

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

**EP 0 704 567 A1**

(12)

**EUROPEAN PATENT APPLICATION**(43) Date of publication:  
03.04.1996 Bulletin 1996/14(51) Int. Cl.<sup>6</sup>: **D06F 35/00**(21) Application number: **95111984.1**(22) Date of filing: **31.07.1995**(84) Designated Contracting States:  
**DE ES FR GB IT**(30) Priority: **28.09.1994 IT PN940057**(71) Applicant: **ELECTROLUX ZANUSSI  
ELETTRODOMESTICI S.p.A.  
I-33170 Pordenone (IT)**(72) Inventor: **Battistella, Silvio  
I-33170 Pordenone (IT)**(74) Representative: **Giugni, Valter et al  
PROPRIA  
Protezione Proprietà Industriale S.r.L.  
Via Mazzini 13  
I-33170 Pordenone (IT)****(54) Improvement in an unbalance preventing arrangement for clothes washing machines**

(57) A clothes washing machine provided with a washing tub, a drum adapted to rotate inside said tub and to hold the washload, a motor capable of driving said drum at a number of variable rotating speeds, and an arrangement adapted to detect an unbalance condition of the washload, is adapted to perform a spin-extraction phase comprising a sequence ( $T_1$ - $T_2$ ) of drum revolutions under low-speed (CBV) spinning conditions so as to favour a balanced distribution of the washload in the drum, wherein after such a distribution of the washload within a predetermined balancing level a second spin-

extraction phase ( $T_2$ - $T_4$ ) is started at an intermediate spinning speed (CMV) for a very short period of time.

After this second spinning phase, the speed of rotation of the drum is reduced to the low-speed (CBV) spinning value so as to keep the distributed washload adhering against the walls of the drum. Thereupon, the drum RPM is again increased up to said intermediate spinning speed (CMV), which is then maintained for a given period of time ( $T_5$ - $T_6$ ).

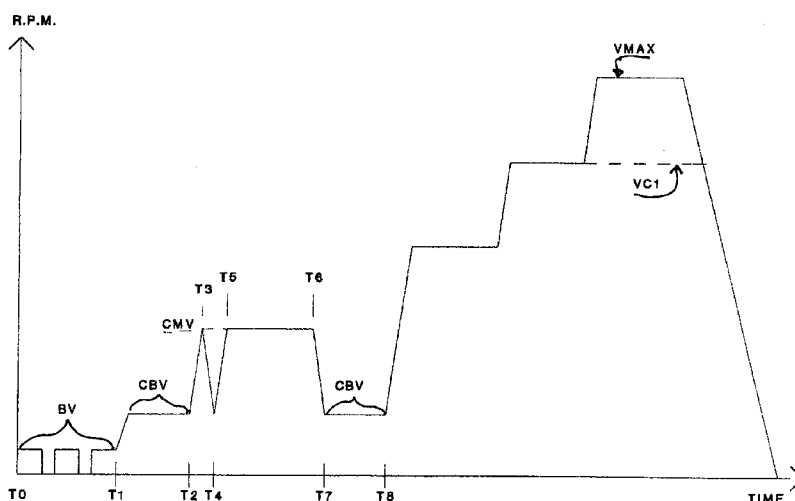


FIG. 1

EP 0 704 567 A1

## Description

The present invention refers to a clothes washing machine, such as in particular a household clothes washing machine, provided with improved arrangements capable of measuring and re-balance unbalanced washloads in the rotating drum of such washing machines when the washload undergoes spin-extraction cycles in the same machines.

It is common knowledge that, during each washing process performed in household-type clothes washing machines, the clothes loaded in the rotating drum thereof tend to distribute in a sometimes quite irregular manner along the inner periphery of said drum, thereby originating unbalance moments that bring about an anomalous extent of vibrations and mechanical stresses which, if they happen to exceed pre-determined critical levels, may even cause the mechanical structure of the machine to suffer damages, particularly in the case in which the oscillations of the washing drum assembly of the machine are of such a high level as to cause said assembly to impinge against the outer casing of the washing machine.

In view of preventing such conditions from occurring, it is in practice necessary that the level of the mechanical stresses arising each time depending on the actual speed of rotation of the drum be instantly known in advance so as to prevent them from reaching their critical levels. This is usually achieved by modifying the speed of rotation of the drum in an appropriate manner, i.e. by slowing it down to such an extent as to enable the washload in the same drum to get more evenly distributed and to at the same time effect a reduction in, or even the elimination of, the unbalance conditions brought about by the uneven distribution of said washload.

A number of solutions to this problem are known in the state of the art which, although differing from each other, are all aimed at detecting the presence of some excessive extent of unbalance conditions and accordingly adjusting the manner in which the speed of rotation of the drum is increased, as well as the highest speed of rotation of the drum itself, in view of achieving the above cited goal.

Solutions are for instance disclosed in the patent specifications DE 3822924-C, FR 2629484 and DE 3606819, according to which the washload unbalance conditions are detected on the basis of either the oscillations of the current absorbed by the drum driving motor or the oscillations of the speed of rotation of the drum.

Various types of sensors are used in the solutions disclosed in the patent specifications DE 3605924, GB 2174564 and J 60137389 to measure the oscillations in view of detecting the washload unbalance conditions, whereas in the solution described in the patent specification J 6013 2598 unbalance conditions are determined on the basis of a comparison of the actual speed of rotation of the drum with the profile of a reference speed of rotation that has been previously stored in some appropriate memory.

The Italian patent application IT PN91A000020 by the same applicant teaches how to detect unbalance conditions on the basis of the phase shift between the absorbed current and the supply voltage of the drum driving motor.

All such solutions are to some extent effective in detecting and reducing the oscillations of the washing drum assembly within the outer casing of the machine. However, washing machine manufacturers have more recently been confronted with the need to also cope with problems connected with the reduction of the vibrations being actually transmitted by the machine to the floor, usually through the points where the machine rests on the floor itself.

It has in fact been found experimentally that such an event can take place even in the presence of substantially well-balanced, but quite large washloads which, while not being such as to undermine the integrity of the washing machine or impair its correct operation, may prove sufficient to induce the machine to transmit vibrations to the floor on which it is installed and, from there, to the whole room or building. Such an occurrence, which is usually neglectable in the presence of rigid and quite heavy building structures of the traditional type, can on the contrary become disturbingly perceptible in rooms or buildings constructed with a relatively elastic structure using light materials.

This is a circumstance, as everyone can easily understand, that tends to put a heavy penalty on all those who use washing machines of a traditional type, since it is particularly when such machines are spin-extracting at a high RPM of their drum that vibrations tend to be transmitted from the machine to the whole room or building which starts also to vibrate, thereby creating a quite annoying situation, particularly in the not-so-unusual case that parts of the surrounding building start to resonate.

It would therefore be desirable, and it is actually a main purpose of the present invention, to provide a clothes washing machine which is capable of both doing away with the above cited drawback of a strong transmission of vibrations to the floor when in the presence of rather large, even if well-balanced washloads, and ensuring this additional performance capability through the implementation of some simple, unexpensive improvements and the utilization of readily available techniques.

The invention will be better understood from the description which is given below by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a diagrammatic view of the evolution vs. time of a spin-extraction phase as performed by a clothes washing machine according to the present invention, inclusive of some improvements and variants that will be described further on;

- Figure 2 is a block diagram showing, in the form of an operational flow-chart, the various sequences included in the spin-extraction phase according to the present invention.

In the following description, the term "water" will be used in a general way to also mean washing liquor or rinsing water. Such a simplification, however, will not impair the clear comprehensibility of the description owing to the particular context in which said terms are used, as anyone skilled in the art can readily appreciate.

Referring now to the diagram, which reflects a preferred embodiment of the present invention, a solution according to the present invention and the corresponding principle of operation will be described hereinafter.

The clothes washing machine being described comprises a washing tub, a drum that is rotatably mounted within said washing tub and is capable of holding the items forming the washload, a selectively actuatable drain pump, a driving motor adapted to operate at preselectably variable speeds, an arrangement adapted to detect the unbalance condition of the washload in the rotating drum, to selectively compare it with a plurality of pre-determined unbalance levels and to selectively start different actions or operation modes according to the outcome of said comparisons.

These machines are substantially known in the art, so that they will not be illustrated here any further.

The above mentioned diagram symbolically illustrates the evolution vs. time of the speed of rotation of the drum.

In correspondence of the time  $T_0$ , the drum is completing the last washing cycles at low speed BV and periodically reversing its direction of rotation. In correspondence of the time  $T_1$ , said low-speed washing sequence BV is ended and a low-speed spin-extraction sequence is started along with the energization of the drain pump (not shown). At the end of this sequence, ie. in correspondence of the time  $T_2$ , the arrangement monitoring the unbalance condition of the washload in the drum is then activated: if the detected unbalance condition turns out to be lower than a pre-established value  $B_{C1}$ , the spin-extraction phase goes on beyond said time  $T_2$ ; if on the contrary said condition does not occur, the same spin-extraction sequence is brought back to the afore considered time  $T_0$ , from which the just described sequence then starts again. Such a procedure of low-speed rotations BV, low-speed spin-extraction phases CBV and check-ups of the unbalance condition of the washload is repeated automatically until either a lower value than the specified level  $B_{C1}$  is reached or the same procedure has been repeated for a pre-determined maximum number of times. Anyway, the just described procedure is substantially known in the art, so that it shall not be explained here any further.

As soon as such time  $T_2$  is surpassed, the drum is abruptly driven to perform a spin-extraction cycle for a short impulse, which it reaches in correspondence of the time  $T_3$  and which lasts for a very short period of time,

ie. approx. 3 seconds, at an intermediate speed of usually around 450 rpm.

The purpose of such an impulse, which plays a major role in the present invention, is to obtain the removal of a significant amount of water from the washload, while avoiding that during such a water removal process the clothes, which are still substantially soaked with water and therefore under the effect of the weight thereof, get partially pressed into the perforations provided all along the cylindrical surface of the drum to let out the water removed from the clothes, since this would in fact cause the clothes to practically "stick" to the wall of the drum and it would then prove difficult, if not impossible, to even partially "unstick" said clothes, even if the rotation speed of the drum is to this purpose drastically reduced to values below the minimum spin-extraction speed itself.

Immediately following such a spin-extraction impulse, the rotation speed of the drum is again reduced, in correspondence of the time  $T_4$ , down to the low-speed spin-extraction speed CBV, or similar value, while a spin-extraction sequence is subsequently started at an intermediate speed CMV; this will go on through a period comprised between the time  $T_5$  and the time  $T_6$ . It has been in fact found experimentally that, owing to said short spin-extraction impulse having been performed immediately before said intermediate-speed spin-extraction sequence CMV, clothes do not tend to get pressed into the perforations in the walls of the drum during said intermediate-speed spin-extraction sequence CMV as they on the contrary normally would if said preliminary spin-extraction impulse had not been carried out previously in correspondence of said time  $T_3$ . Such an occurrence eventually plays a particularly advantageous role in the process, as it will be described in greater detail later on.

At the end of said intermediate-speed spin-extraction sequence CMV, the drum RPM is slowed down to the value of the slow-speed spin-extraction sequence CBV and is kept at that value throughout the period extending from the time  $T_7$  to the time  $T_8$ , during which the unbalance condition of the washload is then measured and checked.

If the washload is found to have any greater unbalance than a pre-determined level  $B_{C2}$ , then the whole spin-extraction phase is cycled back to the beginning, ie. to the time  $T_0$ , since that would practically mean that the unbalance condition is still in excess of what is actually required in order to be able to safely start any further spin-extraction sequence at still higher speeds.

The advantage brought about by the afore illustrated spin-extraction impulse can at this point be appreciated in its full extent. In this case, in fact, the clothes, owing to them not having been squeezed into the perforations of the drum, is capable of freely falling down again onto the bottom of the drum, which they certainly would not be able to do, even by letting the drum rotate at a very low speed, in the case that they on the contrary get "stuck" to the walls of the drum. In such a case, therefore,

the existing unbalance condition, albeit reduced in its extent, would necessarily have to be accepted as such and, at the same time, it would also be necessary that the spin-extraction speed be anyway limited to a lower value than the highest one  $VC_{max}$  provided for by the cycle in order to avoid creating conditions of marked vibrations, with limited-amplitude, but high-frequency oscillations of the machine which, albeit not prohibitive as far as the correct operation and the integrity of the structure of the machine are concerned, would be transmitted through the base of the machine to the floor and, ultimately, the whole room.

It therefore can conclusively be affirmed that with said initial spin-extraction impulsion the conditions are created enabling the washload balancing sequences to be repeated at such a level and to such an extent as to enable the final spin-extraction sequence to be started at its highest possible speed without excessive vibrations being transmitted to the floor, whereas in the opposite case the drawback of either high vibrations at the highest spin-extraction speed of the drum or, vice-versa, reduced vibrations at a correspondingly low, and hence less effective, spin-extraction speed of the drum would have to be accepted.

The present invention may be further improved in an advantageous manner through the additions of various features. As a matter of fact, if the unbalance condition detected in the time interval  $T_7-T_8$  is found to be at a level which is below the afore cited pre-determined highest allowable level  $B_{c2}$ , but higher than a pre-determined intermediate level  $B_{c3}$ , the subsequent final spin-extraction sequence may be performed at a speed which is reduced to the value  $VC_1$ , ie. a value which is slightly lower than the highest spin-extraction speed  $VC_{max}$ , but anyway still adequate in order to ensure an acceptable spin-extraction result without giving rise to the undesired vibrations transmitted by the machine.

Finally, if the unbalance condition detected in said last time interval  $T_7-T_8$  is found to be at a level which is below said intermediate level  $B_{c3}$ , the subsequent final spin-extraction sequence can regularly be started and performed at the highest rated speed  $VC_{max}$ .

Figure 2 is self-explaining for anyone skilled in the art and shows a block diagram illustrating the logical flow of the various sequences of drum rotation, measurement of the washload unbalance condition, and corresponding decision concerning the step to be taken subsequently, with reference to the most important ones cited in this description.

It will be now fully appreciated that, whereas the first measurement of the unbalance condition, which is performed in the time interval  $T_1-T_2$ , is required in view of protecting the washing machine against excessive unbalance conditions, even when handling moderate washloads, which might damage the same machine during the subsequent intermediate-speed spin-extraction sequence performed in the time interval  $T_5-P_6$ , the measurement of the unbalance condition which is subsequently performed during the intermediate-speed

spin-extraction sequence in the time interval  $T_7-T_8$  has the purpose to ensure that the unbalance level of the washload is as low as to be able to keep within pre-determined limits the vibrations transmitted by the machine to the surrounding structure of the building during the subsequent high-speed final spin-extraction sequence.

It will be appreciated that anyone skilled in the art is in a position as to identify further technical solutions and optimizations of the present invention by taking advantage of techniques and knowledges that are normally available in the art. Therefore, although the present invention has been described here using a generally known terminology, it shall not be considered as being limited by the embodiments that have been described here by mere way of example, since anyone skilled in the art will be able to make various modifications and variations within the spirit and the scope of the invention. It is therefore intended that the appended claims extend to include such obvious modifications that are within the capacity of anyone skilled in the art and do not depart from the scope of the present invention.

## Claims

1. Clothes washing machine, particularly for household use, provided with a washing tub, a drum rotatably arranged inside said washing tub and capable to contain the washload, a motor adapted to drive said drum at variable pre-selectable speeds, and an arrangement adapted to detect the unbalance condition of the washload, said clothes washing machine being adapted to perform a spin-extraction phase comprising a first sequence ( $T_0-T_1$ ) of drum revolutions in an alternate direction of rotation and at a speed (BV) which is lower than the low-speed spin-extraction speed (CBV), followed by a preliminary sequence ( $T_1-T_2$ ) of drum revolutions in said low-speed spin-extraction (CBV) conditions in view of distributing the washload along the inner surface of the drum so as to obtain an unbalance condition which is lower than a first pre-determined unbalance level ( $B_{c1}$ ), **characterized in that** after said distribution of the washload a spin-extraction impulse ( $T_3$ ) is performed at an intermediate spin-extraction speed (CMV) for a very short period of time, that after said spin-extraction impulse the speed of rotation of the drum is again slowed down to said low-speed spin-extraction speed (CBV) so as to keep the washload adhering against the inner walls of the drum, that the speed of rotation of the drum is subsequently increased to reach again said intermediate spin-extraction speed (BMV) which is then maintained for a pre-determined period of time ( $T_5-T_6$ ).
2. Clothes washing machine according to claim 1, **characterized in that** after said pre-determined period of time ( $T_5-T_6$ ) the speed of rotation of the drum is gradually slowed down to said low-speed

spin-extraction speed (CBV), that said low-speed spin-extraction speed (CBV) is in turn maintained for a pre-determined period of time ( $T_7$ - $T_8$ ), that during said period of time a measurement of the unbalance condition is performed, that if the so detected unbalance condition is found to be in excess of a second pre-set value ( $B_{c2}$ ) the spin-extraction phase is brought back to the beginning of said initial sequence ( $T_0$ ) of low-speed, alternating rotation of the drum.

3. Clothes washing machine according to claim 2, **characterized in that** if said unbalance condition is found to be below said second pre-set value ( $B_{c2}$ ), while however in excess of a third pre-set value ( $B_{c3}$ ), the spin-extraction phase is continued at a spin-extraction speed limited to a value ( $VC_1$ ) which is lower than the highest rated spin-extraction speed ( $V_{max}$ ) of the machine.
4. Clothes washing machine according to claim 2 or 3, **characterized in that** if said unbalance condition is found to be below said third pre-set unbalance value ( $B_{c3}$ ) the spin-extraction phase is continued up to the highest rated spin-extraction speed ( $V_{max}$ ) of the machine.
5. Clothes washing machine according to any of the preceding claims, **characterized in that** said washload balancing sequence at low spin-extraction speed ( $T_1$ - $T_2$ ), which consists in first reducing the speed of rotation of the drum to a value below the slowest spin-extraction speed and then increasing said speed again up to said low-speed spin-extraction speed (CBV), is performed in an automatically repeated manner until the washload is effectively allowed to redistribute along the walls of the drum so as to reach said first balancing level ( $B_{c1}$ ).
6. Clothes washing machine according to any of the preceding claims, **characterized in that** said low-speed spin-extraction speed (CBV) is of approx. 85 rpm.
7. Clothes washing machine according to any of the preceding claims, **characterized in that** said intermediate-speed spin-extraction speed (CMV) is of approx. 450 rpm.
8. Clothes washing machine according to any of the preceding claims, **characterized in that** said spin-extraction impulse ( $T_3$ ) at intermediate spin-extraction speed lasts has a duration of approx. 3 seconds.

55

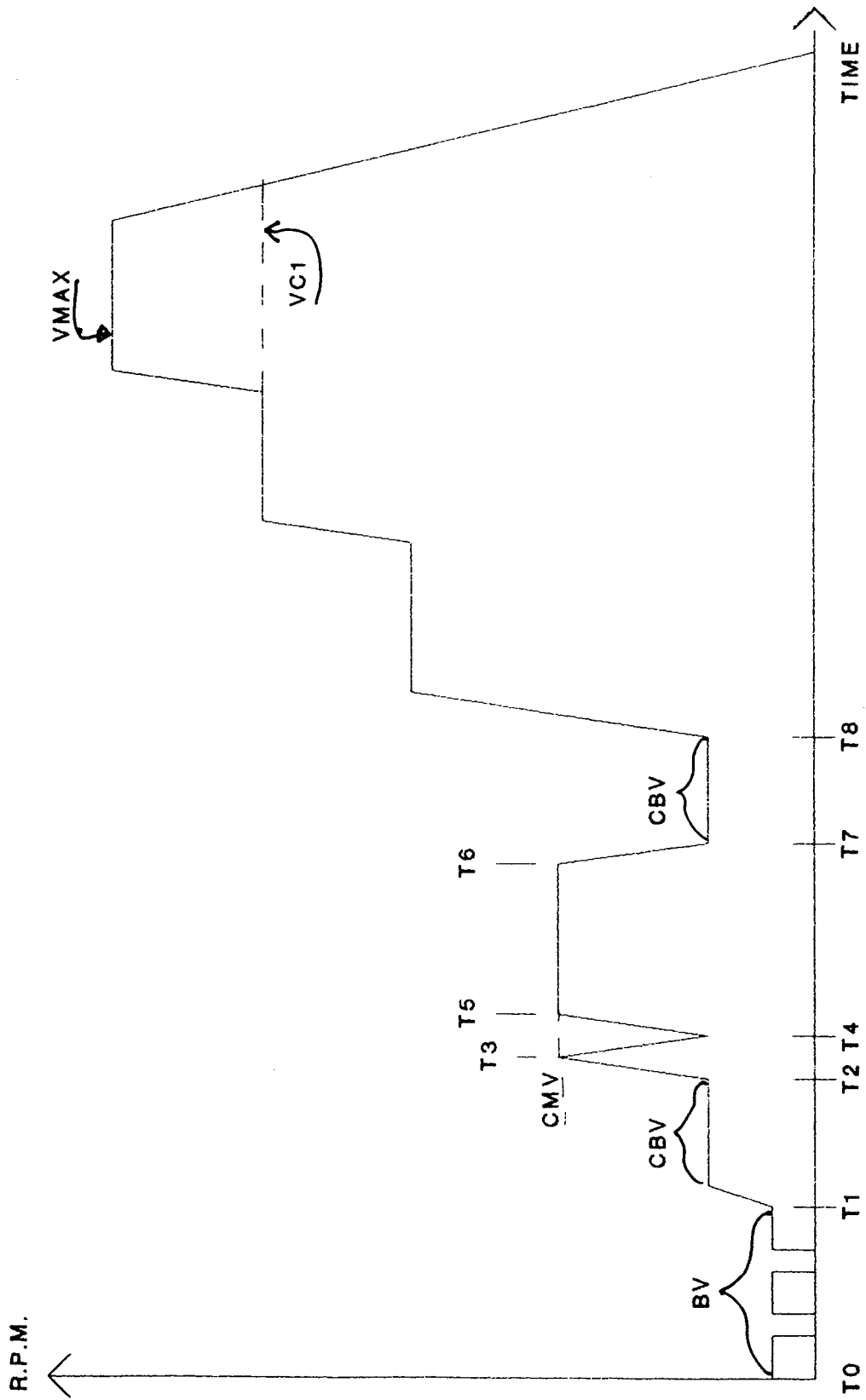


FIG. 1

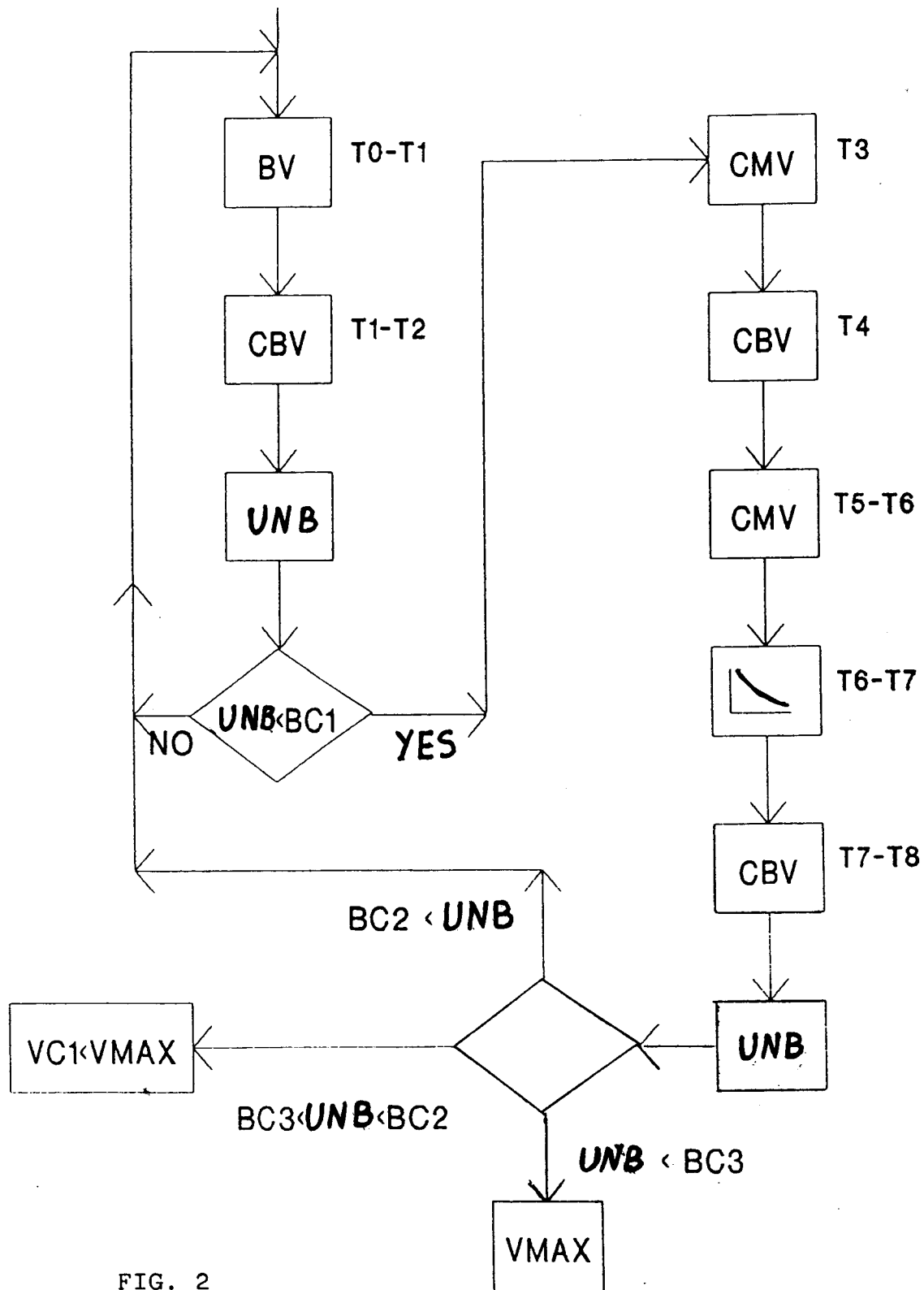


FIG. 2



European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 95 11 1984

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	FR-A-2 501 736 (THOMSON-BRANDT) * claims; figure 3 * ---	1,6-8	D06F35/00
A	FR-A-2 546 540 (THOMSON-BRANDT) * claims; figures * ---	1,6-8	
A	FR-A-2 645 553 (LICENTIA PATENT-VERWALTUNGS-GMBH) * claims; figure 5 * ---	1,5,6,8	
A	GB-A-2 087 103 (BOSCH-SIEMENS HAUSGERÄTE GMBH) * the whole document * -----	1,4-7	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			D06F
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		22 December 1995	Courrier, G
<p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone  Y : particularly relevant if combined with another document of the same category  A : technological background  O : non-written disclosure  P : intermediate document</p> <p>T : theory or principle underlying the invention  E : earlier patent document, but published on, or after the filing date  D : document cited in the application  L : document cited for other reasons  .....  &amp; : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03.92 (P4/C01)