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SWITCHOVER SYSTEM TO PROVIDE ANTENNA PROTECTION AND SPACE DIVERSITY CONFIGURATION

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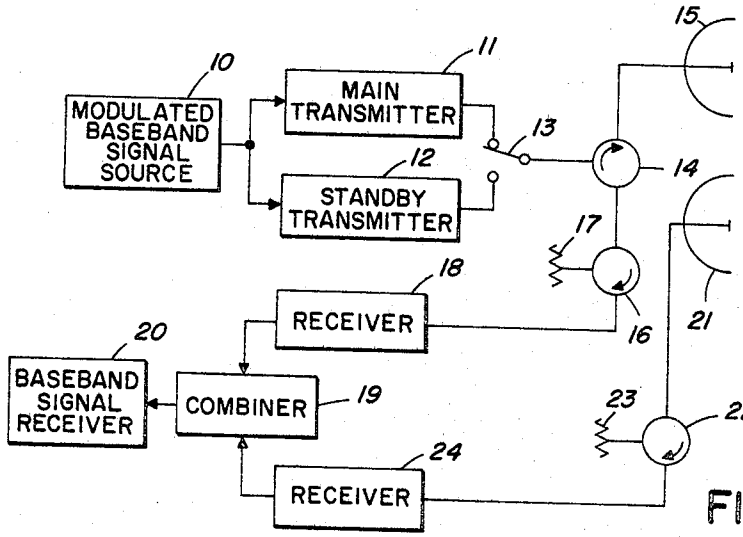

FIG 1

PRIOR ART

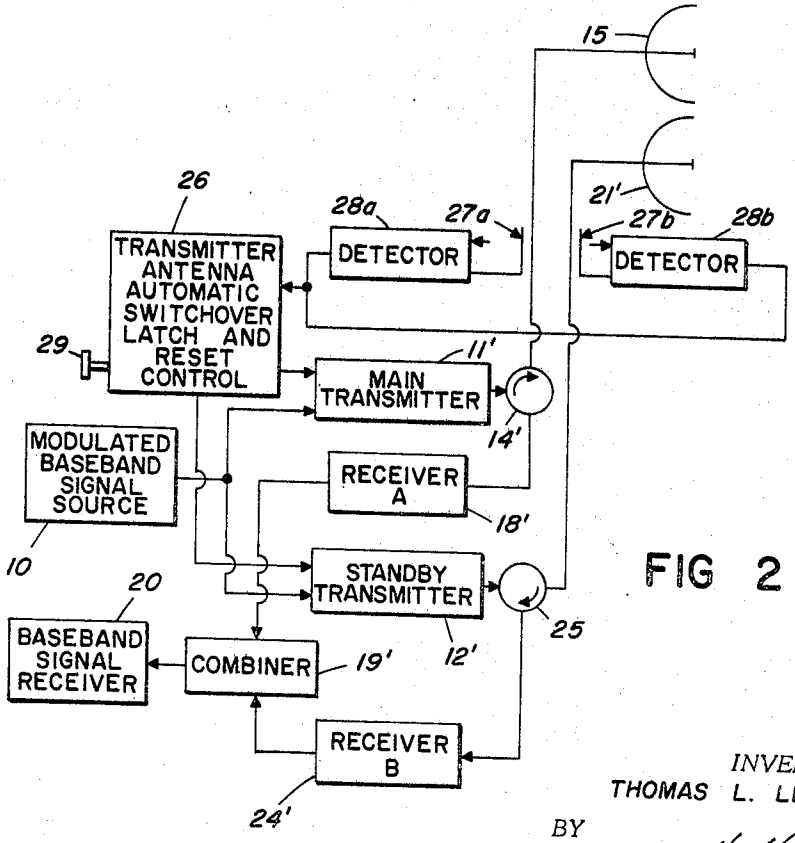

FIG 2

INVENTOR.
THOMAS L. LEMING

BY

Warren H. Kintzinger

ATTORNEY

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SWITCHOVER SYSTEM TO PROVIDE ANTENNA PROTECTION AND SPACE DIVERSITY CONFIGURATION

Thomas L. Leming, Richardson, Tex., assignor to Collins Radio Company, Cedar Rapids, Iowa, a corporation of Iowa

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ABSTRACT OF THE DISCLOSURE

A microwave antenna and transmitter switchover configuration including at least two antennas and at least two transmitters connected to feed separate antennas. Switchover control gives shutoff of an operating transmitter and antenna combination and simultaneous activation of and transmission by another transmitter and antenna combination as automatically initiated by antenna reflected power sensed above a predetermined level as would occur consistent with increasing VSWR with antenna damage.

This invention relates in general to transmitter to antenna switchover, and in particular, to an antenna and transmitter switchover system as controlled by reflected power (a measure of VSWR) from an antenna being used to switch antennas being fed and to simultaneously switch transmitters being used.

With long distance microwave communication systems in order to increase propagation reliability some users, particularly in the industrial microwave bands, have resorted to space diversity configurations. A basic weakness with some such configurations is that both a main transmitter and a standby transmitter are on only one of two or possibly more available antennas and, in the event of damage to the antenna providing transmitter service the system operation is disrupted even though a satisfactory second antenna is available. With these systems using a main and a standby transmitter a switchover control system normally provided senses transmitter power and modulation to determine that appropriate drive to the antenna is available and to activate switchover between transmitters. A major railroad using such a system through a one-year period experienced virtually no equipment or propagation outages aside from antenna failures on a route extending from Los Angeles to Portland via Salt Lake City with, however, outages attributable to this problem amounting to a total of approximately fifty hours.

It is, therefore, a principal object of this invention to provide a microwave system antenna and transmitter switchover configuration with transmitters circuit connected to feed different antennas.

A further object with such an antenna and transmitter feed system is for transmitter and antenna switchover to be controlled by reflected power from an antenna being used.

Another object with such an antenna and transmitter feed system is for antenna reflected power induced automatic switchover to be one way from the transmitter and antenna initially set and used and to provide manual reset in order to preclude any undesired, mechanical multivibrator action.

Features of the invention useful in accomplishing the above objects include, in various embodiments, a microwave antenna and transmitter switchover configuration including at least two antennas and at least two transmitters connected to feed separate antennas when the respective transmitters are individually in operation. One

of the transmitters is a normally used main transmitter and the other transmitter a standby transmitter. A switchover control is provided for shutoff of an operating transmitter and simultaneous activation of and transmission by the other antenna to thereby accomplish switch in transmitted signal feed from one antenna to another antenna, and with this control circuit automatically controlled by a reflective power input sensed and a predetermined level detected for actuating control of the automatic switchover circuit. Generally, an antenna not being used in the transmit mode of operation is employed in a receive mode in such microwave station towers.

A specific embodiment representing what is presently regarded as the best mode of carrying out the invention is illustrated in the accompanying drawing.

In the drawing:

FIGURE 1 represents a prior art block schematic showing of a typical antenna microwave tower installation typical of many of those that have been utilized heretofore; and,

FIGURE 2, a block schematic of an improved microwave antenna tower installation with a combined transmitter and antenna switchover system providing antenna protection and space diversity utilization between antennas of the tower.

Referring to the drawing:

The prior art typical antenna microwave installation of FIGURE 1 shows a modulated baseband signal source **10** connected for supplying a signal input to a main transmitter **11** and a standby transmitter **12** both of which operationally transform the baseband signal input thereto to a microwave transmitter output signal. This signal is passed from the main transmitter or standby transmitter, as the case may be, that is activated and switch selected to and through switch **13** to a microwave circulator junction **14** and from the circulator junction **14** to the top antenna structure **15**. When antenna **15** is used in the receive mode microwave RF signals received thereby are passed by the circulator **14** to and through an additional circulator **16**, having a side port termination in an impedance to minimize reflective signal buildup from such side port, and on through another port to receiver **18** having a resultant output passed to combiner circuit **19** with a combined output ultimately passed to a baseband signal receiver and utilizing circuit **20**. A second antenna **21** similar in many respects to the antenna **15** but used solely in this configuration as a receiving antenna passes received microwave signals to a circulator **22** having an impedance terminated side port **23** and an output from another circulator **22** port. The received microwave signalling is passed from circulator **22** to receiver **24** resulting in an output passed to combiner circuit **19** from which, in combination with signalling, if any, from receiver **18** the combined output is passed to the baseband signal receiver **20**. Please note that a switchover control system would be normally utilized with this typical installation subject to activation by sensed transmitter power and modulation of the operating transmitter **11** or **12**, as the case may be, to initiate warm-up should a standby or non-used transmitter not be maintained in a continuously warmed up ready state. This is with such timed activation of switch **13** to switch after a warm-up interval from the transmitter being used to the previously unused transmitter when the switchover control system is activated for such switching based on predetermined transmitter power and/or modulation sensed value levels.

With applicant's improved microwave antenna tower installation of FIGURE 2, components the same and substantially the same or quite similar are given the same numbers or primed numbers as a matter of convenience as the case may be. With this improved combined transmitter and antenna switchover system providing antenna

protection and space diversity utilization between antennas normally mounted on a microwave tower, modulated baseband signal source **10** is connected for supplying a signal input to a main transmitter **11'** and a standby transmitter **12'** with both capable of operationally transforming the baseband signal input thereto to a microwave transmitter output signal. The signal output passed from the main transmitter **11'** is passed through microwave circulator **14'** to the top antenna structure **15**, or if the standby transmitter **12'** is operating to and through circulator junction **25** to the lower antenna structure **21'**. Whenever antenna **15** or antenna **21'** or both are simultaneously used in the receive mode microwave RF signals received by one or both are passed by circulator **14'** or circulator **25** or both simultaneously, as the case may be, through receive signal output ports of the respective circulators to receiver **18'** or receiver **24'** or simultaneously both generating receiver output signalling passed to a combiner circuit **19'** having an output passed to baseband signal receiver **20**.

A transmitter-antenna automatic switchover, latch, and reset control circuit **26** is included with applicant's improved microwave antenna tower installation as shown in FIGURE 2 that is subject to transmitter activation switchover control by a predetermined level signal input thereto. Control circuit **26** has controlling circuit line connection to the main transmitter **11'** and also to the standby transmitter **12'** for the transmission of switchover control voltage from one of the lines to the other in accomplishing switchover control from one transmitter to the other. Signal directional couplers **27***a* and **27***b* are mounted in operative association with the portion of the transmission line connected to the respective antennas **15** and **21'** at such a location along the respective transmission lines between the respective circulators **14'** and **25** and their antennas **15** and **21'** as a function of signal phase so as to minimize signal coupling from the transmission lines relative to signals in the transmit direction and to maximize the sensing of reflected signal power from the antenna through the respective transmission lines. The directional couplers **27***a* and **27***b* are connected for feeding a sensed signal input to detector units **28***a* and **28***b*, respectively, having in turn detected output line connections as inputs to control circuit **26**. This provides for feeding of directional coupler sensed signalling with respect to the transmission line of an activated transmitter and its antenna as rectified by a detector supplying a signal input to the control circuit **26**. Please note that the control circuit **26** may include automatically induced switchover latching so that once switchover has occurred reset may be accomplished only by manual means as for example with a manual reset **29** provided with the control circuit **26** so as to preclude any mechanical multivibrator action. Please note further, if the switchover control were always to be from the main transmitter **11'** and its associated antenna **15** to standby transmitter **12'** and its associated antenna **21'** that only the directional coupling **27***a* and detector device **28***a* would be required for deriving a controlling level signal input to the control circuit **26** in achieving the desired switchover action. However, with the structure shown, what would otherwise be the standby transmitter **12'** and its associated antenna **21'** could actually be the initially activated antenna subject to deactivation with switchover via the control circuit **26** with a predetermined signal level sensed by the directional coupler **27***b* and as rectified by detector device **28***b*.

Applicant's protection system as a workable and dependable sytem is dependent upon variation in the return loss of the antenna system. In normal installations where due care has been exercised, the antenna feedline would be expected to provide an output from the transmitter as passed to and through a transmission line and reflected from the antenna with a VSWR of less than 1.10. This is equivalent to a 26.5 db return loss; that is, the power reflected back from the antenna sytem toward the equipment would be 26.5 db below the transmitter power. In the event of antenna damage the VSWR normally may be expected to rise greatly; for instance, in excess of 2.0, in which case the return loss would be reduced to approximately 9.5 db. Obviously, as the antenna damage becomes greater from whatever cause, the return loss decreases, that is, less of the transmitted power is actually transmitted by the antenna with a greater portion of this transmitter output power being reflected back from the antenna system as such so that at a 10.0 VSWR, almost all of the power is returned in the form of reflected power from the antenna system. The detector devices **28***a* and **28***b* are signal coupled to the respective transmission lines by directional couplers **27***a* and **27***b* that are capable with proper location and design relative to the transmission lines they are in operative association with of generally providing at least 20 db directivity. The detector devices **28***a* and **28***b* are either so selected or adjustably set so that the threshold for switchover falls within a desired range normally that which would allow a VSWR of something in the order of approximately 1.8 as that generating a sensed signal level such as to cause antenna-transmitter switchover. Please note at this point that this is so set as to exceed normally encountered VSWR's of as much as 1.4 that occur on occasion by causation such as of moisture on a radome or water on a transmitter feed. Please note further, switchover systems such as have been employed herebefore, although not shown, that sense transmitter power and/or modulation for initiating switchover may still be used in various supplemental combinations with applicant's improved switchover system.

Whereas this invention is here illustrated and described with respect to a specific embodiment thereof, it should be realized that various changes may be made without departing from the essential contributions to the art made by the teachings hereof.

I claim:

1. In an antenna and transmitter switchover system, at least two antennas; at least two transmitters connected by individual transmission line means to feed separate antennas; control means connected to at least two transmitters and normally set for maintaining only one of said transmitters and one of said antennas in the transmit mode of operation at a time; antenna and transmission line reflected power sensing means in operative association with the transmission line means interconnecting one of the transmitters and one of the antennas; said control means, signal connected to said sensing means and being predetermined level responsive to the signal sensed by said reflected power sensing means to initiate switchover activation from one transmitter and antenna combination to another.

2. The antenna and transmitter switchover system of claim **1**, including an RF receiver for each antenna; and wherein an individual circulator junction having a received signal output port connection to one of said receivers is included in the individual transmission line means of transmitter and antenna combinations.

3. The antenna and transmitter switchover system of claim **2**, wherein output connections of multiple receivers are connected to a combiner circuit having an output connection to a baseband signal receiver.

4. The antenna and transmitter switchover system of claim **2**, wherein said reflected power sensing means is mounted in operative association with the portion of transmission line means between a circulator junction and an antenna.

5. The antenna and transmitter switchover system of claim **4**, wherein said antennas and transmitters are designed to be usable in a microwave communication system with, a modulated baseband signal source connected for supplying an input to the transmitters; with the transmitters being of the type transforming, when selectively in operation, the baseband signal input thereto to a microwave transmitter output signal; and with multiple re-

ceivers connected to a common combiner circuit having an output connection to a baseband signal receiver.

6. The antenna and transmitter switchover system of claim 4, wherein said reflected power sensing means includes, a directional coupler; and a detector connected between the directional coupler and said control means.

7. The antenna and transmitter switchover system of claim 6, wherein at least two said reflected power sensing means are used in operative association, individually, with the transmission line means of at least two respective transmitter-antenna combinations.

8. The antenna and transmitter switchover system of claim 6, wherein said control means is an automatically actuated, with a predetermined controlling input signal level, switchover latched control device with manual reset.

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ROBERT L. GRIFFIN, Primary Examiner

JAMES A. BRODSKY, Assistant Examiner

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