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A Method of Remote-controlling the Polar Pattern of a Condenser Microphone with Standard Phantom Powering

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A Method of Remote-controlling the Polar Pattern of a Condenser Microphone with Standard Phantom Powering

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Introduction

Microphones with remote-controlled directional characteristic are offered by various manufacturers. Common to all is the fact that, in addition to the modulation leads, control leads are required, necessitating a special microphone cable. This frequently opposes the use of such microphones, as studio microphones are usually operated with 3-core XLR cables.

The following is a description of a circuitry technique, with the aid of which the directional characteristic of a condenser microphone can be remote-controlled while operating on 48 V phantom powering and connected by a 3-core XLR cable.

The Principle of Directional Characteristic Switching

The beginnings of the microphone with remote-controlled directional characteristic go back to the year 1949, in which Grosskopf was granted a patent for a "Capacitive microphone with variable directional characteristic"*).

In this, Claim 1 states:
"Capacitive microphone, in which several individual microphones are united in a combination characterized by the fact that the individual microphones are joined in the ac sense but separated in the dc sense, so that the bias of the individual microphones, and therewith the directional characteristic of the combination, can be independently varied from one directional characteristic to a number of others".

In Fig. 1, the example of the dual diaphragm capsule as shown in the patent application is depicted. The two halves of this provide a "cardioid" polar pattern; in the ac sense, they are connected by the capacitor C, but in the dc sense, they are separated. The common back-electrode B is at zero voltage; together with the diaphragm M_F, which is at dc –U, it constitutes a microphone of constant sensitivity. This is usually the forward-facing system of the dual-diaphragm capsule.

The dc voltage at the rear diaphragm M_B can be varied with the aid of the potentiometer P. At the limits of the latter's travel, the diaphragm M_B receives the voltages –U or +U respectively, so that this microphone system displays the same sensitivity as the front one first described. The combination yields a microphone with two cardioid capsules arranged back to back and emitting ac voltages in the same or opposite sense. The acoustical result is depicted in Fig. 2:

*) Patent No. 927037, Deutsches Patentamt, April 28, 1955. Inventor: Herbert Großkopf

With a bias voltage of the same sense, the two microphone systems operate additively. The ac voltages of the two individual systems augment each other at every angle of sound incidence to provide a constant overall sensitivity, producing an omnidirectional characteristic equally sensitive in all directions (Fig. 2a).

If the bias voltage is of the opposite sense, the microphone systems operate subtractively. The ac voltages of the two individual systems are in counterphase. Consequently, with sound arriving from the side, for example, they cancel each other, resulting in a two-sided characteristic familiar as the "figure-8" (Fig. 2e).

If the potentiometer is in its central position, the diaphragm M_B is at zero potential, as is also the back-electrode B. There is no ac voltage at this microphone system and the entire system operates with the cardioid characteristic of the other half (Fig. 2c).

Intermediate voltage settings result in directional characteristics somewhere between omnidirectional and cardioid, as, for example, the "hemisphere" in Fig. 2b, or between cardioid and figure-8, such as the "hypercardioid" in Fig. 2d.

At the time of the patent, suitable dc capsule voltages were always available in the microphone, as they could be derived from the anode voltage required for the valves.

With today's switchable microphones, the various voltages are generated by a dc converter. Fig. 3 depicts for example a modern transformerless microphone which offers five switchable directional characteristics. The switch was preferred to a potentiometer in order to be able to reproduce more easily the various settings.

If it is required to remote-control the directional characteristics, the appropriate voltages must be provided by a power or control unit and fed to the microphone as shown in Fig. 4.

For this reason, all remote-controllable microphones require a control lead in addition to the two modulation leads. However, the non-variable dc voltage for the front capsule system is usually generated in the supply unit as well.

The result is that there must be five leads to the microphone, including the zero-volt lead. However, as three-core XLR cable is used throughout the world for microphones, a growing wish was expressed for a circuit in the microphone which would receive and convert information for the control of the directional characteristic via the modulation leads. Naturally, such a circuit must be able to meet a number of requirements.

Conditions Imposed on the Control Circuit

1. Most professional condenser microphones are phantom-powered at 48 V. This method should be retained for reasons of compatibility, but leaves very little latitude with regard to additional current consumption in the microphone without forfeiting some of its loadability. Therefore a circuit for the reception, interpretation and conversion of control information in the microphone must have a current consumption which is well under 1 mA.

2. The control information must not be allowed to cause interference with any other equipment. This applies also to "normal" microphones which are connected to the control lead, as it is not necessarily apparent whether an XLR lead of the usual type is a controlled microphone lead.
3. The control system is required also to function normally over longer distances, e.g. into other rooms. For this reasons, long leads with unknown cable impedances must also have no effect on the control system.
4. The control information must be unambiguous. The microphone must not be subject to inadvertent change to another polar pattern.
5. The circuit must be inexpensive.

Early Attempts to find a Solution

Various ideas were advanced as to how to transmit information to a microphone via a three-core cable so as to vary its polar pattern. For example, specific tone series, impulses or frequencies outside the audible range were all feasible.

Acoustical and optical control signals for the purpose of influencing the microphone were likewise considered. They had the advantage of not requiring any wiring, which meant that the control signal and the audio signal of the microphone were de-coupled from the start.

However, every suggested solution was opposed by at least one of the above-mentioned conditions, so that gradually every form of analogue or digital encoding was abandoned.

Control via Phantom Powering

Finally the idea was conceived of going, so to speak, to the source of the microphone. i.e. to the phantom powering circuit.

According to CCIR 268-15 or DIN 45596, the 48 V supply voltage may vary between 44 V and 52 V, i.e. 48 V ± 4 V (Fig. 5).

If now there were a reference in the microphone with which the absolute level of a phantom voltage within the prescribed tolerance could be compared, information for the control functions could be derived from it. This was implemented in the form of a hybrid circuit, which can be accommodated in a studio type microphone without difficulty.

The way in which a microphone of this type functions is shown in Fig. 4:

The +48 V supply voltage at the two modulation leads (minus the known voltage drop at the two standard infeed resistors in the power supply unit) is decoupled (A) and fed to a dc/dc converter and the evaluating circuit B. The converter generates a +10 V dc voltage for the supply of the remaining circuits and four further voltages, with the aid of which the dual-diaphragm capsule can be switched to any one of the five directional characteristics omnidirectional, wide-angle cardioid, cardioid, hypercardioid and figure-eight by means of the rotary switch S.

Together with the decoupled voltage, the evaluation circuit B receives information about the

Together with the decoupled voltage, the evaluation circuit B receives information about the absolute level of the voltage at the two modulation leads and compares it with an inherent reference. Comparators control switching transistors on the principle of a 4-bit A/D converter and these apply +60 V and –60 V or intermediate capsule voltages as preset by the dc/dc converter to the rear microphone capsule. For this purpose, the rotary switch S must be previously set to the sixth position R (= Remote), in order to switch over from the internal control of the directional characteristic of the microphone to remote control.

As the signalling device for the control information, a power supply unit the size of a standard phantom powering unit is used (Fig. 7). This is of the double-channel type, and is equipped with two rotary stepping switches, which set the absolute voltage level at the modulation leads. Since this voltage is dependent on the current requirement of the connected microphone, the voltage is fed back to the modulation leads behind the standard infeed resistors (2 x 6.8 kohms), and compared with a high-precision reference voltage. From this a control system is obtained, so that the effect is that of a closed control circuit. Proceeding from the nominal +48 V, to which the directional characteristic "cardioid" is assigned, the voltage is raised or lowered by 1.5 V per step. Thus, the polar pattern is switched in one direction to "wide-angle cardioid" and "omnidirectional" and in the other to "hypercardioid" and "figure-eight".

Advantages of Control System

This control system embodies the following advantages over those in the above-mentioned early attempts:

1. The sole specific component in the microphone for remote switching is the evaluation circuit B. This is small, inexpensive and consumes less than 0.25 mA current.
2. The switching steps are large and unambiguous, in order to be able to effect reliable control at distances of up to several hundred metres.
3. The method is compatible. The microphone can be operated on any standard phantom powering unit and via any three-core XLR cable. On the other hand, every studio condenser microphone will operate on the associated control unit, as the device remains within the standard tolerance range.
4. There is no interference with any following devices, as only the 48 V dc voltage with the admissible tolerance deviation is used as control information.
5. The remote-controllable microphone can be neither endangered, damaged nor get into an inadmissible condition by operating errors or by a "wrong" power unit. For if the microphone is operated by a "normal" phantom powering circuit, it can be switched to one of the microphone's directional characteristics by means of the switch S. However, if the switch S is placed inadvertently in the "remote" position, one of the five possible directional characteristic comes likewise into play. This cannot be defined in advance though, as it is dependent on the phantom voltage of the power supply used.

Fig. 8 shows a condenser microphone in which the control method for remote selection of the directional characteristic is realised. If required, this can also be selected at the microphone itself, as hitherto. The microphone is the TLM 170 R.

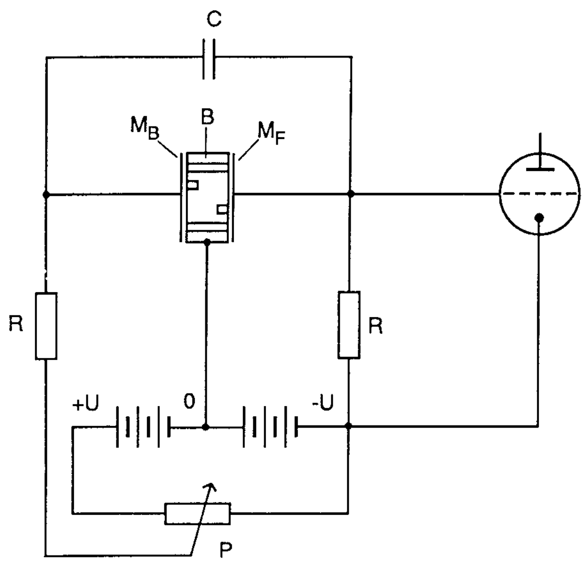

Fig. 1

Principle of a condenser microphone with variable polar pattern.
M_F: Front membrane, M_B: Back membrane, B: Back electrode.

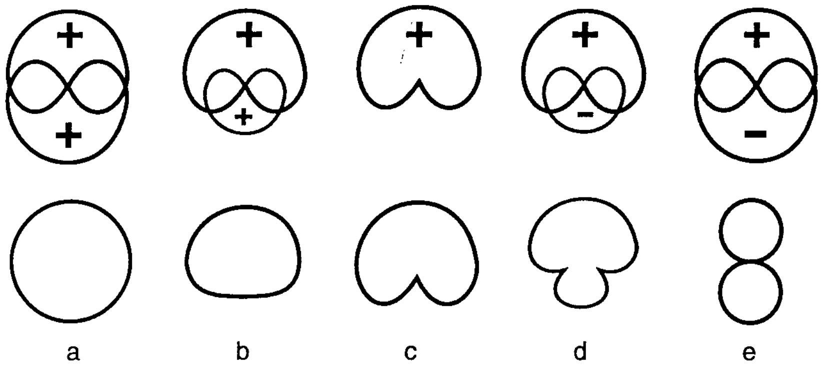

Fig. 2

The development of different polar patterns
by superimposition of two directional characteristics.

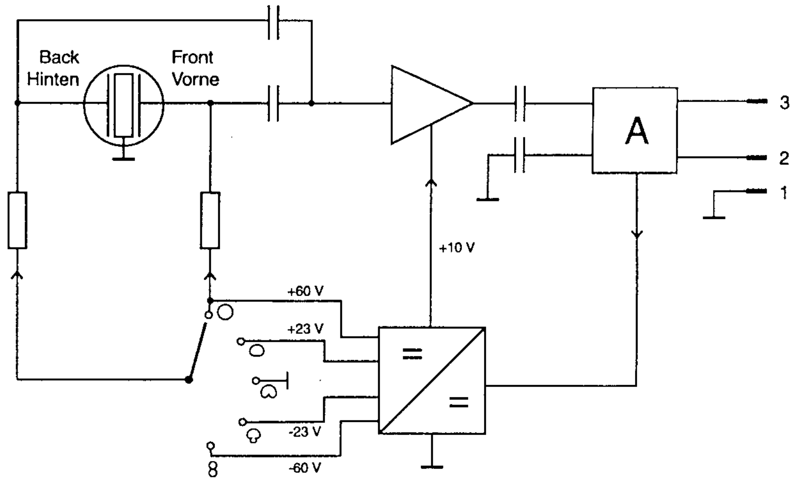

Fig. 3

Condenser microphone with five switchable polar patterns. A: Decoupling circuit.

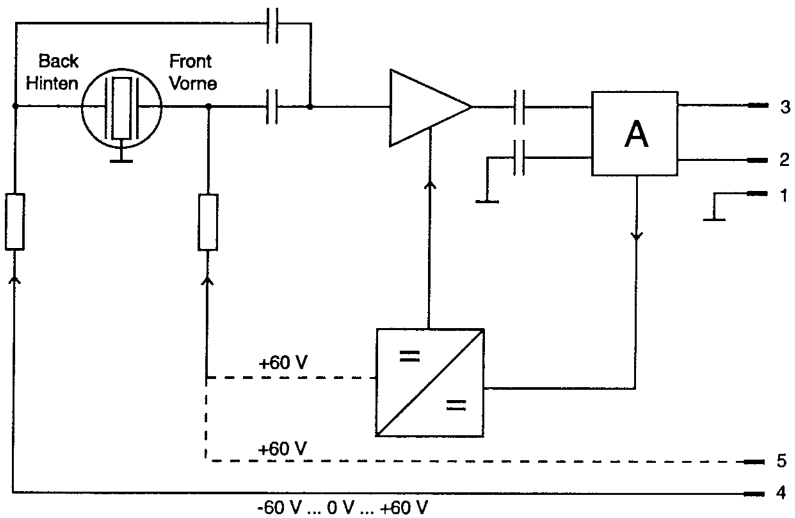

Fig. 4

Condenser microphone with remote-controlled polar pattern.
A: Decoupling circuit.

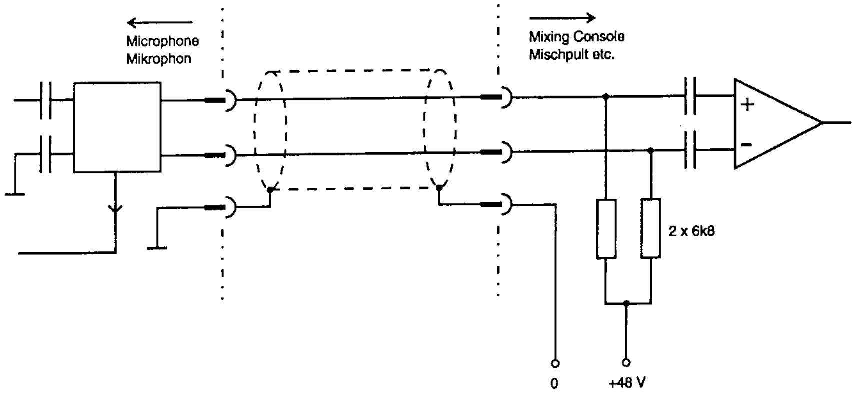

Fig. 5
The 48 V phantom power circuit as per DIN 45596/CCIR 268-15

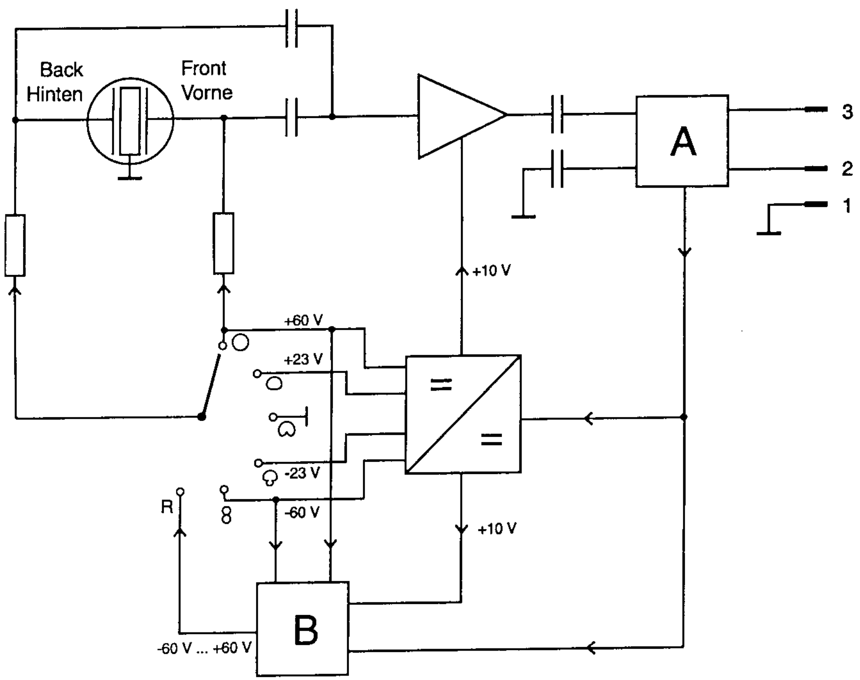

Fig. 6
The evaluation and control circuit B in the microphone shown in Fig. 3.

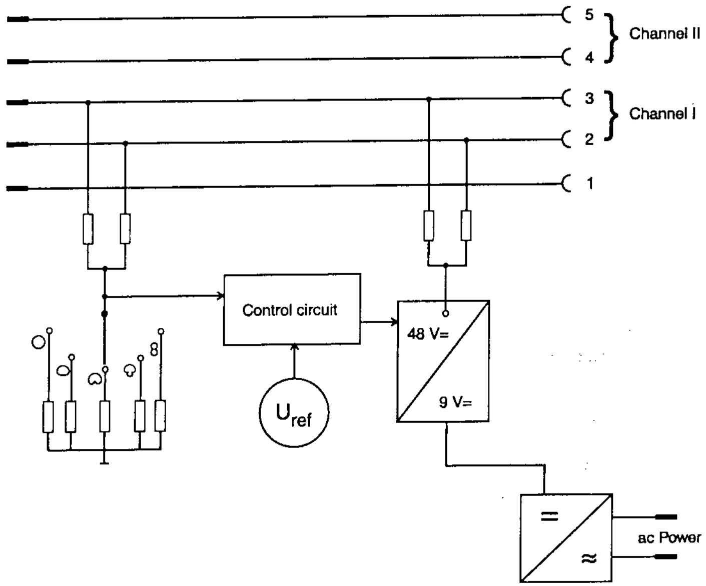

Fig. 7
The two channel power supply for remote control.

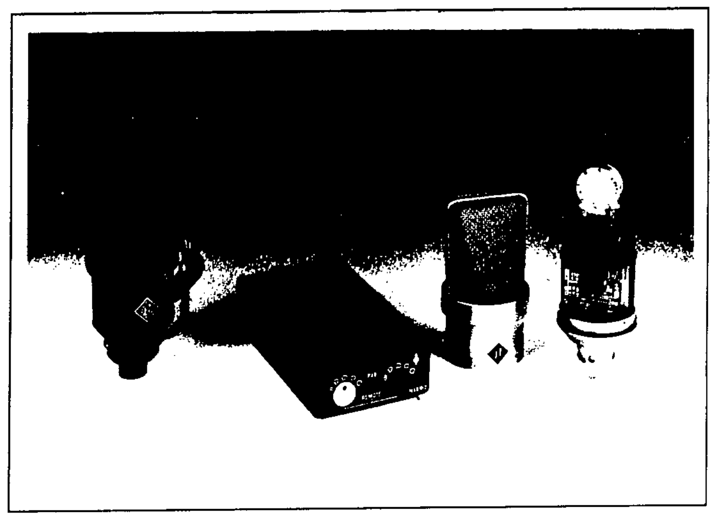

Fig. 8
The (remotely) switchable TLM 170 R Condenser Microphone.