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Internal distribution code:
(A) [ ] Publication in OJ
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(C) [X] To Chairmen

D E C I S I O N
of 8 February 1996

Case Number: T 1039/93 - 3.5.2

Application Number: 88117592.1

Publication Number: 0318695

IPC: H03B 9/10

Language of the proceedings: EN

Title of invention:
Magnetron drive apparatus

Applicant:
KABUSHIKI KAISHA TOSHIBA

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56
EPC R. 27(1)(b)

Keyword:
"Erroneous presentation of prior art by the applicant corrected"
"Inventive step - yes, after amendment"

Decisions cited:
-

Catchword:
-

Case Number: T 1039/93 - 3.5.2

D E C I S I O N
of the Technical Board of Appeal 3.5.2
of 8 February 1996

Appellant: KABUSHIKI KAISHA TOSHIBA
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Decision under appeal: **Decision of the Examining Division of the European Patent Office dated 2 July 1993 refusing European patent application No. 88 117 592.1 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: W. J. L. Wheeler
Members: A. G. Hagenbucher
M. Schar

Summary of Facts and Submissions

I. The present appeal contests the decision of the Examining Division to refuse European patent application No. 88 117 592.1. The reason given for the refusal was that the subject-matter of the claims then on file did not involve an inventive step, having regard to the following prior art:

D1: US-A-3 407 333,
D2a: Patent Abstracts of Japan, vol. 9, no. 263 (E-351) [1986], 19 October 1985; & JP-A-60109211,
D2b: Patent Abstracts of Japan, vol. 8, no. 107 (E-245)[1544], 19 May 1984; & JP-A-5922305,
D3: US-A-4 076 996.

II. During the appeal proceedings the Board referred also to the following prior art documents:

D4: Metaxas and Meredith, "Industrial Microwave Heating", 1983, pages 246 to 249
D5: Philippow, "Taschenbuch der Elektrotechnik", 1979, volume 4, pages 575 and 576, chapter 4.2.6.2.

In the course of the appeal proceedings, the appellant amended the claims, description and drawings.

III. Claim 1 is now worded as follows:

"1. A magnetron drive apparatus in which a frequency converter is provided for generating a high frequency voltage to be inputted to a primary winding (52a) of a transformer (52) and a high voltage power outputted from a secondary winding (52b) of said transformer (52) is rectified and supplied to an anode (A) of said magnetron (12), and a power outputted from a heater winding (52c) of said transformer (52) is supplied to a heater (F) of said magnetron (12), said transformer (52) comprising a core (52e, 52e) on which said primary winding (52a), said secondary winding (52b) and said heater winding (52c) are wound, and said core having a first core portion (52e) with legs and a second core portion (52e) with legs wherein the legs of the two core portions are opposed to each other with some leakage and the heater winding is wound on the leg of only one core portion;

characterized in that

the first core portion (52e) and the second core portion (52e) are entirely separated from each other by a clearance (AG); and

said primary winding (52a) is wound only on said first core portion (52e), whereas said secondary winding (52b) and said heater winding (52c) are wound only on said second core portion (52e);

such that the coupling coefficient between said secondary winding (52b) and said heater winding (52c) is large, whereas the coupling coefficient between said primary winding (52a), on the one hand, and said secondary winding (52b) and said heater winding (52c), on the other hand, is small."

Claims 2 to 7 are dependent on claim 1.

IV. The appellant argued essentially that:

(a) Figures 1 to 3 of the present description represented circuits known only to the applicant but not made available to the public before the priority date.

(b) D1 described with reference to Figure 2 a magnetron drive apparatus with a transformer comprising an essentially closed core structure. The core had an additional middle leg including a non-magnetic series gap. In contrast thereto the magnetron drive apparatus of the present invention made use of a transformer comprising a core with a first and second core portion which were entirely separated from each other by a clearance and permitted an easier winding. According to D1 the non-magnetic series gap of the middle leg of the transformer core and the reactance of a capacitor connected to the secondary winding were chosen to be theoretically equal in impedance magnitude at a frequency above line frequency in order to stabilize current flow. In the Figure 2 embodiment two heater windings having magnetically opposite sense were provided, such that one heater winding served as a control winding on that core leg where the primary winding was located. The other heater winding was wound on that core leg where the secondary winding was provided. The algebraic sum of the voltages supplied by the two heater windings was supplied to the filament of the magnetron in order to decrease the filament voltage for a high magnetron load current thereby eliminating the deleterious effects of overheating. The control winding and, for low magnetron load, also the other heater winding were strongly coupled to the primary winding and therefore influenced by fluctuations of the power source voltage. In contrast thereto the present invention secured smaller variation in power supplied to the filament when the power source voltage fluctuated by providing a small coupling coefficient between the primary winding on the first core portion, on the one hand, and a large coupling coefficient between the secondary winding and the heater winding on the second core portion, on the other hand.

(c) D3 disclosed a magnetron drive apparatus with the features in the preamble of claim 1. Fluctuations of the power produced in the heater winding due to variations of the voltage applied to the primary winding of the step-up transformer were reduced by a ferroresonant circuit including the step-up transformer and a capacitor connected to the heater winding. The transformer core as shown in Figure 9 was formed by a pair of "E" shaped portions. Two neighbouring leg portions of these core portions were shorter than the remaining leg portion so that when the core portions were disposed with their legs opposed to construct the core, the short leg portions did not contact each other but defined clearances therebetween. The primary and secondary windings were provided around both leg portions of respective ones of the legs with clearances. The heater winding was wound around the third leg, which had no clearance. A coupling coefficient was determined by the number of turns of the respective windings, the geometrical configuration of a magnetic core and the locations of the respective windings. The present invention was primarily concerned with the influence of the geometrical configuration of a magnetic core and the locations of the respective windings on the coupling coefficient. D3 required only a certain coupling coefficient between the primary and secondary windings but was silent on the coupling between the primary winding and the heater winding. Contrary to the present invention, from a geometrical and/or topological point of view the construction of the core shown in Figure 9 of D3 was such that the coupling between the heater winding and the primary winding was similar to that between the heater winding and the secondary winding.

V. The appellant requested that the decision under appeal be set aside and a patent be granted on the basis of the application in its present form, namely:

Claims: 1 to 7 filed with the letter dated 3 January 1996,

Description: pages 1, 1a, 1c and 5 filed with the letter dated 22 August 1995,
pages 2 to 4, 7 to 14 received in the oral proceedings of 5 April 1995
pages 1b and 6 filed with the letter dated 3 January 1996

Drawings: first sheet showing Figures 1 to 3 received in the oral proceedings of 5 April 1995
sheets 2 to 6 showing Figures 4 to 10A, B, C and D as originally filed.

Reasons for the Decision

1. The appeal is admissible.

2. During the oral proceedings the appellant explained that Figures 1, 2 and 3 of the application as filed had been erroneously labelled as prior art, whereas in fact they showed in house technical knowledge of the appellant which had not been made available to the public. The Board is not in a position to contradict this. Deletion of the labels "(prior art)" from Figures 1, 2 and 3, as was done in the copies of Figures 1, 2, and 3 filed on 5 April 1995, was therefore necessary to avoid giving an inaccurate representation of the state of the art (cf. decision T 6/81, OJ EPO, 1982, 183). This deletion does not affect the disclosure of the invention and is not

objectionable under Article 123(2) EPC (cf. decision T 22/83 of 6 December 1985, not published). The description now correctly indicates the prior art, as required by Rule 27(1)(b) EPC.

The features recited in claim 1 were all disclosed in combination in the application documents as originally filed (see Figures 4, 5, 10A to D and the related description). In the opinion of the Board, the present form of the application does not infringe Article 123(2) EPC.

3. None of the prior art documents on file discloses a magnetron drive apparatus comprising all the features recited in claim 1. Thus, the subject-matter of independent claim 1 is novel within the meaning of Article 54 EPC.

4. *Inventive step*

4.1 Closest prior art and problem to be solved

In the opinion of the Board, D3 (especially Figures 1, 2 and 9) represents the closest prior art. It shows a magnetron drive apparatus with the features in the preamble of claim 1. Fluctuations of the power produced in heater winding W3 due to variations of the voltage applied to the primary winding of the transformer are reduced by a ferroresonant step-up transformer wherein heater winding W3 is connected to a capacitor (5) and in which the saturation of the step-up transformer core is used for control. The transformer core shown in Figure 9 is formed by a pair of "E" shaped portions. Two neighbouring leg portions of these core portions are shorter than the remaining leg portion so that when the core portions are disposed with their legs opposed to construct the core, the short leg portions do not contact each other but define clearances therebetween. Primary and secondary windings are provided around both leg portions of respective ones of the legs with clearances. The heater winding is wound around a third leg, which has no clearance. D3 requires a certain coupling coefficient between the primary and secondary windings but is silent on the coupling between the primary and heater winding. From a geometrical and/or topological point of view the construction of the core shown in Figure 9 of D3 is such that the coupling between the heater winding and the primary winding is similar to that between the heater winding and the secondary winding. Effects of fluctuations of the voltage applied to the primary winding of the transformer on the heater winding are reduced by providing a ferroresonant element utilising the saturation of the transformer core and a capacitor connected to the heater winding. Such a solution is sensitive to supply frequency variations (compare D4, chapter 9.2.5.3).

Starting from D3, the problem underlying the subject-matter of claim 1 may be seen in designing a magnetron drive apparatus for achieving a smaller variation in power supplied to the magnetron when the power source voltage applied to the primary winding, including its frequency, fluctuates.

4.2 Solution

According to claim 1 this problem is solved in a magnetron drive apparatus with the features indicated in the preamble of claim 1 and known from D3 by

(a) entirely separating the first and second core portions from each other by a clearance and

(b) applying the primary winding only on that first core portion, whereas the secondary winding and that heater winding are wound on that second core portion and

(c) designing the above features in such a way that the coupling coefficient between the secondary winding and the heater winding is large, whereas the coupling coefficient between the primary winding, on the one hand, and secondary winding and the heater winding, on the other hand, is small.

4.3 The solution in D3 is different from that of the subject-matter in claim 1. According to D3 (especially Figure 9) the core structure and arrangement of the windings are not designed for making the coupling coefficient between the primary winding and the secondary winding different with respect to the heater winding. D3 reduces the effects of variations in power supplied to the magnetron by providing a ferroresonant element as explained above. The present invention reduces the influence of possible fluctuations in the voltage input to the primary winding by geometrical and/or topological features of the core structure and the arrangement of the windings in order to influence the coupling coefficient as indicated in feature (c) of claim 1 (see paragraph 4.2 above). Hence, since D3 does not suggest redesigning the transformer core and winding arrangement to obtain a coupling coefficient between the heater winding and primary winding different from that between the heater winding and secondary winding, it does not render it obvious to a person skilled in art to counteract the influence of voltage and frequency fluctuations at the primary winding by means of a core structure and winding arrangement according to features (a) and (b) in order to obtain the effect indicated in feature (c) of claim 1.

4.4 D1 describes and shows in Figure 2 a magnetron drive apparatus which has neither the core structure nor the winding arrangement defined in features (a) and (b) of claim 1 nor does it generally achieve the effect in feature (c) of claim 1. The core structure of Figure 2 (D1) is essentially closed but has an additional middle leg including a non-magnetic series gaps. This gap and the reactance of the capacitor connected to the secondary winding are chosen to be theoretically equal in impedance magnitude at a frequency above line frequency in order to stabilize current flow. In contrast to the present invention two heater windings having magnetically opposite senses are provided, of which one heater winding on the core leg with the primary winding serves as a control winding and the other heater winding is wound on the core leg with the secondary winding. The algebraic sum of the voltages supplied by the two heater windings is supplied to the filament of the magnetron in order to decrease the filament voltage for a high magnetron load current in order to eliminate the deleterious effects of overheating. The control winding and, for low magnetron load, also the heater winding are strongly coupled to the primary winding. They are therefore for low magnetron loads to a great extent influenced by fluctuations of the power source voltage supplied to the primary winding. Figure 1 of D1 referred to by the Examining Division concerns a conventional electron discharge device essentially having the same core structure as shown in Figure 2 but with only one heater winding on the core leg with the secondary winding. For this embodiment it can also be said that for a low discharge device load the heater winding is strongly coupled to the primary winding so that apart from the structural differences the achieved function is not generally as indicated in feature (c) of present claim 1.

4.5 D4 concerns magnetron drive apparatuses which are controlled either by a non-linear inductor provided in series with a transformer which is series resonated with a capacitor or by phase controlled thyristors used to control the A.C. supply to the transformer in a servo system based on the anode current of the magnetron. D4 is not concerned with the structural design of a transformer core in order to influence the coupling coefficients as indicated in feature (c) of present claim 1.

4.6 D2a, D2b and D5 are still less pertinent. D2a and D2b disclose transformers having two core portions separated by an air gap. These transformers are, however, not used for a magnetron drive apparatus. The function of these transformers is completely different from those of the transformers known from D1 and D3 so that a person skilled in the art would not derive any incentive therefrom for improving a magnetron drive apparatus as known from D3. According to D2a a detecting coil is provided in an air gap for detecting a deviation of the magnetic field if a load is half-wave discharged and for generating a high voltage to be supplied to a thyristor. The leakage transformer disclosed in D2b is designed for reducing eddy-current loss. D5 has been cited only as background document for understanding the function of a ferroresonant circuit, but it is not concerned with a magnetron drive apparatus.

4.7 It follows from the above that there is nothing in the prior art pointing in the direction of reducing the influence of fluctuations in the voltage input to the primary winding of a magnetron drive transformer by a specific core structure and arrangement of the windings as defined in features (a) and (b) of claim 1 so as to achieve the functional feature (c) of this claim. The Board therefore comes to the conclusion that the subject-matter of claim 1 involves an inventive step within the meaning of Article 56 EPC.

4.8 In the opinion of the Board, independent claim 1, together with dependent claims 2 to 7 are allowable. The amended application documents meet the requirements of the EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent according to the appellant's request (see paragraph V above).

The Registrar: The Chairman:

M. Kiehl W. J. L. Wheeler