

parallel beams (10), which extend over the whole width of the combustion chamber (1) and which are mutually spaced so as to form gaps (18) therebetween, said combustion chamber (1) in its upper portion furthermore having an orifice (4) for admixing secondary air to the combustion gas leaving the combustion chamber (1) in order to carry out a subsequent secondary combustion in a secondary combustion chamber (5), c h a r a c t e r i z e d i n that the fuel supply inlet (2) is located at a position on an end wall of the combustion chamber (1) at a vertical height spaced above the bottom of the latter (10) but below the upper surface of the fuel bed (3) during the furnace operation and adapted to supply fuel positively and intermittently and substantially in horizontal direction, and in that the beams (10) are arranged horizontally movable in parallel by associated endless conveying means (12) driven by a drive device (17) in order to provide for a mechanical ash removal during the operation of the furnace.

Fig. 1

1/2

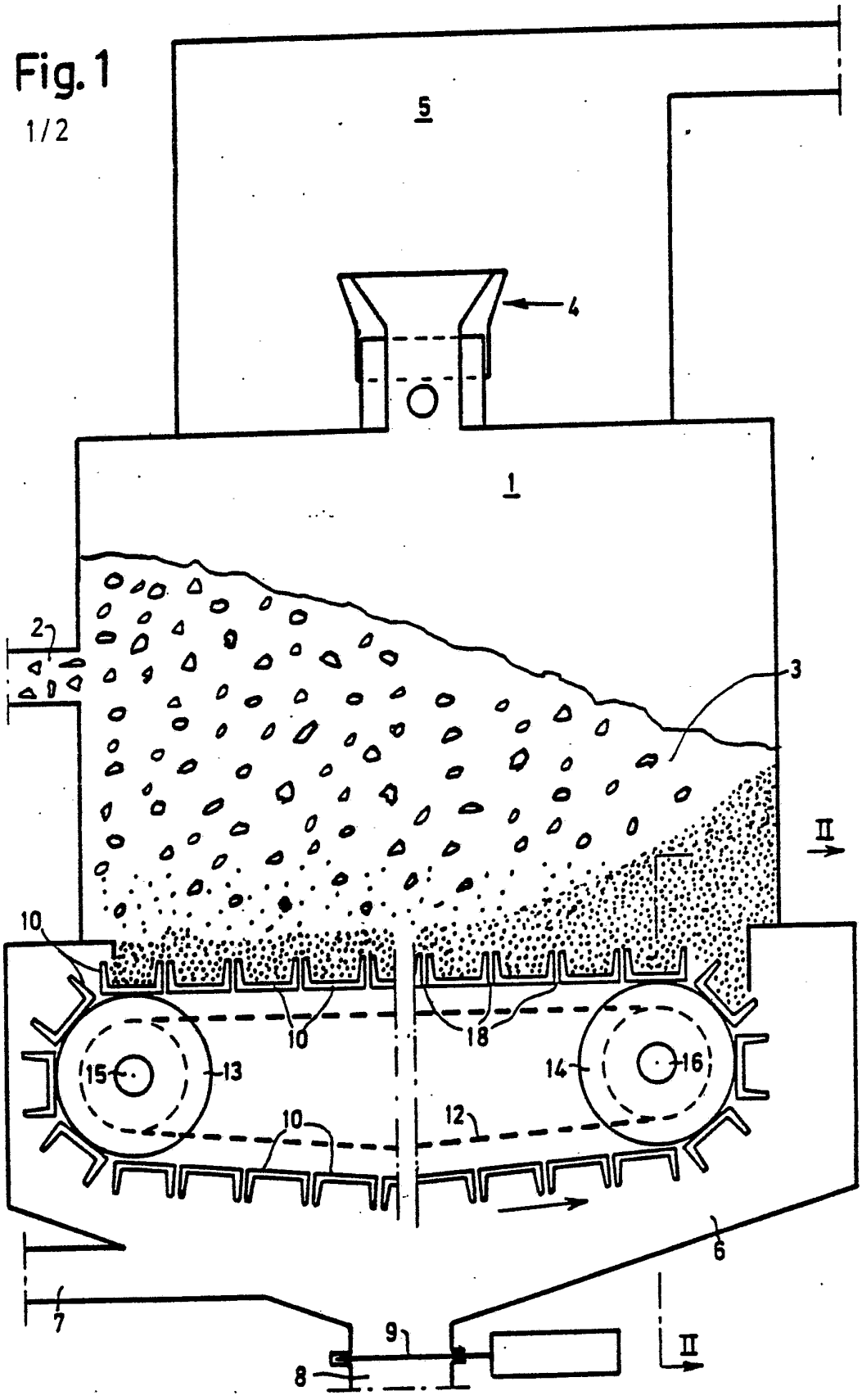
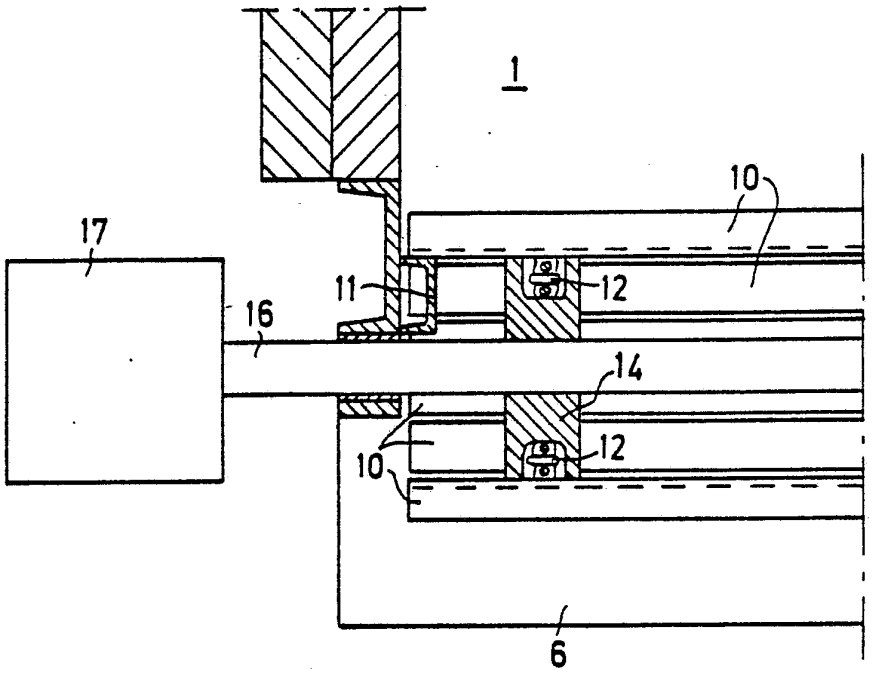


Fig. 2



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE84/00342

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC4

F 23 K 3/00, F 23 J 1/02

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC 4	F 23 B 1/00-7/00; F 23 H 1/00-17/12; F 23 J 1/00-1/06; F 23 K 1/00-3/22; C 10 J 3/20, 3/30-3/42
National Cl	24e: 9, 11/02; 24f:16/01-16/13, 17, 18; 24h:1/01, .../...

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category [6]	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	SE, C, 181 676 (S E B KARLSSON) 27 November 1962	
A	DE, A, 3 149 548 (G GREBE) 23 June 1983	
A	FR, A, 1 075 077 (SOCIETE FRANÇAIS DE CONSTRUCTIONS BABCOCK & WILCOX) 12 October 1954	
Y	GB, B, 20 573. (J HARGREAVES) 29 October 1892	1,2
Y	GB, B, 26 169 (HJ GRICE) 14 November 1910	1,2
A	US, A, 2 476 567 (CH SPARKS) 19 July 1949	
A	US, A, 3 358 625 (RW JONES) 19 December 1967	

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"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)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"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

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

"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

IV. CERTIFICATION

Date of the Actual Completion of the International Search [9]	Date of Mailing of this International Search Report [9]
1984-12-14	1985 -01- 03
International Searching Authority [1]	**Signature of Authorized Officer [20]**
Swedish Patent Office	Axel Lindhult L.E.

Form PCT/ISA/210 (second sheet) (October 1981)

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II Fields Searched (cont).

National Cl 24h:7/01-7/02, 8

US Cl 110:32-34, 40-43, 101, 267-294; 126:152

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers ....., because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers ....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.