June 30, 1970 P. E. KIEPE 3,518,681

BACK-COUNTRY RADIO BOOSTER

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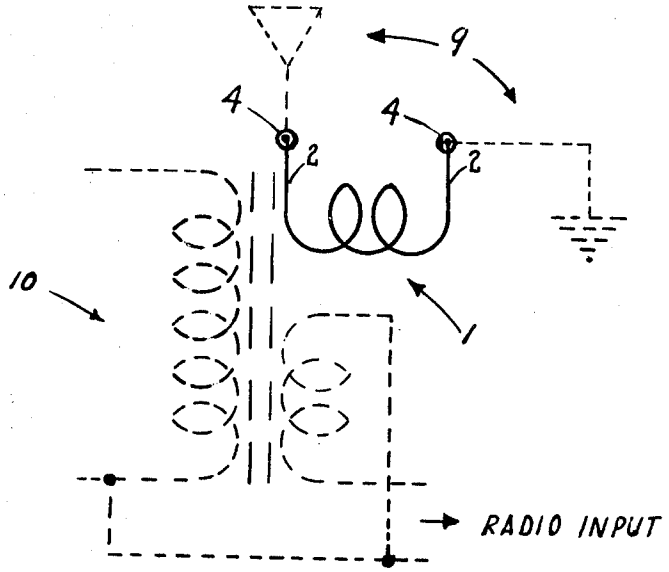

Fig. 1.

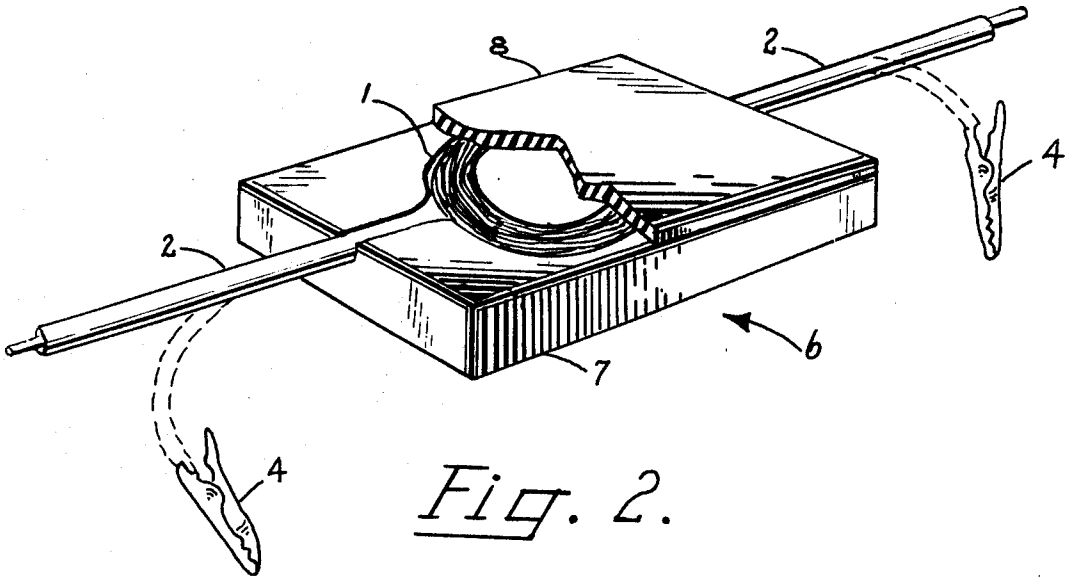

Fig. 2.

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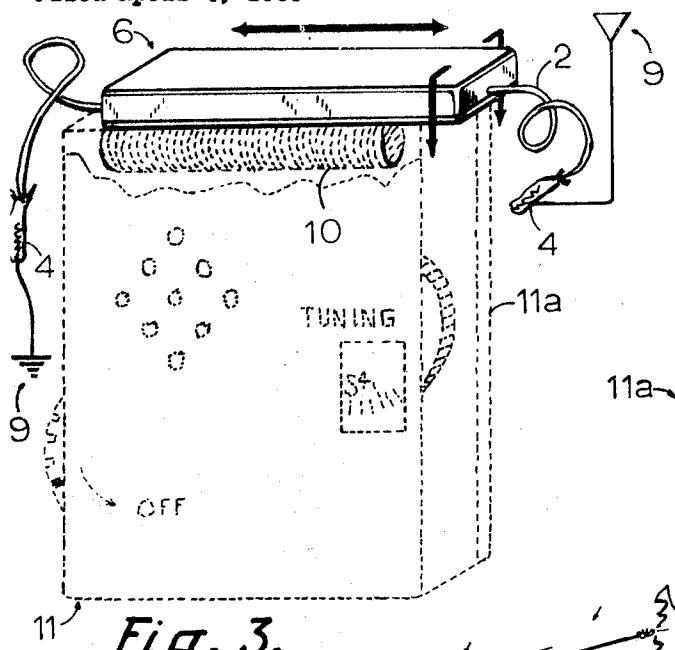

Fig. 3.

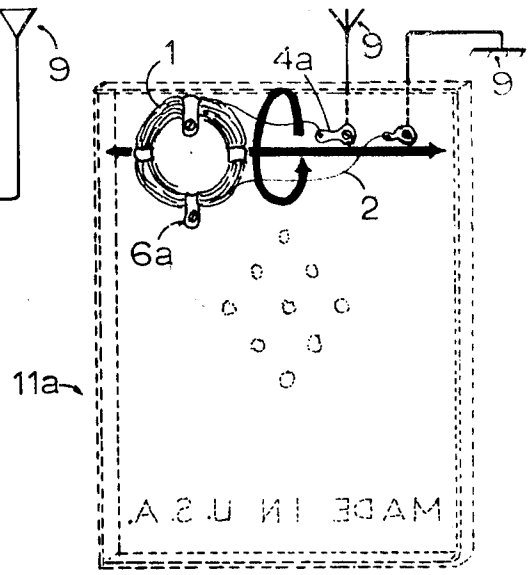

Fig. 4.

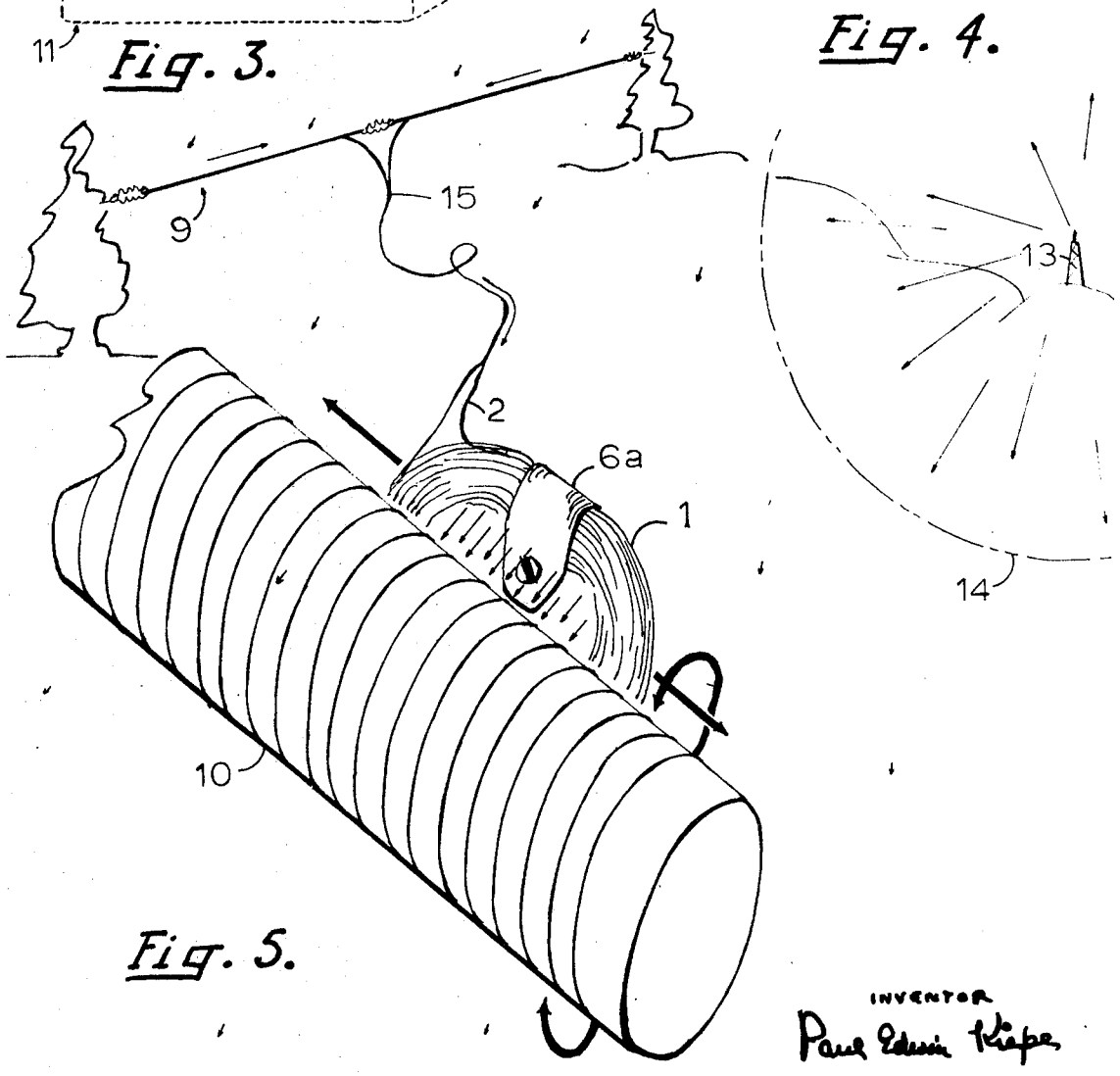

Fig. 5.

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BACK-COUNTRY RADIO BOOSTER

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ABSTRACT OF THE DISCLOSURE

The back-country radio booster of this invention consists of a small induction coil of about 100 turns of magnet wire whose windings are positioned near the ferrite-rod antenna system of a broadcast-band AM radio receiver in a relationship that minimizes detuning of the ferrite-rod standard coils when the induction coil is interconnected with a large antenna and ground system, and that maximizes signal induction to the ferrite rod. In preferred embodiment, the windings of the induction coil are in doughnut form and are positioned adjacent and at right angles to the windings of the ferrite-rod standard coils. When, at a geographical site remote from broadcasting stations, the user connects the terminals of the induction coil, so positioned, to a large antenna and ground system, a booster effect occurs: the radio, previously useless during daylight hours, comes alive with stations hundreds of miles away.

This invention relates to radio boosters of the class adapted to amplitude-modulation radio broadcast receivers—"radios"—that employ a ferrite-rod antenna as signal accumulator.

Most radios of this sort work well both day and night in cities and suburbs where broadcasting stations are nearby, being designed to do just that. They work less well at nightime and poorly to not at all during daylight hours when called upon to perform in back-country areas, this condition being the result of (a) the attenuation of radio broadcast waves with distance and (b) the ferrite-rod antenna's electrical limitations.

The reduced performance of these radios in remote districts leaves gaps in the usefulness of such radios. The city radio owner who visits back-country areas in expectation of radio entertainment and information may meet with disappointment. The back-country radio listener may "give up" on this class of radio, and fall back upon his "farm radio" of pretransistor days, thus missing the notable economies and superior tone qualities of the newer radios.

Radio manufacturers have sought to expand the usefulness of a percentage of such radios by boosters for back-country listening. Boosters of this class have two elements in common: (c) they provide means for employment of a conventional wire-antenna system as signal accumulator, and (d) they provide circuitry and equipment that either by-passes or over-rides the ferrite-rod antenna when its limits of usefulness have been reached. Such boosters work satisfactorily, but because of their sophistication they cannot feasibly be applied to the millions of radios manufactured without them, and in the market they double and sometimes even treble the cost of radios in which they are installed as original equipment.

By contrast, the back-country booster of the present invention can be applied readily to all AM radio broadcast receivers that employ a ferrite-rod antenna. It is simple of construction, hence inexpensive. Instead of by-passing or over-riding the ferrite-rod antenna to apply to the radio the stronger signal of the conventional wire-antenna system, the present invention, by means of a

simple coil, applies the wire-antenna signal directly to the ferrite rod.

To describe the present invention as simple is not to say it is obvious. The present invention is one of the class of unexpected simple devices that takes a different line from conventional practice. Experiments at coupling an extra coil to the standard coils of a ferrite-rod antenna for a booster effect from an external accumulator doubtless have been many. Conventional theory would call for a supplementary coil coupled closely to the standard coils.

The discovery underlying the present invention, whilst happened upon empirically, would seem to rely on theory divergent from the foregoing but none the less sound. Instead of a coupling of electrical expression to the ferrite-rod standard coils, what the present invention appears to use is a coupling of magnetic expression to the ferrite rod.

In practice the present invention employs a coil of size, shape, and orientation with respect to the ferrite rod that presumably presents to the rod, when the coil is suitably preconnected to a larger signal accumulator, the magnetic component of the received signal as derived from the external accumulator in a manner similar to a signal received on the rod direct, only proportionately stronger. This presentation of supposed magnetic signal component to the rod is had not alone by placing the coil of this invention near the ferrite rod, but also by orienting the axis of the air core of said coil so as to be at right angles, or nearly so, to the principal axis of the metallic core within the ferrite-rod antenna coils. This juxtapositioning places the windings of the coil of this invention in a relationship to the windings of the antenna coils of putatively least coupling—quite the opposite of "correct" procedure under conventional theory to obtain a useful transference—hence booster—effect.

Accordingly it is the general object of the present invention to provide a simple back-country booster for amplitude-modulation radio broadcast receivers—"radios"—that employ a ferrite-rod antenna as signal accumulator.

The advantages of the back-country radio booster provided by the present invention include the following:

(1) It provides a means for boosting back-country performance of said radios that uses, rather than bypasses, the ferrite-rod antenna, at a net saving of circuitry and equipment;

(2) It may be employed advantageously by radio manufacturers as a supplement to such radios in lieu of present modes of improving back-country performance;

(3) It may be employed by radio listeners outside the radio cabinet of such radios;

(4) When employed outside the radio cabinet, it transforms such radios into back-country radios after a brief, non-technical positioning operation that involves no adjustment inside the cabinet.

Generally stated, the back-country radio booster of this invention comprises a continuous coil of insulated electrical wire, suitably protected from physical damage, suitably terminaled for use disconnectably in combination with a conventional wire-antenna system, and suitably formed so as to be placable in relationship to the ferrite-rod antenna of radios that employ such antenna that it may lie close thereto, with the axis of its air core substantially at 90° to the principal axis of the metallic core of the said ferrite-rod antenna.

Considering foregoing in greater detail and with particular reference to the drawing:

FIG. 1 is a schematic diagram of the said coil of the back-country radio booster of this invention shown schematically in appropriate relationship to the standard coils and rod (represented by the dashed double vertical lines)

of a ferrite-rod antenna in a typical broadcast-radio circuit that is shown only in part.

FIG. 2 is a perspective view of one of the optional forms of the back-country radio booster of this invention in a form suitable for use as a radio accessory.

FIG. 3 is a perspective view of a small radio with the back-country radio booster of FIG. 2 in an operational position outside the radio cabinet.

FIG. 4 is a perspective view of just the back cover of the small radio of FIG. 3, looking at the inside of said cover, that shows the booster coil of this invention affixed inside the radio cabinet in one of numerous optional modes and positions.

FIG. 5 is a perspective view of an enlarged ferrite-rod antenna fragment with the booster coil of this invention depicted at a back-country site in operative relationship both with a conventional wire-antenna system and with a ferrite-rod antenna as claimed herein. The numerous slim arrows appear throughout the drawing in several lengths to suggest electro-magnetic energy differences at various points in the total system that has its origin at a distant radio broadcasting station at far right.

COIL AND CONNECTIVES

The general character of the back-country radio booster described herein is apparent from the schematic diagram of FIG. 1, wherein the booster coil **1** is shown in operative relationship with a conventional wire-antenna system **9** and with a ferrite-rod antenna **10** of a conventional radio receiver circuit, the ferrite rod of said ferrite antenna being depicted by the two dashed vertical parallel lines.

A specific embodiment of this invention illustrated in FIG. 2 employs a continuous coil **1**—the booster coil— of about 100 turns of No. 33 B&S-gage magnet wire wound randomly into a doughnut coil of about ⅝" inside diameter and about 1" outside diameter. The booster coil is terminaled at insulated connecting wires **2** by soldering, and the opposite ends of the connecting wires are laid bare for appropriate use by the user-manufacturer; or, alternatively, the insulated connecting wires are terminaled by soldering to electrical clips **4** for appropriate use by the user-listener.

FIG. 3 depicts the booster coil **1** concealed within such an enclosure as enclosure **6** of FIG. 2, now resting in an operative position outside the cabinet of a small radio **11** in such manner as a listener might place it. The radio cabinet has the upper portion of its face cut away to show the ferrite-rod antenna **10** within a position more or less typical of such radios. By a trial method, to be explained more fully hereinafter, the listener has placed the booster—that is, the booster coil **1** affixed inside enclosure **6**—as near to the ferrite-rod antenna **10** as interior arrangements of the radio and the cabinet permit, and he has disposed the axis of the air core of the coil **1** at right angles to the principal axis of the radio's ferrite rod—all in accordance with instructions that accompany the back-country radio booster of this invention when marketed in this or similar forms. The two heavy arrows that FIG. 3 shows proximate to the enclosure **6**, one horizontal and one radial, depict a range of options the listener has with respect to this particular radio **11** and with respect to any radio as defined herein above of which this particular radio is generally representative, to get best results by moving the booster around on the outside of the radio cabinet. There are many "loud and clear" locations for the booster—not just one—on the outside of the radio cabinet: this is what the heavy arrows signify. As the arrows indicate, the booster may be moved back and forth on the top of the radio cabinet, and near the top of the cabinet may, alternatively, be placed at the front or the rear, or even inside the cabinet under the ferrite antenna **10** if there is enough room for such a disposition—which generally there is not in these compact radios, but which often is the case with the larger table models. Nothing in FIG. 3 is to be understood as modifying, more particularly, limiting, the depiction of FIG. 1 as a generalization: this is another way of stating the significance of the heavy arrows of FIG. 3. Operationally speaking, the coil **1** wants to be placed by the listener where it works well, and it tends to work well at many sites similar to the one shown in FIG. 3 so long as the general principals of FIG. 1 are adhered to. A particular usefulness and convenience of the booster arrangement of this invention is the many sites the booster coil may be located inside and/or outside the radio cabinet so as to be useful in improving radio reception, particularly when combined with the ease with which one such site may be located by trial of the listener, as set forth below in the subsection, "Use by the radio listener," following a hook-up of the electrical clips **4** with a wire-antenna system **9** as depicted here in FIG. 3.

BOOSTER-COIL ENCLOSURE

In the embodiment of this invention illustrated in FIG. 2, the booster coil **1** and its connecting wires **2** are protected against physical damage and against electrical short-circuit, the external connecting wires are made appropriately available, and the completed device is given its correct form for use, by dielectric enclosure **6** whereof the body part **7** of the enclosure is wood appropriately gouged out by common wood drills and chisels to receive the booster coil and connective wires, the gouged-out side of said wood enclosure, thereafter being covered by a suitably formed dielectric cover **8**—shown in FIG. 2 in section to disclose the booster coil beneath—of 1/32" vulcanized hard-fiber membrane held securely in place by an appropriate glue. The dielectric enclosure **6** fits the booster coil closely through the short axes of each not only to permit, in use, a close juxtaposing of the booster and the ferrite-rod, but also to facilitate achievement of a correct relationship between the two by simple trial of the user-listener in consideration of the conventional manufacturing mode of mounting the ferrite rod immediately inside of and parallel to one of the dielectric walls of the radio cabinet, as exemplified in FIG. 3. The booster coil enclosure **6** can be simpler than that illustrated in FIG. 2. In FIGS. 4 and 5 the enclosures ***6a*** are simple dielectric bands, and any similar simple system is satisfactory that makes possible a practical work-out of the general conditions depicted schematically in FIG. 1 and pictorially in the other figures as to produce and maintain the physical relationships herein claimed between the booster coil **1** of this invention and the ferrite-rod antenna **10** of one of these radios. The FIG. 4 enclosure ***6a*** of booster coil **1** exemplifies means of enclosing the coil within a radio cabinet, and will be described more fully hereinbelow in the subsection titled "Use by radio manufacturer."

USE BY RADIO LISTENER

The radio listener who employs a radio of the class to which this invention is adaptable, that is, an AM broadcast-band radio with ferrite-rod antenna as signal accumulator, uses the invention by first attaching the electrical clips **4** of FIGS. 2 and 3 to a conventional wire-antenna system **9** as shown schematically in FIGS. 1 and 3; by then switching on the radio—such a radio, that is, as portable radio **11** of FIG. 3—at a back-country site in the evening when some broadcasting is audible, however feebly, via the ferrite-rod antenna alone; and by then establishing an optimum relationship between the radio's ferrite-rod antenna **10** and the booster coil **1** of this invention by trial. Trial consists in moving the booster of this invention about on the outside of the radio cabinet until a loud and clear signal becomes audible at the radio

loudspeaker. The user then fixes the booster-radio relationship he has achieved by some such means as attaching the booster to the radio cabinet with adhesive tape. When the listener follows this method of trial so as to get good back-country reception, technical study (which the listener need not get involved in at all) will reveal he has attained one of the booster-coil/ferrite-antenna relationships suggested by the two heavy arrows of FIG. 3. Numerous loud and clear positions for the said relationship exist in the areas the arrows designate.

By the term "conventional wire-antenna system" in the foregoing and succeeding descriptions is to be understood such a system as is comprised in a 50-ft. to 200-ft. inverted L antenna wire plus connection to ground as is illustrated schematically in FIGS. 1 and 3, or similar systems as illustrated schematically in FIGS. 4 and 5.

Because of the radical variability of the back-country ambient radio conditions with respect to distant broadcasting stations, it is necessary that the listener be able effectively to connect and disconnect the booster of this invention in accordance with varying reception conditions. Even partial disconnection, as of the ground contact alone, or as of one element of a dipole antenna, may serve, at times, to clear up reception from overlapping stations. Such connection, disconnection, and partial disconnection the listener achieves by means of the electrical clips **4**.

USE BY RADIO MANUFACTURER

In the manufacture of new radios of the class that employ a ferrite-rod antenna, the manufacturer uses this invention as illustrated schematically in FIG. 1. He employs a mode of the invention such as depicted in FIG. 2 with suitable adaptations to surrounding conditions within the radio chassis. Preferably, the manufacturer mounts the invention in appropriate relation with the ferrite-rod antenna as a permanent installation within the radio cabinet, employing fixed binding posts that extend through the cabinet to the outside for the user-listener to attach detachably a conventional wire-antenna system in accordance with the manufacturer's accompanying instructions. A typical manufacturer's installation of the booster coil of this invention is depicted in FIG. 4, the booster coil **1** being mounted by means of the coil enclosures **6***a* in the rear cover **11***a* of a typical radio **11** of FIG. 3. Binding posts **4***a* and **4***b* attach to the coil endings inside the cabinet, and are available outside the rear of the cabinet for use by the listener for attachment of a conventional wire-antenna system as illustrated in FIG. 4.

The manufacturer using the invention achieves correct positioning of the booster coil in a manner substantially similar to that set forth above for the user-listener. After winding the doughnut coil, affixing connecting wires, and protecting the coil and wires in a suitable manner, the manufacturer (e) connects the coil ends electrically to a conventional wire-antenna system; (f) tunes the radio to a distant broadcasting station or to an appropriate signal generator; (g) adjusts the physical relationship between booster coil and ferrite-rod antenna for optimum signal; and (h) by appropriate means, such as dielectric coil enclosures **6***a* of FIG. 4, makes the optimum relationship permanent.

Radios so manufactured with the booster of this invention enclosed within the radio cabinet are subject to adjustment under ambient radio conditions by connection, disconnection, or partial disconnection of the wire-antenna system by the user-listener from the binding posts provided by the manufacturer that serve in lieu of clips **4**.

OPERATING CONDITIONS

FIG. 5 shows the booster coil **1** held by enclosure **6***a* in operative relationship with ferrite-rod antenna **10**, as in the other figures, with the two heavy arrows, one radial and one transverse, indicating the general areas beyond the specific area depicted where the booster coil will operate also. The ferrite-rod antenna **10** is shown here in oval shape, rather than in the round shape of FIG. 3 in order to make it clear that the coil of this invention **1** operates with any ferrite-rod antenna without regard to the shape of the rod's cross-section or to any other incidental feature of said rod. FIG 5 shows operating conditions of the booster coil **1** of this invention at a back-country site where a typical broadcasting station **13** is situated a hundred miles or more distant, or at least well beyond the broadcaster's geographic horizon **14** and beyond the perimeter of the so-called "ground wave" of the transmitter. Under such conditions, what broadcast energy gets into remote geographical areas is thought to result from partially refracted reflections of electro-magnetic waves of virtual photons from the transmitter that go upward from the broadcasting antenna, hit the Heaviside layer of ionized atmospheric particles high above the earth, then strike downward again in areas geographically distant. Because of the long journey and possibly other factors, such as altered polarization, attenuation of energy, symbolized in FIG. 5 by the slim arrows of reduced length coming from overhead, occurs at a faster rate than the intervening surface distance suggests. Moreover, high mountain ranges, heavily wooded areas, and other such surface features appear to absorb additional portions from the energy that arrives in the back-country, and during the daylight hours these effects become especially pronounced in steep canyons such as the great canyons of the Rockies. Thus, what the back-country gets from the distant transmitter **13** is a weak radio signal, especially feeble during the daylight hours, that is too weak for these common transistor radios to respond usefully to the minuscule energies their ferrite-rod antennas pick up. Such a wire-antenna system as shown at **9** of FIG. 5 completely alters this situation when interconnected through lead-in **15** then through connective wires **2** to booster coil **1** situated as shown here and in the other figures in operational relationship to ferrite-rod antenna **10**. The multiplicity of slim arrows of moderate length shown in FIG. 5 between booster coil **1** and ferrite-rod antenna **10** depict the increased energy that reaches the ferrite-rod antenna by this route as compared to the lesser energy received from the "sky wave" direct. At night, a somewhat altered condition appears to exist. General conductivity of the continuum is thought to increase for electro-magnetic particle-waves because of the disappearance of certain effects of sunlight; hence only some back-country nights direct reception on the ferrite-rod antenna of these radios becomes possible, without the need for a booster, from the very stations not available except with the booster during daylight. It is under these altered conditions—and they vary radically from night to night—that the user-listener must disconnect part or all of the signal accumulator, or reconnect part or all of it, to get best results.

Having thus described my invention in preferred embodiment, I claim:

1. A ferrite-rod antenna associated in close physical relationship with a coil of magnet wire of about the same diameter as the ferrite rod's diameter where the axis of the windings of said coil and the axis of the windings of the antenna coils run at right angles to each other so as to be at a position of least electrical intercoupling, said coil being terminaled for disconnectable connection with an outside radio-signal accumulator, said ferrite-rod antenna being terminaled for employment in a broadcast-radio receiver circuit.

2. A signal booster for broadcast-band AM radios comprising the combination of a broadcast-band AM radio with ferrite-rod antenna and a coil of magnet wire small with respect to the size of said radio, said coil being associated with the said ferrite-rod antenna in a physical relationship not only of nearness that transfers radio energies

from said coil to said ferrite-rod antenna when the ends of the windings of said coil interconnect with a conventional wire-antenna system, but also of inter-orientation where the axis of the windings of the said coil and the axis of the windings of the ferrite-rod antenna coils stand to each other at or near right angles.

3. A broadcast-band AM radio receiver with ferrite-rod antenna as signal accumulator, equipped inside the radio cabinet with a coil of magnet wire that is small with respect to the size of the radio, that is wound around an air core, that is terminaled at binding posts inside the radio cabinet that extend to the outside, and that is associated by nearness but not by wire connection with said ferrite-rod antenna, said association of nearness occurring with the axis of the windings around the air core of the said coil running at or near 90° to the principal axis of the ferrite core of the said ferrite-rod antenna.

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U.S. Cl. X.R.

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