(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 080 691 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
11.10.2006 Bulletin 2006/41

(21) Application number: **00111262.2**

(22) Date of filing: **25.05.2000**

(51) Int Cl.:
A61B 8/08 *(2006.01)* ***A61B 8/00*** *(2006.01)*

(54) An ultrasonic diagnosis apparatus

Vorrichtung für Ultraschalldiagnose

Dispositif de diagnostic par ultrasons

(84) Designated Contracting States:
DE FR GB

(30) Priority: **30.08.1999 JP 24391799**

(43) Date of publication of application:
07.03.2001 Bulletin 2001/10

(73) Proprietor: **MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.**
Kadoma-shi, Osaka 571-8501 (JP)

(72) Inventor: **Watanabe, Yoshinobu**
Yokohama-shi,
Kanagawa-ken 230-0076 (JP)

(74) Representative: **Manitz, Finsterwald & Partner GbR**
Postfach 31 02 20
80102 München (DE)

(56) References cited:
US-A- 5 839 442

EP 1 080 691 B1

Printed by Jouve, 75001 PARIS (FR)

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] This invention relates to an ultrasonic diagnosis apparatus for providing ultrasonic diagnostic image data and in particular to an ultrasonic diagnosis apparatus of the Kind as defined in the preamble of claim 1.

2. Description of the Prior Art

[0002] An ultrasonic diagnosis apparatus for providing ultrasonic image data having independent cases is known. Japanese patent application provisional publication No. 5-228139 and No. 6-225874 disclose the independent case type of ultrasonic diagnosis apparatus.

[0003] Fig. 5 is a block diagram of a prior art ultrasonic diagnosis apparatus disclosed in Japanese patent application provisional publication No. 5-228139. In this ultrasonic diagnosis apparatus, the whole unit is divided into the main body 1 and an operation unit 2 which are electrically connected to each other with connection cables. An operation panel 4 and a display monitor 5 are provided to the operation unit 2 to which an ultrasonic wave probe 3 is connected. The main body 1 and the operation unit 2 can be independently moved.

[0004] Fig. 6 is a block diagram of another prior art ultrasonic diagnosis apparatus disclosed in Japanese patent application provisional publication No. 6-225874. In this ultrasonic diagnosis apparatus, the whole circuitry is divided into two parts. The first case having a compact size is arranged near the person to be diagnosed. On the other hand, the second case having a large scale of circuitry necessary for high performance diagnosis is remotely arranged. Thus, digital data transmission is effected between both cases with a fiber optic cable.

[0005] An ultrasonic diagnosis apparatus of the Kind as defined in the preamble of claim 1 is disclosed in US-A-5 839 442.

SUMMARY OF THE INVENTION

[0006] The aim of the present invention is to provide a superior ultrasonic diagnosis apparatus.

[0007] This aim is achieved by the characterizing features of claim 1. A preferred embodiment of the ultrasonic diagnosis apparatus according to the invention is specified in claim 2.

[0008] In an ultrasonic diagnosis apparatus, the circuitry is divided into two parts, that is, first and second units which are connected with a cable. The first unit includes a trigger signal generation circuit for generating a trigger signal in response to a command signal, an ultrasonic wave transmitting and receiving circuit including a probe for transmitting ultrasonic waves in response to the trigger signal and receiving reflected ultrasonic waves. The cable transmits the received reflected ultrasonic waves and the trigger signal. The second unit includes a clock signal generation circuit for generating a clock signal in response to the trigger signal transmitted through the cable, and an a/d converter for a/d converting (sampling) the received reflected ultrasonic waves in response to the clock signal to output ultrasonic diagnosis data. A frequency difference detection circuit for detecting a frequency error between the clock signal and a reference frequency signal is also provided. A compensating circuit may compensate the ultrasonic diagnostic data to output compensated ultrasonic diagnostic data.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The object and features of the present invention will become more readily apparent from the following detailed description taken in connection with the accompanying drawings in which:

Fig. 1 is a block diagram of an ultrasonic diagnosis apparatus which is not part of the present invention;
Figs. 2A to 2C are graphical drawings showing the operation of said ultrasonic diagnosis apparatus which is not part of the present invention;
Fig. 3 is a block diagram of an ultrasonic diagnosis apparatus according to an embodiment of this invention;
Figs. 4A to 4D are graphical drawings showing the operation of the ultrasonic diagnosis apparatus according to this embodiment;
Fig. 5 is a block diagram of a prior art ultrasonic diagnosis apparatus; and
Fig. 6 is a block diagram of another prior art ultrasonic diagnosis apparatus.

[0010] The same or corresponding elements or parts are designated with like references throughout the drawings.

DETAILED DESCRIPTION OF THE INVENTION

[0011] Fig. 1 is a block diagram of an ultrasonic diagnosis apparatus according to an apparatus which is not part of the present invention.

[0012] The ultrasonic diagnosis apparatus includes a probe 110, an operation unit 101, a cable unit 105, and a processing unit 102.

[0013] The probe 110 includes a plurality of ultrasonic vibration elements arranged in an array.

[0014] The operation unit 101 is coupled to the processing unit 102 with the cable unit 105 to independently locate the operation unit 101 and the processing unit 102. That is, the operation unit 101 is located adjacent to the human body subjected to the diagnosis. On the other hand,the processing unit 102 can be remotely arranged.

[0015] The operation unit 101 includes a crystal oscillator 113 for generating a first clock signal, a trigger signal generation circuit 114 for generating a trigger signal in response to the first clock signal, a transmitting and receiving circuit 111 for generating a drive pulse in response to a trigger signal to supply the drive pulse to the probe 110, and a delaying/combining circuit for delaying respective reception components derived from a plurality of ultrasonic vibration elements and combines the delayed reception components to output a combined reception signal.

[0016] The cable unit 105 transmits the combined reception signal and the trigger signal to the processing unit 102.

[0017] The processing unit 102 includes a clock signal generation circuit 122 for generating a second clock signal, an a/d converter 121 for a/d-converting (sampling) the combined reception signal to output a digital reception signal in response to the second clock signal, a FIFO (first-in-first-out) memory 131, a crystal oscillator 136 for generating a reference clock signal, a video data processing circuit 132 for processing the combined reception signal from the FIFO memory 131 to generate display data, and a display monitor 134 for displaying the display data to provide display image for ultrasonic diagnosis to the operator.

[0018] Figs. 2A to 2C are graphical drawings showing the operation of the ultrasonic diagnosis apparatus according to the above apparatus of fig. 1.

[0019] The trigger signal generation circuit 114 generates the trigger signal in response to the first clock signal as shown in Fig. 2B. The first clock signal is periodically generated at a desired cycle of data transmission. The transmitting and receiving circuit 111 generates the drive pulse in response to the trigger signal to supply the drive pulse to at least one of vibration elements of the probe 110. The probe 110 generates (induces) an ultrasonic wave pulse which is transmitted through the human body.

[0020] The reflected ultrasonic waves (echo signal) is received by the prove 110 as shown in Fig. 2A. More specifically, respective vibration elements receive the reflected ultrasonic wave signals (echo signals) to generate reception signals.

[0021] The delaying/combining circuit 112 delays respective reception signals derived from a plurality of ultrasonic vibration elements in accordance with delaying data for a desired directivity and combines the delayed reception signals to output the combined reception signal having the desired directivity.

[0022] The cable unit 105 transmits the combined reception signal and the trigger signal to the processing unit 102.

[0023] The clock signal generation circuit 122 is reset and started in response to the trigger signal transmitted from the operation unit 101 through the cable unit 105 as shown in Fig. 2C.

[0024] The a/d converter 121 a/d-converts the combined reception signal to output a digital reception signal in response to the second clock signal. The FIFO (first-in-first-out) memory 131 stores the digital reception signal. The FIFO memory 131 outputs the stored digital reception signal in response to the reference clock. The image data generation circuit 132 generates image data for ultrasonic diagnosis from the reception signal from the FIFO memory 131. The display monitor 134 provides a display image for ultrasonic diagnosis to the operator from the image data from the image data generation circuit 132.

[0025] The circuitry in the processing unit 102 is divided into a first block 103 and a second block 104. The storing side of the FIFO memory 131 is included in the first block 103. On the other hand, the reading side of the FIFO memory 131 is included in the second block 104. The first and second clock signals for respective blocks (including the operation unit) are independently generated. Thus, the necessity of transmitting clock signals through the cable unit 105 is eliminated, so that asynchronous operations at respective blocks are provided.

[0026] As mentioned above, according to the mentioned apparatus, the necessity of a fiber optic cable having a high noise resistivity can be eliminated. Moreover, according to the mentioned apparatus, the necessity of transmitting the clock signal through the cable can be eliminated.

[0027] As mentioned above, according to the mentioned apparatus, the necessity in transmitting a clock signal for synchronous operation between respective blocks is eliminated. Accordingly, it becomes easy to extend the length of the cable.

[0028] Fig. 3 is a block diagram of an ultrasonic diagnosis apparatus according to an embodiment of this invention. Figs. 4A to 4D are graphical drawings showing the operation of the ultrasonic diagnosis apparatus according to this embodiment.

[0029] The structure of this embodiment is substantially the same as the apparatus of Fig.1. The difference is that a

frequency error detection circuit 235 is further provided. Moreover, an image data generation circuit 232 generates the image data for diagnosis such that a frequency error between clock signals is compensated.

[0030] The clock accuracy detection and compensation circuit 235 detects difference in counts of clock pulses between the second clock signal and the reference clock signal to generate a compensation signal in accordance with the difference in counts, i.e., the frequency error. The compensation signal is supplied to an image data generation circuit 232 to compensate the image data such that error in the image displayed on the display monitor 134 due to difference in frequency between the second clock signal and the reference clock signal is compensated.

[0031] In Fig. 3, the ultrasonic diagnosis apparatus according to this embodiment includes a probe 210, an operation unit 201, a cable unit 205, and a processing unit 202.

[0032] The probe 210 includes a plurality of ultrasonic vibration elements arranged in an array.

[0033] The operation unit 201 is coupled to the processing unit 202 with the cable unit 205 to independently locate the operation unit 201 and the processing unit 202. That is, the operation unit 201 is located adjacent to the human body subjected to the diagnosis.

[0034] The operation unit 201 includes a crystal oscillator 213 for generating a first clock signal, a trigger signal generation circuit 214 for generating a trigger signal in response to the first clock signal, a transmitting and receiving circuit 211 for generating a drive pulse in response to a trigger signal to supply the drive pulse to the probe 210 and a delaying/combining circuit for delaying respective reception components derived from a plurality of ultrasonic vibration elements and combines the delayed reception components to output a combined reception signal.

[0035] The cable unit 205 transmits the combined reception signal and the trigger signal to the processing unit 202.

[0036] The processing unit 202 includes a clock signal generation circuit 222 for generating a second clock signal, an a/d converter 221 for a/d-converting the combined reception signal to output a digital reception signal in response to the second clock signal, a FIFO (first-in-first-out) memory 231, a crystal oscillator 236 for generating a reference clock signal, a video data processing circuit 232 for processing the combined reception signal from the FIFO memory 231 to generate display data, and a display monitor 234 for displaying the display data to provide display image for ultrasonic diagnosis to the operator.

[0037] Figs. 4A to 4D are graphical drawings showing the operation of the ultrasonic diagnosis apparatus according to the mentioned embodiment.

[0038] The trigger signal generation circuit 214 generates the trigger signal in response to the first clock signal as shown in Fig. 4B. The transmitting and receiving circuit 211 generates the drive pulse in response to the trigger signal to supply the drive pulse to the probe 210. The probe 210 induces an ultrasonic pulse in the human body or the like.

[0039] The reflected ultrasonic waves (echo signal) is received by the prove 210 as shown in Fig. 4A. More specifically, respective vibration elements receive the reflected ultrasonic wave signals (echo signals) to generate reception signals.

[0040] The delaying/combining circuit 212 delays respective reception signals derived from a plurality of ultrasonic vibration elements in accordance with delaying data to have a desired directivity and combines the delayed reception signals to output the combined reception signal having the desired directivity.

[0041] The cable unit 205 transmits the combined reception signal and the trigger signal to the processing unit 202.

[0042] The clock signal generation circuit 222 is reset and started in response to the trigger signal transmitted from the operation unit 201 through the cable unit 205 as shown in Fig. 4C.

[0043] The a/d converter 221 a/d-converts the combined reception signal to output a digital reception signal in response to the second clock signal. The FIFO (first-in-first-out) memory 231 stores the digital reception signal. The FIFO memory 231 outputs the stored digital reception signal in response to the reference clock.

[0044] The frequency error detection circuit 235 detects a frequency error of the second clock signal (f1) from the reference clock signal (f2) as shown in Figs. 4C and 4D. That is, the frequency error detection circuit 235 counts M pulses (cycles) in the reference clock signal from the crystal oscillator 236 and counts the pulses (N) of the second clock signal. The frequency error detection circuit 235 calculates the actual frequency as follows:

$$f1 = f2 \times N/M \qquad \text{--- (1)}$$

[0045] In this process, there may be two counts of error between the second clock signal and the reference clock signal, the maximum frequency error is give by:

$$\triangle f = 2/N \qquad \text{--- (2)}$$

[0046] Accordingly, it is assumed that the compensation error should be suppressed below 0.1%. M is determined

such that the value N is made more than 2000.

[0047] The image data generation circuit 232 generates the image data such that error in the image data due to the frequency difference between the second clock signal and the reference signal is compensated.

[0048] The display monitor 234 displays a display image for ultrasonic diagnosis from the image data from the image data generation circuit 232 of which error due to the frequency difference is compensated.

[0049] As mentioned above, according to the mentioned embodiment, the necessity in transmitting a clock signal for synchronous operated between respective blocks is eliminated. That is, asynchronous operation every block is provided. Accordingly, a high noise resistivity is not required in the communication cable. Moreover it becomes possible to extend the length of the cable. Moreover, it is possible to select the optimum frequency for each block, so that this eliminates the necessity of high speed responsive ICs. Moreover, the image data generation circuit 232 generates image data to draw a display image on the display monitor 234 in accordance with the frequency difference data (compensation data), so that if clock frequencies at respective clocks are different from each other, the displayed image is free from the frequency errors. In other wards, the clock signal generator 222 can be structured with a simple self-oscillation circuit, so that miniaturization can be provided and reduction in the cost is also provided.

[0050] According to the mentioned embodiment, the necessity of using clock signals having the same frequency and the same phase between respective blocks can be eliminated.

Claims

1. An ultrasonic diagnosis apparatus comprising:

a first unit (201) having:

ultrasonic wave transmitting and receiving means including a probe (210) for transmitting ultrasonic waves through a human body and receiving reflected ultrasonic waves to generate a reception signal; and
transmitting means (211; 212) fro transmitting the reception signal, and
a second unit (202) having:

sampling means (231, 232, 234) for sampling the reception signal from the transmitting means (212) to output ultrasonic diagnosis data;
the first unit (102) further comprising :

trigger signal generating means (214) for generating a trigger signal in response to a command signal to make the ultrasonic wave transmitting and receiving means (210) transmit the ultrasonic waves to the human body in response to the trigger signal and
transmitting the trigger signal to the second unit (202); the second unit (202) further comprising:

clock signal generation means (222) for generating a clock signal in response to the trigger signal generated by the trigger signal generating means (214) such that the sampling means (231, 232, 234) generates ultrasonic diagnostic data from the reception signal in response to the clock signal;
characterized by
frequency difference detecting means (235) for detecting a frequency difference between the frequency of the clock signal and a reference frequency signal.

2. The ultrasonic diagnosis apparatus as claimed in claim 1, wherein the frequency difference detecting means includes compensating means (235) for compensating the ultrasonic diagnosis data in accordance with the detected frequency difference to output compensated ultrasonic diagnosis data.

Patentansprüche

1. Ultraschalldiagnosevorrichtung, mit:

einer ersten Einheit (201), mit:

einem Ultraschallwellenübertragungs- und Empfangsmittel, das eine Sonde (210) zur Übertragung von

Ultraschallwellen durch einen menschlichen Körper und zum Empfangen von reflektierten Ultraschallwellen umfasst, um ein Empfangssignal zu erzeugen; und
einem Übertragungsmittel (211, 212) zur Übertragung des Empfangssignals, und
einer zweiten Einheit (202) mit:

einem Abtastmittel (231, 232, 234) zum Abtasten des Empfangssignals von dem Übertragungsmittel (212), um Ultraschalldiagnosedaten auszugeben;
wobei die erste Einheit (102) ferner umfasst:

ein Triggersignalerzeugungsmittel (214) zum Erzeugen eines Triggersignals in Ansprechen auf ein Anweisungssignal, um das Ultraschallwellenübertragungs- und Empfangsmittel (210) zur Übertragung der Ultraschallwellen an den menschlichen Körper in Ansprechen auf das Triggersignal zu veranlassen, und zum Übertragen des Triggersignals an die zweite Einheit (202);
wobei die zweite Einheit (202) ferner umfasst:

ein Taktsignalerzeugungsmittel (222) zur Erzeugung eines Taktsignals in Ansprechen auf das Triggersignal, das durch das Triggersignalerzeugungsmittel (214) erzeugt wird, so dass das Abtastmittel (231, 232, 234) Ultraschalldiagnosedaten von dem Empfangssignal in Ansprechen auf das Taktsignal erzeugt;
gekennzeichnet durch ein Frequenzdifferenzdetektionsmittel (235) zur Detektion einer Frequenzdifferenz zwischen der Frequenz des Taktsignals und einem Referenzfrequenzsignal.

2. Ultraschalldiagnosevorrichtung nach Anspruch 1, wobei das Frequenzdifferenzdetektionsmittel ein Kompensationsmittel (235) zur Kompensation der Ultraschalldiagnosedaten gemäß der detektierten Frequenzdifferenz umfasst, um kompensierte Ultraschalldiagnosedaten auszugeben.

Revendications

1. Appareil de diagnostic à ultrasons, comprenant :

une première unité (201) ayant :

des moyens d'émission et de réception d'ondes ultrasonores incluant une sonde (210) pour émettre des ondes ultrasonores à travers un corps humain et pour recevoir des ondes ultrasonores réfléchies pour générer un signal de réception ; et
des moyens de transmission (211 ; 212) pour transmettre le signal de réception, et
une seconde unité (202), ayant :

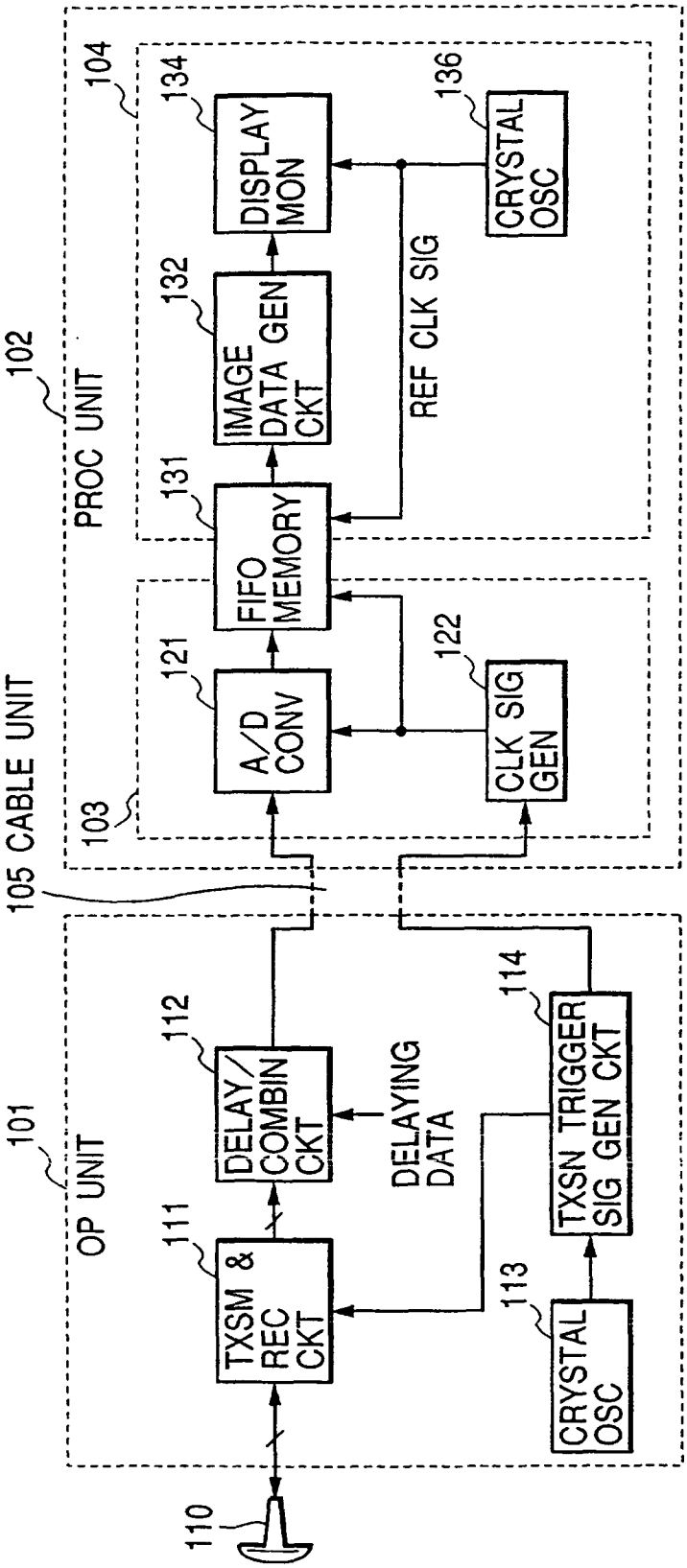
des moyens d'échantillonnage (231, 232, 234) pour échantillonner le signal de réception provenant des moyens de transmission (212) pour sortir des données de diagnostic à ultrasons ; et
la première unité (102) comprenant en outre :

des moyens de génération de signal de déclenchement (214) pour générer un signal de déclenchement en réponse à un signal d'ordre pour amener les moyens d'émission et de réception d'ondes ultrasonores (210) à émettre les ondes ultrasonores vers le corps humain en réponse au signal de déclenchement et transmettre le signal de déclenchement à la seconde unité (202) ;
la seconde unité (202) comprenant en outre :

des moyens de génération de signal d'horloge (222) pour générer un signal d'horloge en réponse au signal de déclenchement généré par les moyens de génération de signal de déclenchement (214) de telle façon que les moyens d'échantillonnage (231, 232, 234) génèrent des données de diagnostic à ultrasons à partir du signal de réception en réponse au signal d'horloge ;
caractérisé par
des moyens de détection de différence de fréquence (235) pour détecter une différence de fréquence entre la fréquence du signal d'horloge et un signal de fréquence de référence.

2. Appareil de diagnostic à ultrasons selon la revendication 1, dans lequel les moyens de détection de différence de fréquence incluent des moyens de compensation (235) pour compenser les données de diagnostic à ultrasons en accord avec la différence de fréquence détectée pour sortir des données de diagnostic à ultrasons compensées.

FIG. 1


101
OP UNIT
102
PROC UNIT
103
104
105 CABLE UNIT
110
111
TXSM & REC CKT
112
DELAY/ COMBIN CKT
DELAYING DATA
113
CRYSTAL OSC
114
TXSN TRIGGER SIG GEN CKT
121
A/D CONV
122
CLK SIG GEN
131
FIFO MEMORY
132
IMAGE DATA GEN CKT
134
DISPLAY MON
136
CRYSTAL OSC
REF CLK SIG

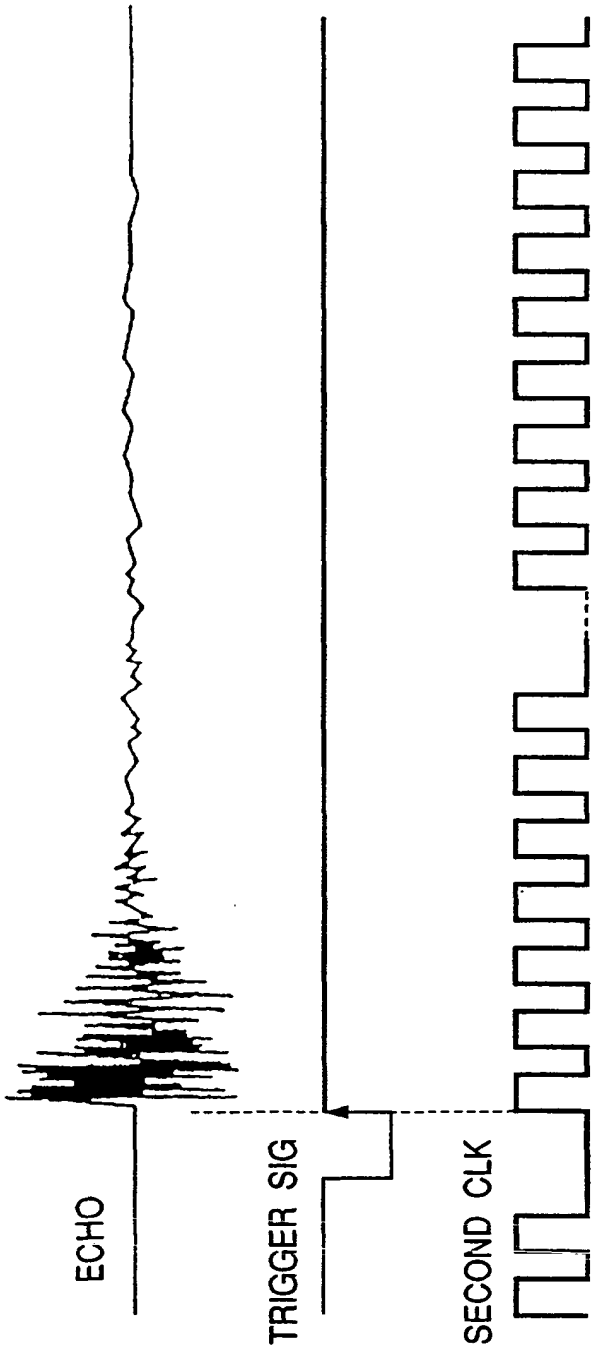
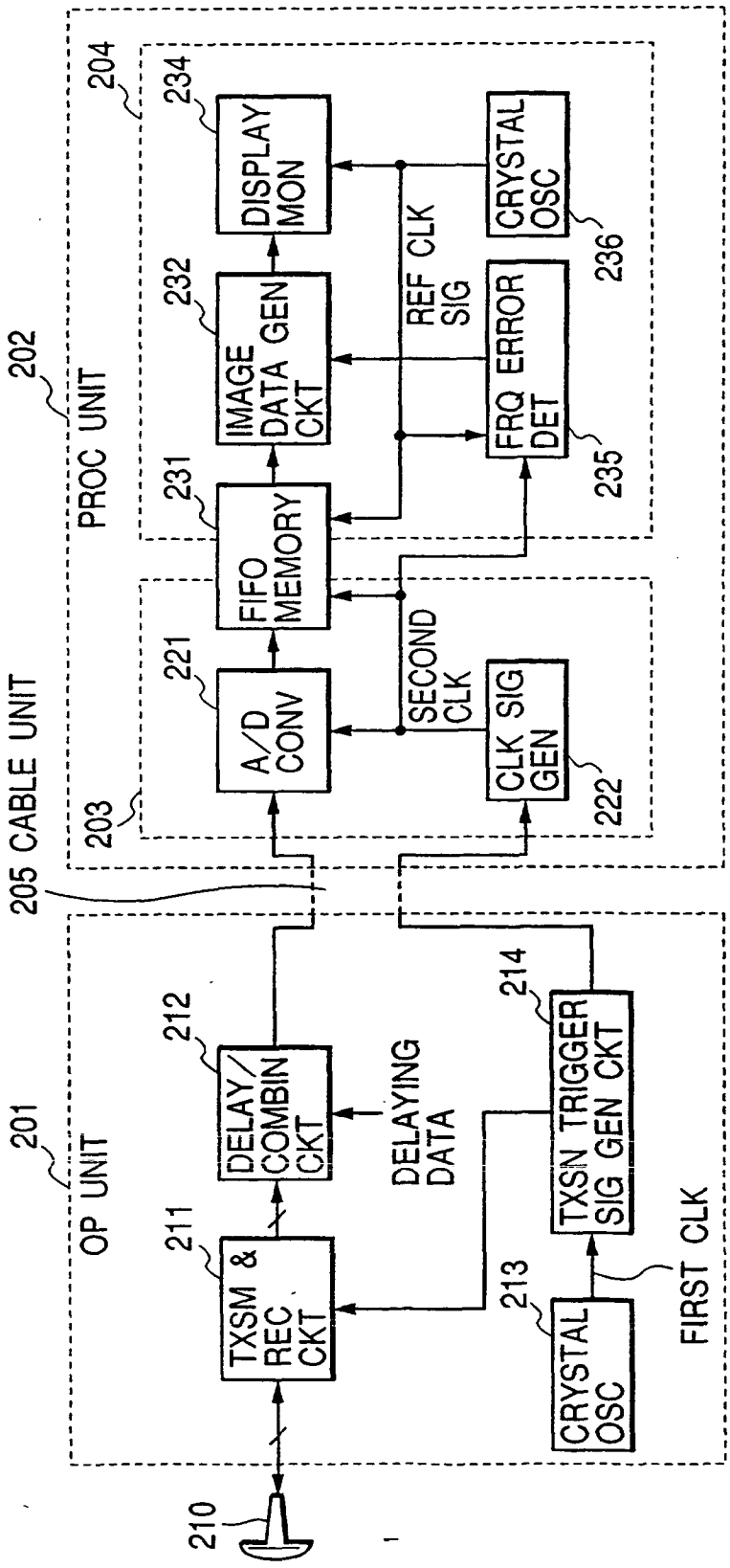


FIG. 2A

FIG. 2B

FIG. 2C

FIG. 3


201
OP UNIT
202
PROC UNIT
203
205 CABLE UNIT
204
210
211
TXSM & REC CKT
212
DELAY/ COMBIN CKT
DELAYING DATA
213
CRYSTAL OSC
214
TXSN TRIGGER SIG GEN CKT
FIRST CLK
221
A/D CONV
SECOND CLK
CLK SIG GEN
222
231
FIFO MEMORY
232
IMAGE DATA GEN CKT
REF CLK SIG
FRQ ERROR DET
235
234
DISPLAY MON
CRYSTAL OSC
236

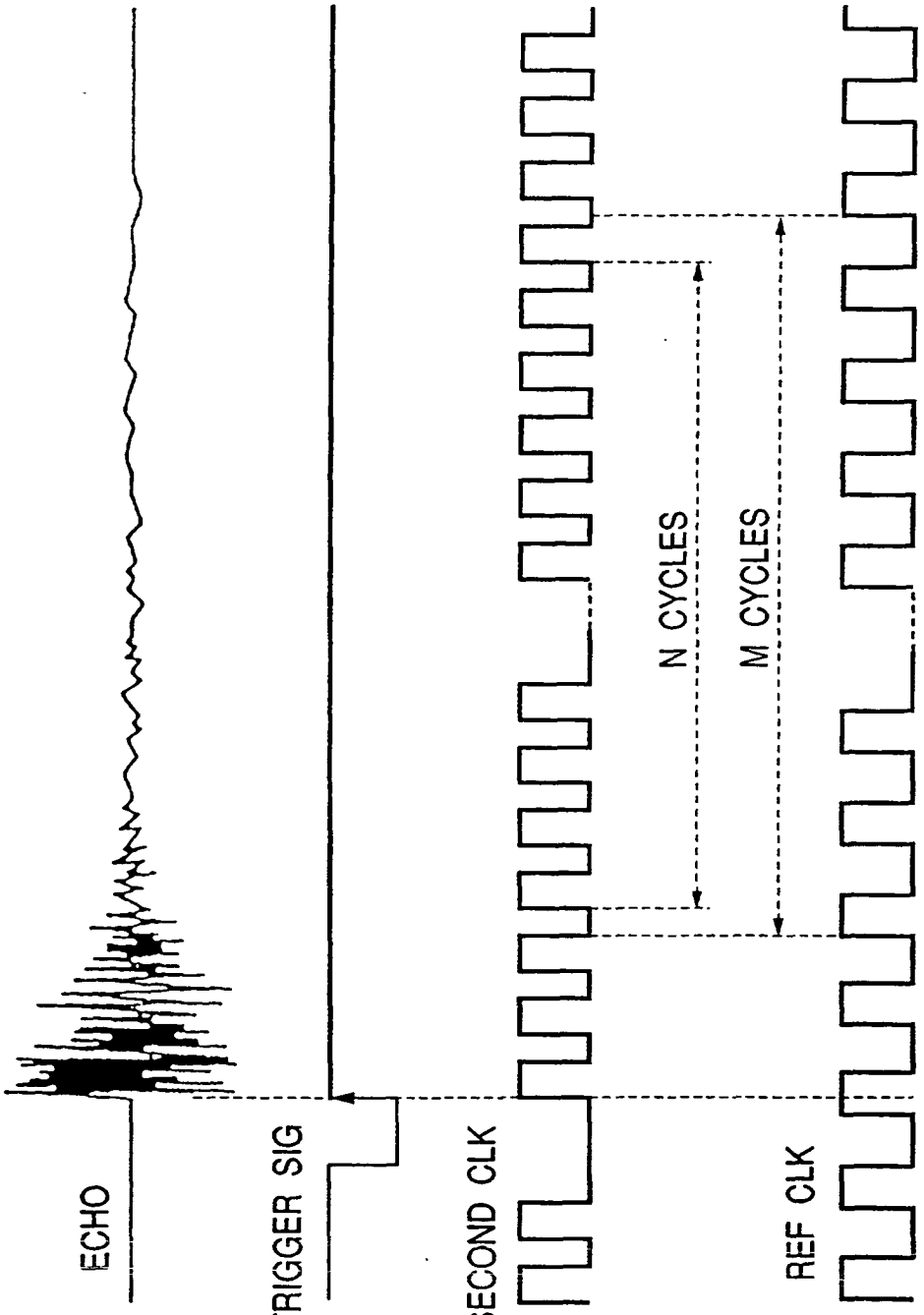


FIG. 4A

FIG. 4B

FIG. 4C

FIG. 4D

FIG. 5
PRIOR ART

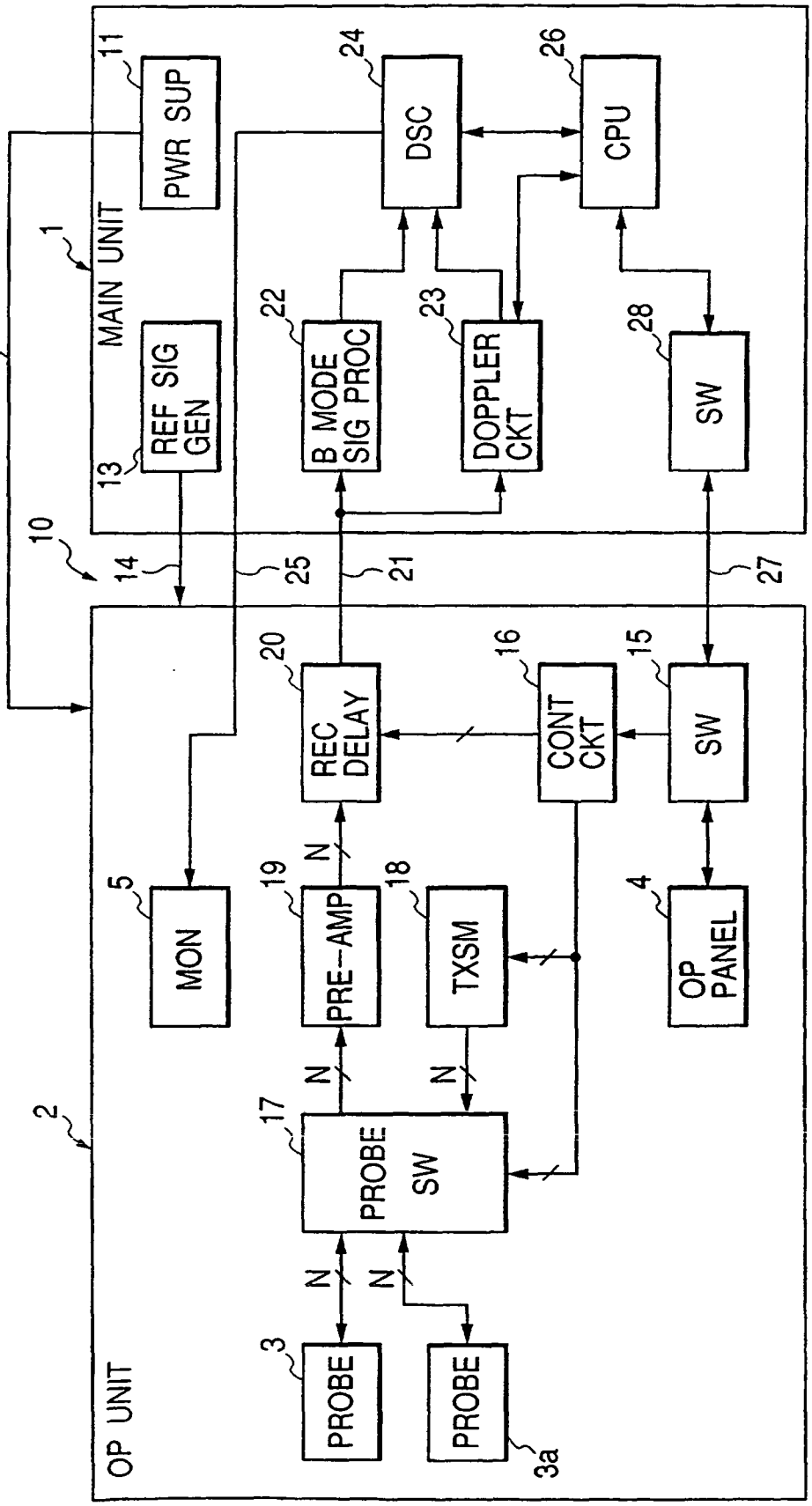
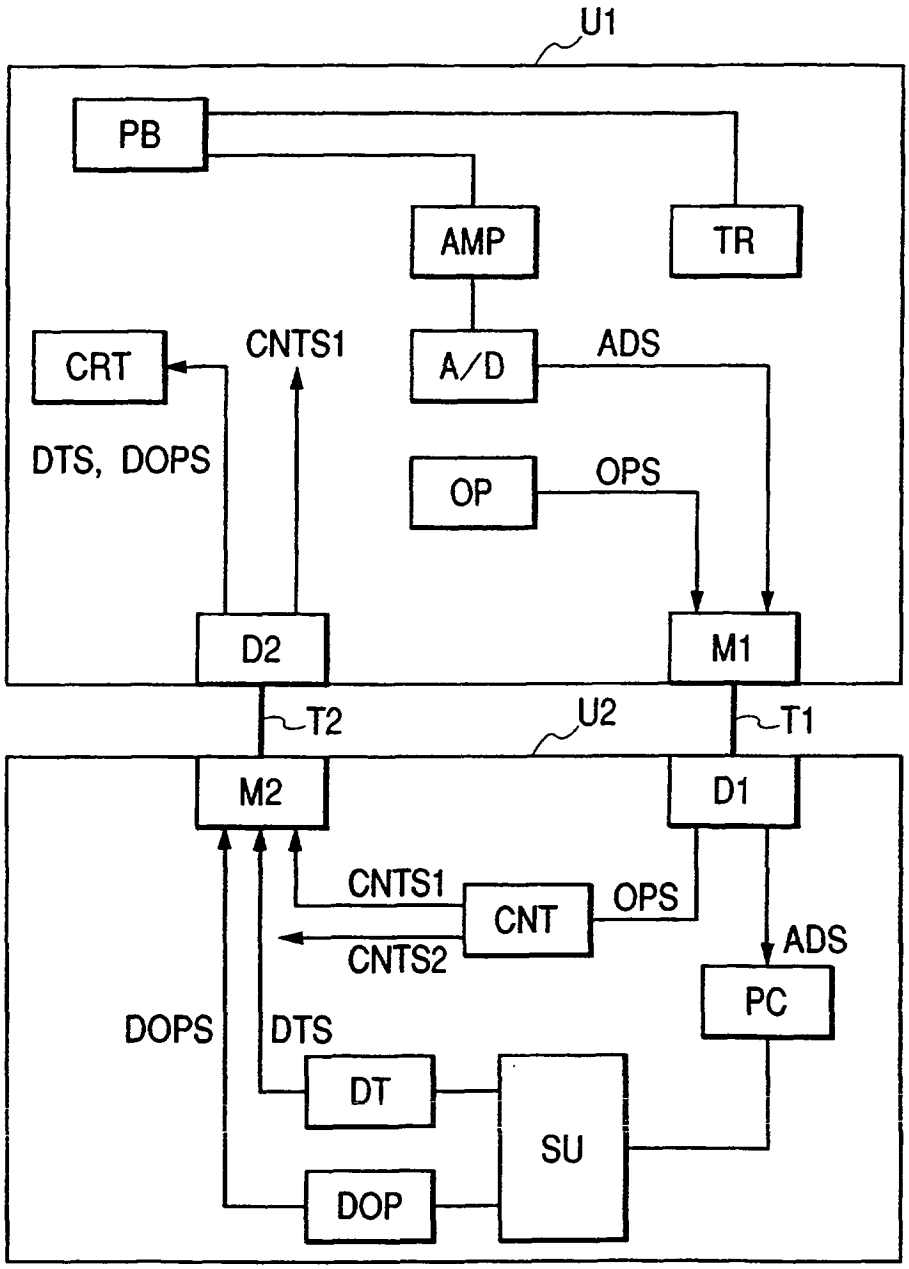


FIG. 6
PRIOR ART



专利名称(译)	超声波诊断装置		
公开(公告)号	EP1080691B1	公开(公告)日	2006-10-11
申请号	EP2000111262	申请日	2000-05-25
申请(专利权)人(译)	松下电器产业有限公司.		
当前申请(专利权)人(译)	松下电器产业有限公司.		
[标]发明人	WATANABE YOSHINOBU		
发明人	WATANABE, YOSHINOBU		
IPC分类号	A61B8/08 A61B8/00		
CPC分类号	A61B8/00 A61B8/08		
代理机构(译)	MANITZ，FINSTERWALD & PARTNER GBR		
优先权	1999243917 1999-08-30 JP		
其他公开文献	EP1080691A1		
外部链接	Espacenet		

摘要(译)

在超声诊断设备中，电路被分成两部分（101,102），它们与电缆（105）连接。第一单元（101）包括触发信号发生电路（114）和超声波发射和接收电路（111），其包括探测器（110），用于响应于触发信号发射超声波并接收反射的超声波以产生接收信号。电缆（105）发送接收信号和触发信号。第二单元（102）包括：时钟信号发生电路（122），用于响应于通过电缆（105）发送的触发信号产生时钟信号;以及/ d转换器（121），用于a / d转换接收信号响应时钟信号。还可以提供用于检测时钟信号和参考频率信号之间的频率误差的装置（235）和用于补偿超声诊断数据的装置。