

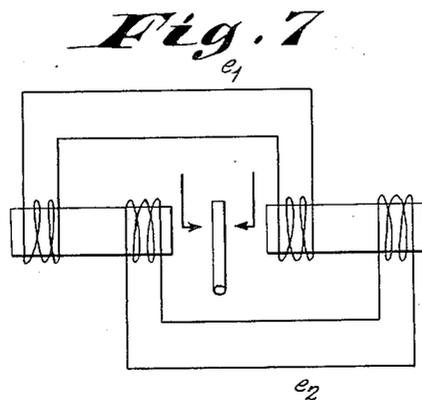
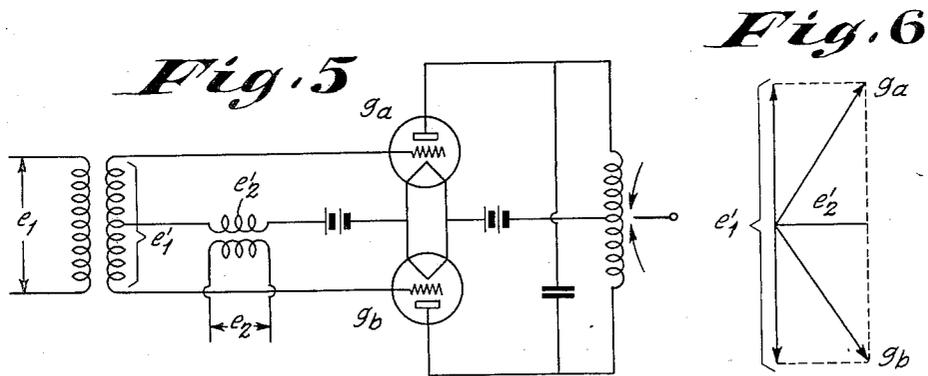
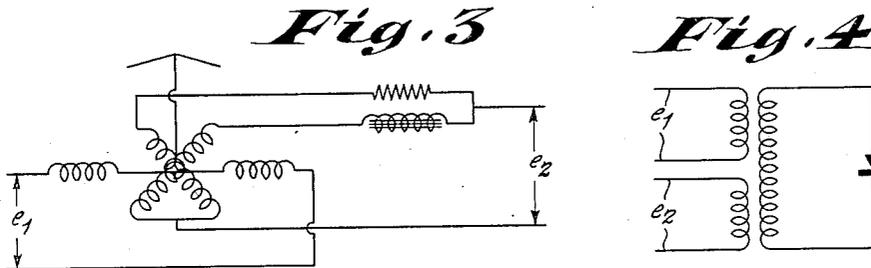
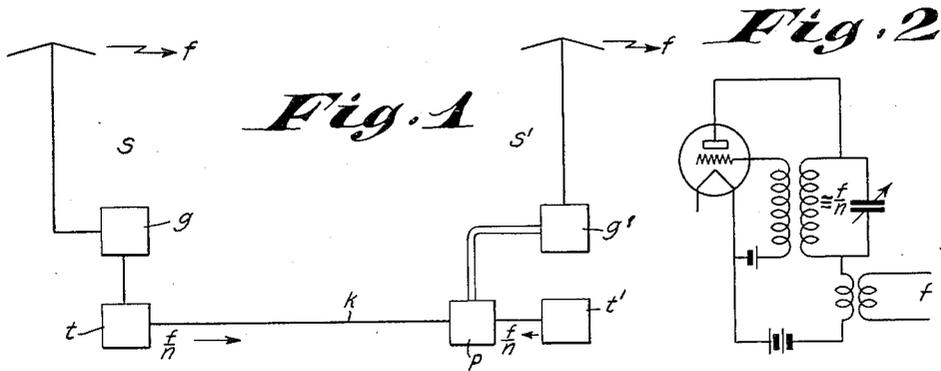
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W. RUNGE ET AL

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RADIO TRANSMISSION SYSTEM

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INVENTOR
WILHELM RUNGE
MAX POHONTSCH
BY *H.S. Swover*
ATTORNEY

UNITED STATES PATENT OFFICE

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RADIO TRANSMISSION SYSTEM

Wilhelm Runge and Max Pohontsch, Berlin, Germany, assignors to Telefunken Gesellschaft für Drahtlose Telegraphie m. b. H., Berlin, Germany, a corporation of Germany

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1 Claim. (Cl. 250—2)

An object of this invention is to provide a method of and apparatus for synchronizing transmitters or broadcast stations working on synchronized waves over wire lines. In the methods customarily used in the prior art and practice, recourse is had to an audio frequency control note or wave which is supplied to the transmitter or broadcast stations by way of wires, and which there furnishes the carrier wave, after having been subjected to frequency multiplication in a plurality of stages; or else in one of the stations the carrier frequency is divided, reduced or sub-multiplied to result in the control wave or note, and from the latter, by corresponding frequency multiplication at the other stations, the common carrier frequency is recovered or restored. This latter method necessitates an essentially different construction from standard practice of the controlling transmitter station (master broadcaster) and the other stations operating in synchronism. But still more serious is the disadvantage residing in the requisite frequency multiplication in both of the methods hereinbefore referred to. Frequency multiplication methods and means, as known from actual practice, are hard to stabilize, and they require a considerable amount of filter apparatus to eliminate disturbing side or stray waves. However, what is worse, all of these methods fail to afford any protection against the inevitable transient fluctuations of the controlling phase transmitted by the cable or line, and this is conducive to transient disturbances in the synchronism.

All of these drawbacks are obviated in the present method in the following fashion:

All of the synchronized stations operate as self-excited oscillation generators. The control note or wave serves merely for the purpose of insuring automatic stabilization rather than for the direct production of the carrier wave. It is an easy matter to introduce into the mechanism for frequency correction a time constant such that rapid alterations in the control frequency such as those due to sudden changes in the cable, will remain ineffective and harmless. At all of the transmitter stations the carrier frequency is lowered or stepped-down to a sub-harmonic by division at the same ratio, and this sub-harmonic wave is transmitted from one of the stations to the other stations in the form of a control or check-up or stabilizer frequency or wave, and at these other broadcast stations the same is fed conjointly with the locally generated sub-harmonic to a suitable phase check-up or balance instrument. Upon the arising of phase differ-

ences, this latter device actuates control means whereby the frequency of the local oscillator is caused to come in step again with the remote control-wave transmitter.

The application of the invention as applied to a complete system is schematically illustrated by way of example in Figure 1. Figures 2 to 7 inclusive illustrate different embodiments of elements of the system which may be used in Figure 1.

Referring to Figure 1, s denotes the master broadcast station where the frequency f is generated and radiated. Associated with the generator g is a frequency-divider equipment t whereby a sub-harmonic f/n is produced from the sending frequency. The said sub-harmonic wave is transmitted by a cable k to the sub-station s' . At the substation s' there is likewise provided generator equipment g' to produce a frequency f . From the frequency f generated at the generator outfit g' and which is required to have absolutely the same value as the transmitted frequency f coming in from the master broadcaster station s , there is also formed a sub-harmonic f/n by means of the frequency sub-multiplier t' . The sub-harmonic locally produced by the frequency converter t' , together with the sub-harmonic transmitted by cable from the master transmitter s is fed into a control or check-up device p . According to the discrepancy which may be discovered between the locally generated sub-harmonic and the sub-harmonic transmitted by way of the cable, there is occasioned action upon the generator outfit g' of the transmitter s' .

For the purpose of producing the audio frequency control note from the carrier wave, recourse may be had, fundamentally speaking, to all known means of frequency division or sub-multiplication, in other words, arrangements which comprise amplitude-dependent impedances, e. g., saturated iron-cored choke coils; furthermore, arrangements for producing relaxation waves, for example, means comprising glow discharge (gaseous-conduction) lamps or multi-vibrators, and finally also feed-back schemes of suitable sort such as illustrated by way of example in Figure 2.

Figure 2 is a regenerative tube circuit which is roughly tuned to the sub-harmonic wave f/n . The tube operates at a point just before oscillating would be initiated. There is further supplied to the same a frequency f to serve for controlling purposes, with the result that the device is caused

to start oscillating in such a way that the desired sub-harmonic wave ensues.

Phase comparison of the wave sent by way of a cable line and the locally produced frequency may be accomplished in various ways. An arrangement suited therefor is illustrated by way of example in Figure 3 comprising two crossed and firmly inter-connected coils which are pivotally suspended within the field of a third coil. One of the voltages to be checked up upon, e_2 , is impressed upon the said crossed coils, but under a phase displacement angle of 90 degrees, whereas the other voltage e_1 is applied to the fixed coil e_1 . The rotation of the mobile system is directly proportional to the phase difference between the two potentials, and is independent of the amplitude thereof.

There may further be considered for the sake of insuring a comparison of the phase a number of arrangements which are not predicated for their use upon any moving parts. A scheme of this sort is illustrated, for instance, in Figure 4. The two voltages e_1 and e_2 which are to be compared are supplied to the primary windings (turns) of a differential type of transformer; a rectifier device included in the secondary circuit results in a current which is directly proportional to the phase difference, if any. Of course, a device of this nature depends for its action upon the amplitude, hence, it necessitates prior amplitude regulation between the voltages to be compared.

A differential arrangement of the kind illustrated in Figure 5 is free from this difficulty. One of the potentials is impressed upon the grids of the two rectifier tubes under isophasic condition, whereas the other one is impressed in the presence of phase opposition. If, then, under normal condition, the two voltages have been so adjusted by a phase shifter to present a phase angle between each other of exactly 90 degrees, equality of the resultant grid voltage amplitudes ga and gb will exist according to Figure 6, and the same situation will hold true of the plate currents of both tubes, and this regardless of the amplitudes of the two impressed potentials. Upon the arising of phase shifts, the state of balance between the two plate currents is disturbed, with the result that there is effected a shift in the differential relay in either direction, as the case may be.

The operation of the arrangement shown in Figure 7 is similar to that above described. The circuit of this figure comprises a soft-iron keeper between two iron-cored coils, one thereof being energized under co-phasic condition, and the other one in the presence of phase opposition. If the voltages from the outset are again shifted

an angle of 90 degrees in reference to each other, there holds true also in this instance the diagram Figure 6; and because of the fact that the dependence between torque and coil currents obeys a square law, there prevails a similar relationship between such phase differences as may arise and the ensuing torque exerted upon the keeper.

The phase comparison device, generally speaking, will result in an effect the size of which corresponds to the prevailing phase angle, and will thus prove serviceable for the purpose of automatically restoring synchronism. For instance, the said device may be caused to insure a mechanical control action whereby, for instance, the condenser included in the oscillation circuit of the local wave generator is re-adjusted; or else, in the case of transmitters subjected to quartz-crystal control, the temperature of the quartz thermostat could be controlled by the said phase equalizing or comparison device, with the consequence that thus a fine adjustment of the frequency is assured. Finally, also the frequency of the local transmitter could be acted upon by electrical means and ways. One method known in the prior art utilizes the regulator current for the saturating and thus the alteration of inductance of an iron-cored tuning coil; another method consists in that the regulator current is used to alter the grid biasing voltage and thus the internal resistance of a tube, the tube being so coupled with the master transmitter that its internal resistance will affect the damping, the capacity, or the inductance of the transmitter and thus the frequency thereof.

We claim:

In a radio signaling broadcasting system having a master radio transmitting station and a remote radio transmitting station connected thereto by a transmission line, the method of synchronizing the frequency produced at said remote station which comprises generating a carrier wave at said master station, obtaining from said carrier a sub-harmonic frequency, transmitting said sub-harmonic frequency over said line to said remote transmitting station, locally generating at said remote transmitting station a carrier whose frequency approximates that of the carrier generated at said master station, obtaining from said local carrier at said remote station a sub-harmonic similar to that received from said master station, comparing the phase relations of both said sub-harmonics and controlling the frequency of said locally generated carrier from the difference in phase existing between said two sub-harmonic frequencies.

WILHELM RUNGE.
MAX POHNTSCH.