



# PATENT SPECIFICATION

DRAWINGS ATTACHED

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## COMPLETE SPECIFICATION

### Improvements in or relating to Phonographs

We, RADIO CORPORATION OF AMERICA, a Corporation organized under the laws of the State of Delaware, United States of America, of 30, Rockefeller Plaza, City and Square of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to phonographs.

In accordance with one aspect of the present invention, we provide, as a modular unit for a phonograph: a metal motorboard; electrical circuit components, for example amplifier stage circuit components, on a circuit board which is mounted on but electrically insulated from said motorboard; and a power transistor which is connected in circuit with said circuit board and is mounted on an in thermal contact with said motorboard.

In accordance with another aspect of the present invention, we provide, as a modular unit for a phonograph: a metal motorboard; a turntable mounted for rotation on the motorboard; electrical circuit components for example amplifier stage circuit components, on a circuit board which is mounted on the motorboard, but electrically insulated therefrom, in the space between the motorboard and the turntable; and a power transistor which is connected in circuit with said circuit board and is mounted on and in thermal contact with said motorboard.

The circuit board, which conveniently is a printed circuit board, may be mounted on the motorboard by means of supports which are electrically insulated from the motorboard but which provide electrical connections to the circuit components on the circuit board and which thereby provide circuit connection terminals. In addition to

providing a support for the power transistor, the motorboard serves as a heat sink to dissipate heat generated by the power transistor. The resultant unit occupies no more space than is required by the record playing mechanism alone.

The invention will now be described with reference to the accompanying drawings, in which:

FIGURE 1 is a top view, in perspective, partially broken away of a phonograph embodying the invention, showing the assembly of an amplifier printed circuit board on the motorboard, underneath the turntable;

FIGURE 2 is an exploded view showing the mounting of the printed circuit board on the motorboard;

FIGURE 3 is a plan of the phonograph of FIGURE 1;

FIGURE 4 is a cross sectional view, taken along section line 4—4 of FIGURE 3;

FIGURE 5 is a less inclusive cross sectional view, similar to FIGURE 4, showing further details of the mounting of the power transistor on the motorboard in a phonograph embodying the invention; and

FIGURE 6 is a schematic circuit diagram of an amplifier circuit employed in a phonograph embodying the invention.

In the drawings like reference numerals are applied to like elements and parts throughout the several figures. A phonograph 10, embodying the invention, is provided with a metal motorboard or turntable base 12 on which is mounted the usual motor driven turntable 14. A record to be played is placed on the turntable on the central turntable spindle 15, of known construction, and which may be of the manual play type or the automatic release type. A tone arm 16 is mounted on a tone arm shaft to enable independent pivoting in a vertical plane to permit pickup servicing.

[Price 4s. 6d.]

A phonograph pickup (not shown) is supported near to the free end of the tone arm 16. The phonograph pickup may include a rotatable stylus changing control knob 17 extending from a side of the free end of the tone arm.

A record stabilizing arm 19 may, as shown in FIGURE 3, be mounted in a housing 18 on the motorboard 12.

An amplifier printed circuit board 20, including the pre-amplifier, or first two stages of a three stage amplifier circuit, is mounted on the motorboard by means of a set of screws or mounting studs including screws 22, 24, 26 and 28, which are inserted through appropriate opening on the motorboard and which are fastened against the printed circuit board by means of corresponding nuts 32, 34, 36 and 38. As will be shown below, one of these screws or mounting studs (in this particular instance, screw 26) may be employed as an electrical conductor for connecting the conductive casing 72 of a transistor 57, mounted on the motorboard 12, with an appropriate conductor on the printed circuit board 20.

A set of spacers 42, 44, 46 and 48 (FIGURE 2), which are made of a suitable electrical insulating material are placed between the motorboard 12 and the printed circuit board 20, as shown in FIGURE 2, for mounting the printed circuit board 20 on the motorboard. The screws 22, 24, 26 and 28 are mounted on the motorboard 12 through electrical insulating washers (not shown) placed between the motorboard 12 and the heads of the screws to provide electrical insulation. Also, the openings in the motorboard are sufficient diameter to clear the screws to avoid contact of the screws and the motorboard. To ensure electrical isolation between the screws and the motorboard, insulating bushings extending into the openings may also be provided if desired.

As shown in FIGURES 1, 2 and 3, the printed circuit board 20 is mounted on the motorboard 12 underneath the rotatable turntable 14, thereby utilizing space not otherwise used.

Components on the printed circuit board 20, which are longer than the spacers 42, 44, 46 and 48 are inserted through openings made in the motorboard 12, as shown in FIGURE 2. For example, an electrolytic capacitor 50 and a choke 52 are respectively inserted through openings 54 and 56.

Additional reference is now made to FIGURES 4 and 5, which respectively show an alternative coupling between an amplifier output stage transistor and the printed circuit board 20.

As shown in FIGURE 4, a power transistor 57, which constitutes the amplifier's out-

put stage is not mounted on the printed circuit board 20, but is separately mounted on the motorboard 12. The conductive casing 72 of the transistor 57 which is in electrical and thermal contact with its collector electrode, is mounted by means of screws 26 and 68 respectively inserted through openings provided in the casing 72. An electrical insulating washer 74, having a shape and area similar to the shape and area of the casing 72 is placed between the transistor casing 72 and the motorboard 12 to provide electrical insulation between the transistor collector electrode and the motorboard 12. The washer 74 is made of a material, such as mica for example, which is thermally conductive, so that the motorboard 12 acts as the heat sink for the transistor 57. As shown in FIGURES 3 and 4, an "L" shaped metallic bracket 76 may be provided to increase heat dissipation and hence increase the power operational capabilities of the transistor. The bracket 76 is mechanically mounted between the motorboard 12 and the mica washer 74. If desired, the mica washer 74 may be mounted between the motorboard 12 and the bracket 76. Since the transistor 57 would then be mounted directly on the metallic bracket 76 which is a better heat conductor than mica, and since a mica insulating spacer could be employed covering the entire area of the portion of the bracket 76 which is adjacent to the motor board 12, this will serve to further increase the power dissipation capabilities of the transistor 57.

As shown in FIGURE 2, pins 60 and 62 which constitute the base and emitter electrodes of transistor 57 are inserted through the openings 64 and 66 in the motorboard 12. The base and emitter electrodes of transistor 57 are connected to the printed circuit board 20 by means of a pair of leads 78 and 80, soldered to the printed circuit board 20 at one end and having appropriate terminals to provide electrical connections to the pins 60 and 62, as shown in FIGURE 4 for example, or alternatively by means of a transistor socket 82 soldered to the printed circuit board to receive the transistor pins 60 and 62, as shown in FIGURE 5.

The mounting stud 26 directly connects the collector electrode of the transistor 57 to the printed circuit board 20. The amplifier output signals are taken from the printed circuit board 20 by a pair of conductors 88 and 90, which pass through opening 37, for application to a loudspeaker (not shown).

In addition, an input circuit, including the volume and tone controls, is mounted on the motorboard 12 separately from the printed circuit board 20. As more fully described hereinafter, the knobs for these con-



device  
tols are accessible from the top of the motorboard 12, and the electrically controlled elements thereof are on the bottom. The signals generated by the pickup devices are coupled to the input circuit by means of pair of wires having a section located inside of the tone arm 16 and which have the remaining section inserted through an appropriate opening in the motorboard 12 for connection to the input circuit. The input circuit is coupled to the printed circuit board 20 by means of a pair of wires 87 and 89 (FIGURE 1) which are inserted through the opening 35 in the motorboard 12.

Reference is now made to FIGURE 6 which is a schematic circuit diagram of an amplifier circuit employed in a phonograph embodying the invention, and which is also helpful in illustrating in conjunction with FIGURES 1, 2, 3, 4 and 5 the operation and construction of the phonograph.

A crystal pickup 39, mounted in the tone arm 16 (FIGURE 1), generates electrical signals in a known manner. The input signals are applied to the input circuit 43 by means of a pair of wires 91 and 92 which extend from the tone arm 16 and pass through an opening provided in the motorboard 12. A variable resistor 96 mounted on the bottom side of the motorboard 12, is employed to control the volume of the sound of the phonograph. A knob 84 labelled "Vol." is attached to the shaft of the variable resistor 96 inserted through an appropriate opening in the motorboard 12 to afford manual control of the volume when the record player is in operation. By mounting the input circuit on the motorboard, not only is space used that would otherwise be wasted, but length of the leads between the pickup device and the volume control may be considerably reduced.

A variable resistor 100 is connected to the centre arm of the resistor 96 to provide tone control, in a known manner. The resistor 100 is also mounted on the bottom side of the motorboard 12 in a manner similar to that of the mounting of the variable resistor 96. A knob 86 labelled "Tone," is attached to the shaft of the resistor 100, inserted through an appropriate opening in the motorboard 12, to permit control of the frequency response of the amplifier while the phonograph is in operation.

The pair of wire leads 87 and 89 (see also FIGURE 1) couple the signals from the input circuit to the terminals D and E in the printed circuit board 20. The printed circuit board 20 includes a plurality of serrations or slots such as 101, for the insertion of the metallic connectors connected at the ends of leads 87 and 89 to pro-

vide electrical contact with the terminals D and E.

The phonograph amplifier circuit comprises three stages of amplification. The first two stages, the pre-amplifier portion, includes two transistors mounted on the printed circuit board 20. The output stage, or power amplifier stage, includes the power transistor 57, shown in FIGURES 2, 4 and 5, and which is mounted on the motorboard 12. The pre-amplifier portion, i.e., the input stages of the amplifier circuit, is coupled to the power transistor 57 by the wire leads 78 and 80 (also illustrated in FIGURE 4) or by a suitable transistor socket 82, as shown in FIGURE 5, and as previously described.

The casing 72 of the power transistor 57, which is thermally and electrically connected to the collector electrode of the transistor 57, is connected to the printed circuit by the mounting stud 26, as shown in FIGURES 4 and 5, and provides an output signal terminal C.

The terminal F, on the printed circuit board 20, is electrically connected to the power transistor emitter electrode pin 62. Output signals are derived between the output terminals C and F, across the choke 52, and are coupled to a loudspeaker 141 by the pair of wires 88 and 90 each having a metallic connector inserted in a serration or slot 101 corresponding to terminals C and F, respectively, as shown in FIGURE 1.

Power is supplied to the transistor circuit by means of a half wave rectifier circuit including a rectifier 132 mounted on the bottom side of the motorboard on a suitable small piece of terminal board (not shown) by means of the screw 24, which is in electrical contact with the printed circuit board 20 at terminal A. The anode electrode of the rectifier 132 is in electrical contact with the terminal A on the printed circuit board 20, and the cathode electrode is connected to one end of the secondary winding of an electrical motor employed to rotate the turntable 14. The other end of the secondary winding of the electrical motor is connected to a terminal (not shown) mounted on the bottom side of the motorboard 12 through the screw or mounting stud 22. The screw 22 is electrically connected to terminal B of the printed circuit board 20. By directly applying the input power to the terminals A and B not only the mounting means of the printed circuit board are used, but additional wiring as required heretofore is unnecessary.

The capacitor 50 is electrically connected between the terminals A and B on the printed circuit board. If desired, the capacitor 50 may be a dual electrolytic type



capacitor of known construction, including capacitors 50A and 50B, having two pairs of terminals  $a'$ ,  $a''$ , and  $b'$ ,  $b''$ , each adapted for independent connections. Alternatively, two separate capacitors, each having the desired value of capacitance to provide minimum ripple, may be employed.

A resistor 150 is connected between the terminals  $a'$  and  $b'$  to provide in conjunction with the capacitors 50A and 50B a filter circuit for the half wave rectifier power supply. In addition, to provide temperature stabilization of the transistor 57 by direct current degeneration, the resistor 150 is also connected to the emitter electrode pin 62. The terminals  $a''$  and  $b''$  which are internally connected to each other in the case of a dual type capacitor, are electrically connected to the terminal A of the printed circuit board 20.

As described and as shown in FIGURES 1 to 5, by mounting the amplifier circuit on the top side of the motorboard 12, underneath the turntable 14 and clear from the mechanism associated with the turntable, space which heretofore has been wasted is employed. This results in a compact phonograph with a consequent reduction in cost, and with an increase in the freedom of styling. For example, instead of the extra chassis heretofore required for the amplifier, a single chassis, the motorboard, is employed for both the record player and amplifier. This provides a more compact, light weight and inexpensive phonograph which in the case of portable phonographs, for example, is extremely important.

In addition, to provide transistor amplifiers capable of operation with a desired output power characteristic, a suitable heat sink should be provided for the output transistor with the resulting added cost and weight, and with the additional waste in useable space. By mounting the transistor in thermal conductive relation with the motorboard, the motorboard itself may be employed as a heat sink with the additional savings in cost, space, and weight. If desired, the transistor may be mounted electrically insulated from the motorboard but in thermal conductive relation to increase the freedom of circuit design and still obtain the advantages above mentioned.

An off-on switch (not shown) also mounted on the top side of the motorboard, is connected at one end between the primary winding of the motor and a plug. The off-on switch is mechanically activated by a lever arrangement which includes a control lever in mechanical contact with the switch. The phonograph is turned on or off as desired by closing the switch, which in turn energizes the motor and provides rotation of the turntable. Closing the switch also provides an operating potential for the

amplifier circuit. A function control knob 152 shown in FIGURE 1, is in mechanical relation with the control lever to permit operation of the off-on switch when the phonograph is assembled and ready for operation.

Although a monophonic phonograph embodying the invention has been described and illustrated, the invention is applicable to other type phonographs, such as stereophonic phonographs for example.

In the case of a stereophonic phonograph, the amplifier circuit would include two amplifier channels, each having a pre-amplifier portion, similar to the pre-amplifier shown in FIGURE 6, as the first and second stages of the amplifier, mounted on a single printed circuit board, similar to the printed circuit board 20. The mounting of the printed circuit board may be the same as described above, with the exception that the mounting stud 28 may be utilized for mounting another power transistor, similar to the transistor 57. In this case, the stud 28 would be in electrical connection with the amplifier circuit and it would provide an output terminal for one of the two channels. The mounting of the additional transistor may be similar to the mounting of the transistor 57, as described in connection with FIGURES 4 and 5.

It is not necessary to mount the transistor on the motorboard through an electrical insulator as described in connection with FIGURES 4 and 5. In the case of a stereophonic phonograph, it may be desirable to employ two channels like the circuit configuration shown in FIGURE 6, and in that case at least one of the power transistors should be electrically insulated from the motorboard to avoid connecting both transistors in parallel.

The power transistors, however, may be directly mounted on the motorboard, if for example the motorboard is employed to provide a point of fixed reference potential, such as ground, and the power transistors are connected in the common collector configuration, for example.

In addition, other arrangements of the circuit and utilization of the mounting studs may be employed. For example the mounting studs utilized to apply the power input to the transistor may be utilized to apply the input signal from the input circuit 43, if desired, while the power input would be applied through a pair of lead wires, for example.

#### WHAT WE CLAIM IS:—

1. As a modular unit for a phonograph: a metal motorboard; electrical circuit components, for example amplifier stage circuit components, on a circuit board which is mounted on but electrically insulated from

capacitor of known construction, including capacitors 50A and 50B, having two pairs of terminals  $a'$ ,  $a''$ , and  $b'$ ,  $b''$ , each adapted for independent connections. Alternatively, two separate capacitors, each having the desired value of capacitance to provide minimum ripple, may be employed.

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It is not necessary to mount the transistor on the motorboard through an electrical insulator as described in connection with FIGURES 4 and 5. In the case of a stereophonic phonograph, it may be desirable to employ two channels like the circuit configuration shown in FIGURE 6, and in that case at least one of the power transistors should be electrically insulated from the motorboard to avoid connecting both transistors in parallel.

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In addition, other arrangements of the circuit and utilization of the mounting studs may be employed. For example the mounting studs utilized to apply the power input to the transistor may be utilized to apply the input signal from the input circuit 43, if desired, while the power input would be applied through a pair of lead wires, for example.

#### WHAT WE CLAIM IS:—

1. As a modular unit for a phonograph: a metal motorboard; electrical circuit components, for example amplifier stage circuit components, on a circuit board which is mounted on but electrically insulated from



said motorboard; and a power transistor which is connected with said circuit board and is mounted on and in thermal contact with said motorboard.

2. As a modular unit for a phonograph: a metal motorboard; a turntable mounted for rotation on the motorboard; electrical circuit components, for example amplifier stage circuit components, on a circuit board which is mounted on the motorboard, but electrically insulated therefrom, in the space between the motorboard and the turntable; and a power transistor which is connected in circuit with said circuit board and is mounted on and in thermal contact with said motorboard.

3. A unit according to Claim 1 or Claim 2 wherein any component on said circuit board having appreciable size is located on the side of said circuit board adjacent to said motorboard and extends through appropriate openings in said motorboard.

4. A unit according to Claim 1 or Claim 2, wherein said circuit board is separated from said motorboard by a plurality of electrical insulator studs having openings there-through, a plurality of mounting screws pass through said circuit board, said motorboard and a respective insulating stud, to support said circuit board said screws being electrically insulated from said motorboard and said circuit board, and at least one of said screws serving as a circuit connection between said circuit board and said transistor.

5. A unit according to Claim 1 or Claim 2 wherein a sheet of heat conducting electrically insulating material is included be-

tween said transistor and said motorboard.

6. A unit according to Claim 1 or Claim 2 wherein said transistor is mounted on the side of said motorboard opposite to the side on which said circuit board is mounted.

7. A unit according to Claim 1 or Claim 2 wherein a socket, supported by said circuit board and positioned in alignment with the position of said transistor on said motorboard, has terminals for engagement with leads extending from said transistor so as to interconnect said power transistor and said circuit board.

8. A unit according to Claim 1 or Claim 2, wherein a plurality of flexible leads, each having one end affixed to said circuit board and each having a terminal affixed to their other end for connection each to a different lead extending from said power transistor, interconnect said power transistor and said circuit board.

9. A unit according to Claim 1 or Claim 2 wherein a metal bracket mounted between the motorboard and the transistor provides additional heat dissipation from said transistor to said motorboard.

10. A modular unit for a phonograph substantially as herein described with reference to the accompanying drawings.

11. A unit according to any one of the preceding claims when incorporated in a phonograph.

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