speaker cone **81** is attached in a ring **86** to the open end of the housing **80**. The satellite speaker **80–89** is a conventional speaker, but the signals which drive this speaker are not obtained directly from the audio amplifier. Instead, these signals are generated in the coil **71** by the ceramic magnet **70** which produces signals of sufficient power to drive the second speaker. Consequently, one speaker may be used to power two.

FIG. **13** illustrates a further modification of a high fidelity speaker which eliminates the necessity for connecting electric wires or conductors to the moving voice coil. The speaker of FIG. **13** is similar in construction to the primary speaker of FIG. **12** except that the ends of the voice coil **64** are connected together to short circuit the voice coil. As illustrated in FIG. **13**, the magnet **70** is bonded or attached to the end of the permanent magnet **69** by means of a suitable epoxy layer **72**. Signals from the audio amplifier **68** then are applied to the terminals of the coils **71** instead of to the voice coils **64**. The operation of the speaker of FIG. **13** is substantially identical to the operation of a standard high fidelity speaker where the signal is connected to the end terminals of the voice coil. The limitations created by connections to a moving voice coil, however, are eliminated since the coil to which the audio signals are applied, namely the coil **71**, does not move, but is in a rigid position, attached to the left-hand face of the circular ceramic magnet **70**. The voice coil **64** on its core **63** vibrates in response to variations in the changing magnetic field produced through the magnet **69** (in contrast to a standard high fidelity speaker where the flux field of the magnet **69** does not change). The magnetic field which is produced in the shorted voice coil is an analog of the sound input from the audio amplifier **68** and drives the speaker cone **61** to produce the desired output sounds.

Reference now should be made to FIGS. **14** and **15** which illustrate an improved large solenoid application. A relatively large non-conductive hollow cylindrical coil **100**, typically having a height of 12" and an inside diameter of 22", has a coil **104** wrapped around its outer surface. The ends of the coil **104** are connected to a pulsed DC source **105**. Devices of this type have been used in veterinary medicine, primarily in Europe to produce pulsing magnetic fields. The operation of such a device is significantly enhanced by providing an inner cylinder **102** of permanently magnetized magnetically hard ceramic magnetic material within the cylinder **100**. Flexible material is used to form the inner magnetic cylinder **102**, and the cylinder **102** is magnetized through its thickness (or radially) to cause the outer surface to have one magnetic pole and the inner surface to have a second opposite magnetic pole. The principles of the magnetic flux density multiplication occur in conjunction with the device of FIGS. **14** and **15**, and its operation is enhanced as a result.

The foregoing description, taken in conjunction with the various figures of the drawings, is to be considered illustrative of the different embodiments of the invention and not as limiting. Various changes and modifications will occur to those skilled in the art, once the enhanced operating characteristics of the electromagnetic transducers are fully understood. A number of different system applications have been described, but the invention is applicable over a wide range of electromagnetic transducers, such as hearing aids, earphones, microphones, guitar pick-ups and the like. Utilization of the invention in such products and others will occur to those skilled in the art without departing from the true scope of the invention. The relative dimensions of various components which have been described, also may be varied without departing from the invention.

I claim:

**1.** An electromagnetic transducer including in combination:

first and second closely spaced flat ceramic magnetic plates of permanently magnetized material, said plates each having a thickness substantially less than the length and width thereof, with first and second faces thereon and magnetized through the thicknesses thereof to form a North Pole on the first face thereof and to form a South Pole on the second face thereof; and

a coil of electrically conductive material immovably sandwiched between said magnetic plates and located in the magnetic field between said first face of said first plate and said second face of said second plate for inducing changes in the magnetic field adjacent said second face of said first plate and said first face of said second plate when current is applied through said coil, changes in the magnetic field at said second face of said first plate and said first face of said second plate being proportional to such current.

**2.** The combination according to claim **1** wherein said first and second plates are made of magnetically hard material.

**3.** The combination according to claim **2** wherein said first and second plates are made of magnetically hard dielectric material.

**4.** The combination according to claim **3** wherein said coil is a spiral coil, the plane of which is parallel to the planes of the faces of said plates.

**5.** The combination according to claim **4** wherein said coil is attached to said first face of said first plate.

**6.** The combination according to claim **1** wherein said coil is a spiral coil, the plane of which is parallel to the planes of the faces of said plates.

**7.** The combination according to claim **6** wherein said coil is attached to said first face of said first plate.

**8.** The combination according to claim **1** wherein said coil is attached to said first face of said first plate.

**9.** An electromagnetic transducer including in combination:

a flat ceramic magnetic plate of permanently magnetized material, said plate having a thickness substantially less than the length or width thereof, with first and second faces thereon and magnetized through the thickness thereof to form a North Pole on the first face thereof and to form a South Pole on the second face thereof; and

a coil of electrically conductive material immovably attached to one of said first and second faces of said plate for producing current flow therein proportional to changes induced in the magnetic field at said one face of said plate and for inducing changes in the magnetic field adjacent said first and second faces of said plate when current is applied through said coil.

**10.** The combination according to claim **9** wherein said plate is made of magnetically hard material.

**11.** The combination according to claim **9** wherein said coil is a spiral coil, the plane of which is parallel to said one face of said plate.

**12.** The combination according to claim **11** wherein said coil is attached to said first face of said plate.

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