June 12, 1934. H. H. BEVERAGE 1,962,169

DEVICE FOR REDUCING THE EFFECTS OF STATIC OR FADING

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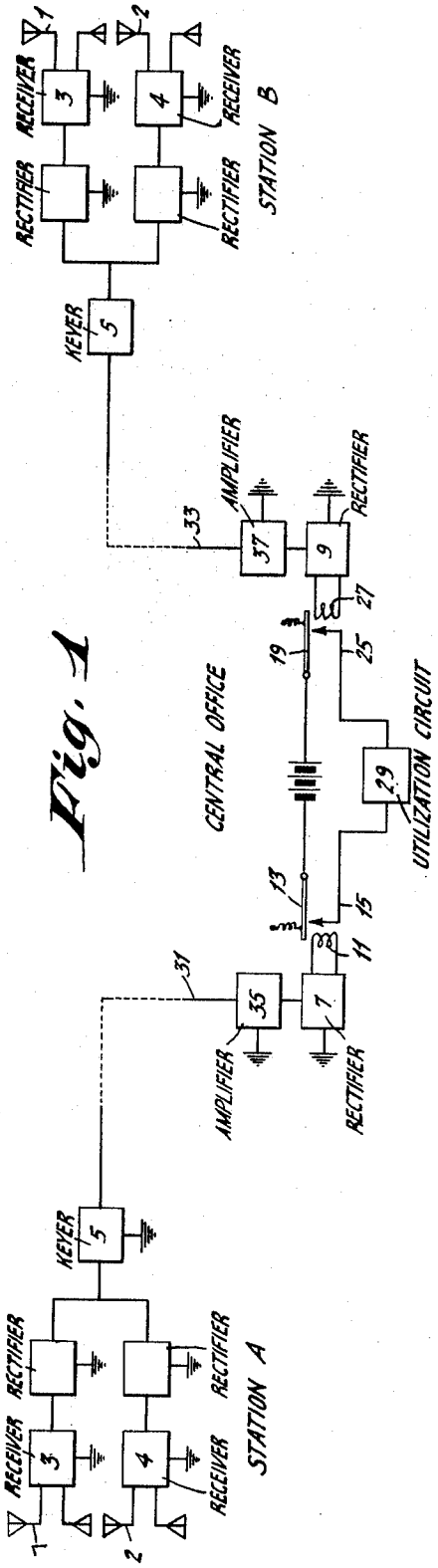

Fig. 1

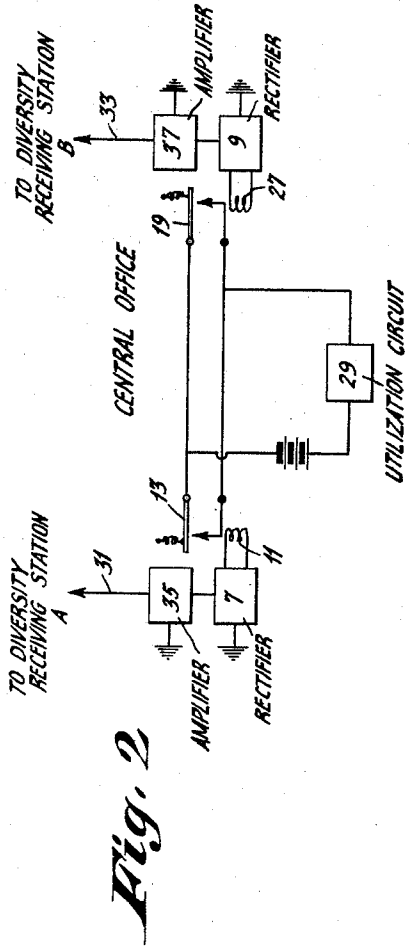

Fig. 2

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DEVICE FOR REDUCING THE EFFECTS OF STATIC OR FADING

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5 Claims. (Cl. 250—8)

This invention relates to radio signalling receiving systems.

In the transmission of code signals, particularly in printing telegraphy, it has been found that false characters are frequently caused by static and interference from fading, the term "fading" being used to designate a variation in the intensity of the signal. In order to overcome these difficulties it has been proposed in the past to repeat the signal characters at the transmitting station a plurality of times at predetermined intervals, and, at the receiver, to store up and compare the received characters before passing the signals on to the printing mechanism. In this way, any false character, such as might be due to static, which was not received identically in all transmissions, would be prevented from operating the recording mechanism, and only those signals which were received in every repetition would set up the storage apparatus to operate the printer.

Such method of repeating signal characters has greatly increased the accuracy of transmission, and it is one of the objects of the present invention to retain the advantage of signal repetition without actually repeating the signals, and by using much simpler equipment.

This object is accomplished in the present invention by employing a plurality of diversity receiving systems at stations which are widely separated from one another in order to control, in common, a central office utilization circuit. At the central office, relays are operated by the signals from each station. In one particular embodiment of the present invention the relay contacts are connected in parallel so that their combined output mitigates against fading, and in another embodiment the relay contacts are connected in series so that their combined output is free from local static clicks.

Observations have shown that both fading and some kinds of static, particularly on short waves, are random and local in their occurrence, and, hence, if signals are received at two separated points neither the fading nor certain types of static will be simultaneous at both locations.

An essential feature of the present invention resides in the diversity receiving arrangement located at each station for insuring reception, wherein a plurality of energy collectors are separated an appreciable fraction of the length of the communication wave, say of the order of a few wave lengths. The signal, it has been found, does not fade similarly at each of the spaced energy collectors, and the possibility, therefore, of the signal fading out equally at all of the energy collectors or antennæ is consequently reduced with increase in the number of antennæ.

In the accompanying drawing, Figures 1 and 2 show, diagrammatically, two different embodiments of radio receiving systems illustrating the principles of the present invention.

Figure 1 shows a system comprising two widely separated diversity receiving stations A and B whose individual output currents are combined at a common central station to overcome local static clicks. At each station A and B is shown a diversity receiver consisting of two receivers 3 and 4 which are associated with directive antennæ 1 and 2. The output of each receiver 3 and 4 is rectified and the rectified currents are added together to operate a tone keying unit 5, the latter functioning to translate the rectified currents into currents chopped up at intervals corresponding to the interruptions of the received signal characters. One suitable arrangement for effecting such reception and translation, to which reference is made, is described in United States Patent 1,874,866, granted August 30, 1932 to Messrs. H. H. Beverage and H. O. Peterson.

The receivers at stations A and B are tuned to the same signals, and the outputs of the tone keyers 5 are sent to a central office over wire lines 31 and 33. The signals are there further amplified by amplifiers 35 and 37, and are then rectified by rectifiers 7 and 9 which, in turn, cause the operation of relays 11 and 27, respectively.

Relay tongues 13 and 19 of Figure 1 are connected in series so that both relays must close before utilization circuit 29 operates, a condition which must exist for anti-static. As an illustration, if a static crash is received at station A, but not at station B, relay 11 will close, but the utilization circuit will not be operated because relay 27 is open. The utilization circuit 29 may, of course, be a printer, recorder, or any other suitable device.

It has been suspected from observations, that some short wave static came from long distances by "sky wave", similar to the manner in which short wave signals are propagated. This was believed to be true, because the directional static distribution on short waves was found to be similar to the long distance static on long waves, although the intensity of the short wave static was much less than on long waves. On the other hand, it has also been noticed that local thunder storms do not create severe disturbances except when the storm is within a few miles

of the receiving station. Even then, the disturbances are usually sharp clicks associated directly with lightning flashes.

If it is assumed that short wave static is propagated like short wave signals, the observations mentioned above are quite logical. Local static produced by local lightning storms would produce electrical disturbances that travel along the ground as "ground waves". The energy would be rapidly attenuated by losses in the ground, and the ground wave would quickly disappear. Hence the static might exhibit "skip" effects the same as signals. The ground wave from a storm 50 miles away might be inaudible, although disturbances from the same storm might be audible thousands of miles away via the "sky" wave route.

Therefore, if we assume that station "A" is at Riverhead, Long Island, for example, and station "B" is at a point in New Jersey, more than 100 miles away, a local storm in New Jersey would be inaudible at Riverhead, and vice versa. Under these conditions, a click from a lightning flash at station "B" would not occur at station "A" and its effect would be eliminated at the central office, because only one of the relays 11 and 27 would close.

If local storms were in progress at both stations, the clicks would be entirely random, and both relays would close simultaneously only at rare intervals.

As an alternative, the distance transmitter might radiate energy for "space" and interrupt it for "mark". Both relays would normally be closed for "space" and open for "mark" and the recorder would be adjusted accordingly. Now if static prevented the relay from opening at one station, but not at the other, the recorder would still be operated correctly by the relay that opened.

Much of the long distance static, it has been found, may be eliminated by directive reception and this is effected in the present invention by the proper positioning of antennæ 1 and 2, thus enabling accurate reception free from effects of distant static or fading. A similar arrangement to that shown in Figure 1 may be used for anti-fading by connecting the tongues of relays 11 and 27 in parallel in the manner illustrated in Figure 2. If the signal fades out for a few seconds or even minutes at one station, but not at the second station, the recorder will operate correctly, as it will register when either relay closes. The parallel relay anti-fading arrangement should be useful in overcoming the condition which is termed "Territorial Fading". This is the condition where the signal fades simultaneously over a large area, but may still be received well, say, fifty miles away. This condition has been observed on numerous occasions.

An advantage of the present invention is that the separation of the two receiving stations in entirely different locations guards against interruptions due to power or tone line failures, fires, sleet, or any other disaster that might interrupt the service at a single station for an extended period of time.

I claim:

1. A radio receiving system comprising a plurality of widely separated diversity receiving stations, each of said stations including at least two spaced antennæ, circuit apparatus at each station for receiving and rectifying the currents received at each antenna and for additively combining the rectified currents, a tone keyer at each station for translating the combined rectified currents into alternating currents chopped up at intervals corresponding to the interruptions of the received signal characters, a central office, and lines extending from each tone keyer to said central office, relay apparatus at said central office under control of the signals sent out by said tone keyers, and a utilization circuit responsive to the operation of said relay apparatus.

2. A system as defined in claim 1 including amplifier and rectifier apparatus at said central office for amplifying and rectifying the signals from said tone keyers, said relay apparatus being connected to said rectifiers.

3. A radio receiving system comprising a plurality of widely separated diversity receiving stations, each of said stations including at least two spaced antennæ, circuit apparatus at each station for receiving and rectifying the signals received in said antennæ and for additively combining the rectified currents, a tone keyer at each station for translating the combined rectified currents into alternating currents chopped up at intervals corresponding to the interruptions of the received signal characters, a central office, and lines extending from each tone keyer to said central office, amplifier, rectifier and relay apparatus at said central office in circuit with each tone keyer, contacts for said relay apparatus, and a utilization circuit serially connected with said contacts and operable only upon the operation of all said relay contacts.

4. A radio receiving system comprising a plurality of widely separated diversity receiving stations, each of said stations including at least two spaced antennæ, circuit apparatus at each station for receiving and rectifying the signals received in said antennæ and for additively combining the rectified currents, a tone keyer at each station for translating said combined rectified currents into alternating currents chopped up at intervals corresponding to the interruptions of the received signal characters, a central office, and lines extending from each tone keyer to said central office, amplifier, rectifier and relay apparatus at said central office in circuit with each tone keyer, contacts for said relay apparatus, and a utilization circuit, said contacts being connected in parallel to said utilization circuit.

5. The method of operating a receiving system comprising a plurality of widely separated diversity receivers, each of said receivers including at least two spaced antennæ, and a central office circuit connected in common to said receivers which includes receiving the signal at each of said widely separeted diversity receivers, rectifying the signals received from the individual antennæ at each receiver and additively combining them at said receivers, and subsequently translating the rectified energies into alternating currents, transmitting said alternating currents to said central office and rectifying said alternating currents to effect signal reception.

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