REPLACED SHEETS SG
Description : paged 1 to paged 15
Claim(s) : paged 16 to paged 17
Drawing(s) : paged ..... to paged .....
Abstract : paged 18 to paged .....

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ROTARY HEAD APPARATUS

The present invention generally relates to a magnetic recording/reproducing apparatus, for example a video tape recorder (hereinafter referred to as VTR), and more particularly, to a rotary head apparatus utilized in such a magnetic recording/reproducing apparatus.

Previously a helical scanning system has been used for a magnetic recording/reproducing apparatus such as a VTR, to perform magnetic recording and/or reproducing by rotary magnetic heads.

On such a helical scanning system VTR, for instance, in the reproducing process, at least two magnetic heads are installed on a rotary drum and these heads rotate as if to helically trace a magnetic recording medium in its running direction to reproduce signals. The signals thus obtained are then amplified to a specified level by an electronic circuit such as a reproduction preamplifier and supplied to a reproducing circuit via a non-contact rotary transformer (hereinafter referred to as a rotary transformer) for reproducing recorded signals. Further, in the case of recording by a magnetic recording/reproducing apparatus, signals to be recorded are supplied via such a rotary transformer. Voltages and currents required for the recording operation are supplied to the magnetic head by an electric circuit such as a recording amplifier. The magnetic head then rotates to helically trace the recording medium, so that the signals are magnetically recorded on the recording medium.

As described above, in case of VTRs there is a rotary transformer between the magnetic head and the circuit for supplying signals to be recorded to the magnetic head, or the circuit for amplifying the signals reproduced by the magnetic head, and therefore

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there is a great transmission loss of the signal. Various proposals to reduce this transmission loss, have been made. In these proposals, electronic circuits such as a reproducing amplifier or a recording amplifier are provided between the rotary transformer and the magnetic head.

One mounting method has been proposed in which such electronic circuits as described above are provided on a circuit board, this circuit board is arranged on the upper portion of a rotary drum and the circuit board is connected to a magnetic head and a rotary transformer through lead wires. In a device with this structure, electronic circuits and other electronic components are provided very close to a magnetic drum more than in previous devices. However, the electronic circuits and the rotary transformer will be located far away from each other. Thus as far as a reduction of signal transmission loss is concerned, a larger improvement over the previous devices cannot be expected.

So, there was made an attempt to mechanically arrange a circuit board provided with electric circuits between a magnetic head and a rotary transformer in a rotary drum. However, a problem arises in that the manufacturing process is complicated as it is necessary to connect magnetic heads and circuit boards, and a circuit board and a rotary transformer with a lead wire when actually mounting the circuit board in the rotary drum.

Further, there is also a mounting method in which a circuit board is formed to fit the shape of a rotary transformer and pasted on the upper surface of the rotary transformer to facilitate the connection of the circuit board with the rotary transformer. However, in this case, it is also troublesome to connect the circuit board to the rotary transformer. Furthermore,

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another problem is caused in that it becomes difficult to install and remove a rotary drum as the circuit board is assembled integrally with the rotary transformer.

As described above, in the previously known rotary head apparatus, a circuit board having electronic components such as an electronic circuit is mounted, for instance, on a rotary drum. Thus there is no possibility of the loss of signal components being transmitted in a signal transmission mechanism which performs magnetic recording onto or magnetic reproduction from a recording medium using a magnetic head provided on the rotary drum, because such electronic components as the electronic circuit are installed near the magnetic head. However, there still remains a problem that a distance between the electronic circuit and the rotary transformer provided in the rotary drum becomes fairly long and thus signals being transmitted may be adversely affected.

Further, for the purpose of solving the problems described above, if the circuit board is located between the magnetic head and the rotary transformer and the distance between them is made short by arranging the circuit board between the magnetic head and the rotary transformer, the problem of transmitting signals affected by a distance may be solved. However, there still remains the problem that the structure of the magnetic head and the circuit board or the rotary transformer and their mutual connections becomes extremely difficult.

The present invention seeks to provide a rotary head apparatus with a circuit board provided at an optimum shortest distance without increasing the distance between the magnetic head and the rotor of a rotary transformer, which is capable of connecting them in a simple construction and reliably communicating

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signals therebetween.

According to the present invention there is provided a rotary head apparatus comprising:

a rotary shaft;

a rotary member fixed to the rotary shaft;

a stationary drum for rotatably supporting the rotary shaft;

a rotary transformer including a rotor having a winding and fixed to the rotary member so that the rotor may rotate together with the rotary member and a stator mounted on the stationary drum, the rotor and the stator being electromagnetically coupled with each other;

the rotary member including:

at least one magnetic head the or each magnetic head having a winding; and

a circuit board provided with a first surface carrying a first conductive member, a second surface carrying a second conductive member, an electronic circuit provided on at least one of the surfaces, a circuit wiring for communicating signals among the electronic circuit, and the first and the second conductive members, the first conductive member being in contact with a terminal of the winding of the magnetic head for establishing an electrical connection therebetween and the second conductive member being in contact with a lead terminal of the winding of the rotor of the rotary transformer for establishing another electrical connection therebetween.

In the present invention, only when the circuit board with the first and second conductive members and the electronic circuit member installed are mechanically mounted between the or each magnetic head and the rotary transformer mounted to the rotary drum, is it possible to make the required electrical

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connections. As a result, signals obtained by the magnetic heads can be supplied to the electronic circuit member via the first conductive member and the signals amplified in the electronic circuit are supplied to the rotor of the rotary transformer via the second conductive member. Thereafter, the signals passing through the rotor are transmitted to the stator which is electromagnetically connected with the rotor and then communicated to an external electronic circuit via lead wires.

Additional objects and advantages of the present invention will be apparent to persons skilled in the art from a study of the following description and the accompanying drawings.

For a better understanding of the present invention and to show how it may be brought into effect, reference will now be made, by way of example, to the accompanying drawings, wherein:

Figure 1 is a diagram showing in section a first embodiment of the rotary head apparatus according to the present invention;

Figure 2 is a plan view showing the circuit board mounted to the rotary drum shown in Figure 1;

Figure 3 is a diagram showing the circuit board for a second embodiment of the rotary head apparatus according to the present invention; and

Figure 4 is a diagram showing the circuit board for a third embodiment of the rotary head apparatus according to the present invention.

The present invention will be described in detail with reference to the accompanying drawings.

Throughout the drawings, like or equivalent reference numerals or letters will be used to designate like or equivalent elements for simplicity of explanation.

Referring now to Figures 1 and 2, a first

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embodiment of the rotary head apparatus according to the present invention will be described in detail.

Figure 1 shows a cross-sectional view of the rotary head apparatus of the first embodiment. Figure 2 shows a plan view of the circuit board mounted to the rotary drum shown in Figure 1.

As illustrated in Figure 1, the rotary head apparatus has a rotary drum 2 which rotates together with a rotary shaft 1; magnetic heads 3 mounted at prescribed positions of the rotary drum 2 while projecting by a given amount from its peripheral surface so that they are in contact with a magnetic recording medium that travels along the peripheral surface of the rotary drum 2; a disc shaped circuit board 4 defining a hole 4a through which the shaft of the rotary drum 2 penetrates; first conductive members 5 which are mounted on the outer edge of the upper surface of the circuit board 4, facing the magnetic heads 3 while in contact with lead terminals of windings of the magnetic heads 3 for making electrical connections; an electronic circuit member 6 provided in a specified area of the circuit board 4, which is connected to the first conductive members 5 by printed wires and is equipped with a preamplifier for amplifying signals from the magnetic heads 3 at a fixed amplification factor; second conductive members 7 provided on the under surface of the circuit board 4 and connected to the electronic circuit member 6 by printed wires; a rotary transformer 8 comprising a rotor 8a having a winding, the lead terminals of which are electrically connected to the second conductive member 7 by contacting them and a stator 8b for transmitting signals by being electromagnetically connected with the rotor 8a; and a stationary drum 10 to which the stator 8b of the rotary transformer 8 is fixed.

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Further, the first and second conductive members 5 and 7 are provided at symmetrical positions with reference to the rotary shaft 1.

In addition, a rotary member 11 is fitted to the rotary shaft 1 and the rotary drum 2 is mounted to the rotary member 11 with the mounting screws 12. Therefore, the rotary drum 2 rotates together with the rotary shaft 1. Disc shape projections are formed near the center of the underside of the rotary drum 2 and the circuit board 4 is mounted to the ends of the projections with mounting screws 13. So, the circuit board 4 rotates together with the rotary drum 2.

Further, at the center of the stationary drum 10 a plurality of bearings 10a are provided facing each other at contacting points with the rotary shaft 1 so that the rotary shaft 1 is able to rotate freely without reducing the rotary speed when passing through the penetrating hole provided on the stationary drum 1.

There are also printed circuit wirings (not shown) provided on both sides of the circuit board 4 for constituting predetermined electric circuits. The printed circuit wirings provided on both sides may be mutually and electrically connected by way of through-holes, for example. As illustrated in Figure 2, there are arrangement areas 60 provided on the upper surface of the circuit board 4, which are functionally optimum arranging areas of the electronic circuit members 6, and electrodes (not shown) for being soldered with lead terminals of the electronic circuit members 6 are formed in these arrangement areas 60. These electrodes are connected with the circuit wirings and the electronic circuit members 6 are electrically and mechanically mounted to the circuit board 4 through soldering. As a result, the electronic circuit members 6 are connected with the first conductive members 5 installed on the circuit board 4 and further, with the

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second conductive members 7 installed on the back or under surface of the circuit board 4. The electronic circuit member 6 may be an integrated circuit device including a preamplifier circuit for amplifying signals reproduced by the magnetic head. Resistors and capacitors are mounted on the circuit board 4 where necessary to constitute an electronic circuit together with the electronic circuit member 6.

To assemble a rotary head apparatus in such a structure as described above, for instance, the rotor 8a of the rotary transformer 8 is fixed to the rotary member 11 and then the rotary member 11 is fitted onto the rotary shaft 1 supported by the stationary drum 10 in the rotatable state. Further, the circuit board 4 is mounted to the rotary drum 2 with the mounting screws 13, and the lead terminals of the winding (not shown) of the magnetic head 3 are in contact with the first conductive member 5. The rotary drum 2 is mounted with the circuit board 4 provided to the rotary member 11 by means of the mounting screws 12. The second conductive members 7 are in contact with the lead terminals of the windings of the rotor 8a of the rotary transformer 8. The rotary head apparatus is assembled in such a manner as described above and is disassembled in the reverse order. Further, the first and the second conductive members 5 and 7 are elastic and are in elastic contact with the respective lead terminals of the windings.

On the rotary head apparatus with the structure as described above, as the circuit board 4 is provided between the magnetic head 3 mounted to the rotary drum 2 and the rotor 8a of the rotary transformer 8 mounted to the rotary member 11 which rotates jointly with the rotary drum 2 as described above, it is possible to arrange the magnetic head 3 and the rotor 8a with the shortest distance between them. Furthermore, as the

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magnetic head 3 and the rotor 8a are connected to each other via the first conductive members 5, the electronic circuit member 6 and the second conductive members 7, signals can be reliably communicated between them.

Now the operation of this embodiment will be explained in detail with reference to Figure 1.

For instance, when a signal reproduction operation is performed using the rotary head according to this embodiment, signals recorded by the magnetic head 3 mounted to the rotary drum 2 are reproduced from a magnetic recording medium (not shown) which travels along the outer surface of the rotary drum 2. As the reproduced signals are signals in a high frequency band but of a low signal level, it is required to amplify them at a certain amplification factor. When reproduced, the signals are supplied to the electronic circuit member 6 on the circuit board 4 via the first conductive members 5 which are in contact with and electrically connected to the lead terminals of the winding of the magnetic head 3. The reproduced signals supplied to this electronic circuit member 6 are amplified at a prescribed amplification factor by, for instance, a preamplifier. The amplifier reproduced signals are transmitted to the rotor 8a of the rotary transformer 8 via the second conductive members 7 which are connected to the electronic circuit member 6 with the circuit board 4 clamped between them. The reproduced signals transmitted to the rotor 8a are transmitted to the stator 8b by the electromagnetic connection of the rotary transformer comprising the rotor 8a and the stator 8b, and then transmitted to an external electronic circuit (not shown) via a lead wire 9 which is connected to this stator 8b. Thus, the signals recorded on a recording medium can be reproduced.

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Further, when a recording operation is performed using this rotary head apparatus, the members for the signal transmission in the reproducing operation are also used in the recording operation. That is, signals to be recorded magnetically are supplied from an external electronic circuit to the rotary transformer 8 via the lead wire 9. The signals supplied to this rotary transformer 8 are transmitted to the electronic circuit member 6 on the circuit board 4 via the stator 8b and the rotor 8a of the rotary transformer 8 and the second conductive members 7. Then, voltages and currents required for the recording operation are supplied by a recording amplifier provided to the electronic circuit member 6. The signals to be recorded are then supplied to the magnetic head 3 via the first conductive members 5 and recorded on a magnetic recording medium (not shown) by the magnetic heads 3.

Further, when replacing the magnetic head or other parts of the rotary head apparatus in this embodiment due to the expiration of their life, the rotary drum 2 assembled integrally with the magnetic head 3 can be easily removed by only removing the mounting screws 12, and furthermore, as the circuit board 4, together with the electronic circuit member 6, the first and the second conductive members 5 and 7, is mounted to the rotary drum 2, the circuit board 4 also can be easily removed. Thus, it becomes possible to facilitate the replacement of the parts. In addition the respective members comprising the rotary head apparatus can be connected at optimum connecting positions and positive signal transmission can be assured.

Therefore, according to the present invention, it is possible to establish a signal transmission path between the magnetic head 3 and the rotary transformer 8 with the optimum shortest distance between them by

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mounting the circuit board 4 with the first conductive members 5 and the electronic circuit member 6 provided in the arrangement area 60 on the upper surface of the electronic circuit member 6 and the second conductive members 7 provided on the under surface of the electronic circuit member 6 between the magnetic head 3 and the rotary transformer 8 mounted to the rotary drum 2. Therefore, it becomes possible to perform the recording or reproducing of signals without oscillations badly affecting the signals being transmitted. Further, the rotary drum 2 and the circuit board 4 can be removed by removing only the mounting screws 12 and it is also possible to easily connect the second conductive members and the electronic circuit member mounted on the circuit board, and in addition the mutual transmission of signals is assured.

Referring now to Figure 3, a second embodiment of the rotary head apparatus according to the present invention will be described. Figure 3 is a plan view showing an improvement of the circuit board to be mounted to the rotary head apparatus shown in Figure 1. The same reference numerals or letters used in the first embodiment shown in Figures 1 and 2 will be used to designate like or equivalent elements and only parts different from the first embodiment will be explained.

This second embodiment is characterised in that if, for instance, two or more magnetic heads 3 are mounted to the rotary drum 2, in order to transmit or receive signals corresponding to these magnetic heads 3, a plurality of first conductive members that are in connect with the respective lead terminals of the windings of the magnetic heads are provided at positions symmetrical with each other in reference to the rotary shaft 1. Correspondingly, the arrangement areas 60 are provided for placing the electronic

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circuit members 6 on a position which is optimum for their functions.

Further, the operation when the circuit board 4 is used in the rotary head is the same as that in the first embodiment, and therefore the related explanation will be omitted.

Therefore, according to this second embodiment, even when a plurality of magnetic heads are provided on the rotary drum 2, the first conductive members 5 are provided on the upper surface of the circuit board 4 to individually face the respective magnetic heads. Further the electronic circuit members 6 are provided in the arrangement areas 60, which are functionally free from effects of oscillation. It is also possible to establish the signal transmission path between the magnetic heads 3 and the rotary transformer 8 with an optimum and shortest distance and further it is possible to transmit signals reliably in each direction without being badly affected by oscillations to the signals being transmitted.

Referring now to Figure 4, a third embodiment of the rotary head apparatus according to the present invention will be described. Figure 4 shows a plan view of the circuit board including integrated circuits and such like, which are mounted in the rotary head apparatus shown in Figure 1. The same reference numerals and letters used in the former embodiments will be used to designate like or equivalent elements and only parts different from them will be explained.

This third embodiment is characterised in that an integrated circuit 12 (hereinafter referred to as IC) is used as the electronic circuit member 6. The IC 12 is provided on the upper surface of the circuit board 4, that is, the same side as the magnetic head 3. As a result, the IC 12 faces the second conductive member 7 provided on the under surface of the circuit board 4.

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The IC 12 provided on the upper surface of the circuit board 4 and the second conductive member 7 provided on the under surface of the circuit board 4 facing the IC 12 are connected together by the IC 12 being inserted into a connecting hole (not shown) defined in the circuit board 4. Alternatively they may be connected by the printed wiring on the board.

Further, when mounting the circuit board 4 in the structure as described above to the rotary drum 2 and performing the reproduction/magnetic recording, the balance of rotation of the rotary drum may become a problem. In this embodiment, in order to balance the rotation so that the rotary drum 2 becomes symmetrical in its shape in reference to the rotary shaft 1, a member that does not function electrically but makes the moment equal by its mass may be provided at required positions of the circuit board 4 or the rotary drum.

All other elements and the operation are the same as those of the first embodiment and therefore, the explanation will be omitted.

Therefore, according to the third embodiment of the present invention, when the IC 12 is provided on the upper surface of the circuit board 4 so that it faces the second conductive member 7 provided on the under surface of the circuit board 4, i.e., the side the same as the rotary transformer, it is possible to obtain a distance between the first conductive members 5 to which a low level signal is transmitted from the magnetic head 3. Thus, a malfunction due to, for instance, the effect of oscillation, can be prevented.

Further, even when the circuit board 4 as constructed above is mounted to the rotary drum 4, it is possible to obtain the same effect as in the first and the second embodiments.

In addition, in the first and the second

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embodiments, the explanation has been made as to the electronic circuit member provided in the arrangement area provided on the surface of the circuit board at the side the same as the magnetic head. This arrangement area may be provided, for instance, on the under surface of the circuit board, the side the same as the rotary transformer, for providing the electronic circuit member in this arrangement area.

Further, in the first, the second and the third embodiments, the explanations have been made as to the first and the second conductive members provided at positions symmetrical with each other in reference to the rotary shaft. In order to maintain the balance of rotation, for instance, another member may be mounted to the circuit board or in the rotary drum.

As described above, according to the present invention, as the first conductive member 5 which is in contact with and electrically connected to the lead terminals of the windings of the magnetic head 3 and the electronic circuit member 6 which are connected to the first conductive member 5 are provided on the upper surface, the side the same as the magnetic head, of the circuit board 4 of the rotary drum, and the second conductive member 7 which is connected to the electronic circuit member 6 and is in contact with and connected to the lead terminals of the winding of the rotor 8a of the rotary transformer 8 are provided on the underside of the circuit board 4, it becomes possible to provide the circuit board 4 with the optimum and shortest distance between the magnetic head 3 and the rotor 8a of the rotary transformer 8 without leaving a long distance between them. Thus these elements are connected with each other with a simple construction. Further, the transmission loss of signal is reduced without being badly affected by oscillations and therefore the signals can be transmitted reliably.

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As described above, the present invention can provide an extremely preferable rotary head apparatus.

While there have been illustrated and described what are at present considered to be preferred embodiments of the present invention, it will be understood by those skilled in the art that various changes and modifications may be made, and equivalents may be substituted for elements thereof without departing from the true scope of the present invention. In addition, many modifications may be made to adapt a particular situation or material to the teaching of the present invention without departing from the central scope thereof. Therefore, it is intended that the present invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out the present invention, but that the present invention includes all embodiments falling within the scope of the appended claims.

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CLAIMS

1. A rotary head apparatus comprising:

a rotary shaft (1);

a rotary member fixed to the rotary shaft;

a stationary drum (10) for rotatably supporting the rotary shaft;

a rotary transformer (8) including a rotor (8a) having a winding and fixed to the rotary member so that the rotor may rotate together with the rotary member and a stator (8b) mounted on the stationary drum, the rotor and the stator being electromagnetically coupled with each other;

the rotary member including:

at least one magnetic head (3), the or each magnetic head having a winding; and

a circuit board (4) provided with a first surface carrying a first conductive member (5), a second surface carrying a second conductive member (7), an electronic circuit (6) provided on at least one of the surfaces, a circuit wiring for communicating signals among the electronic circuit, and the first and the second conductive members, the first conductive member (5) being in contact with a terminal of the winding of the magnetic head (3) for establishing an electrical connection therebetween and the second conductive member (7) being in contact with a lead terminal of the winding of the rotor of the rotary transformer for establishing another electrical connection therebetween.

2. A rotary head apparatus as claimed in claim 1 wherein the rotary member comprises a rotary drum fixed to the rotary shaft, the or each magnetic head being carried by the rotary drum.

3. A rotary head apparatus as claimed in claim 2 wherein the circuit board is mounted on the rotary drum.

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4. A rotary head apparatus as claimed in claim 2 or 3, wherein the first and the second conductive members are installed symmetrically in the rotary drum so that the circuit board is balanced.

5. A rotary head apparatus as claimed in claim 2, 3 or 4, wherein the electronic circuit is connected between the first and the second conductive members.

6. A rotary head apparatus as claimed in any preceding claim, wherein the electronic circuit includes an integrated circuit mounted on the circuit board in a position remote from the first conductive member and including an amplifier circuit for amplifying signals reproduced by a magnetic head.

7. A rotary head apparatus as claimed in any preceding claim, wherein the first and second conductive members have elastic members which are in elastic contact with the respective lead terminals of the winding.

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