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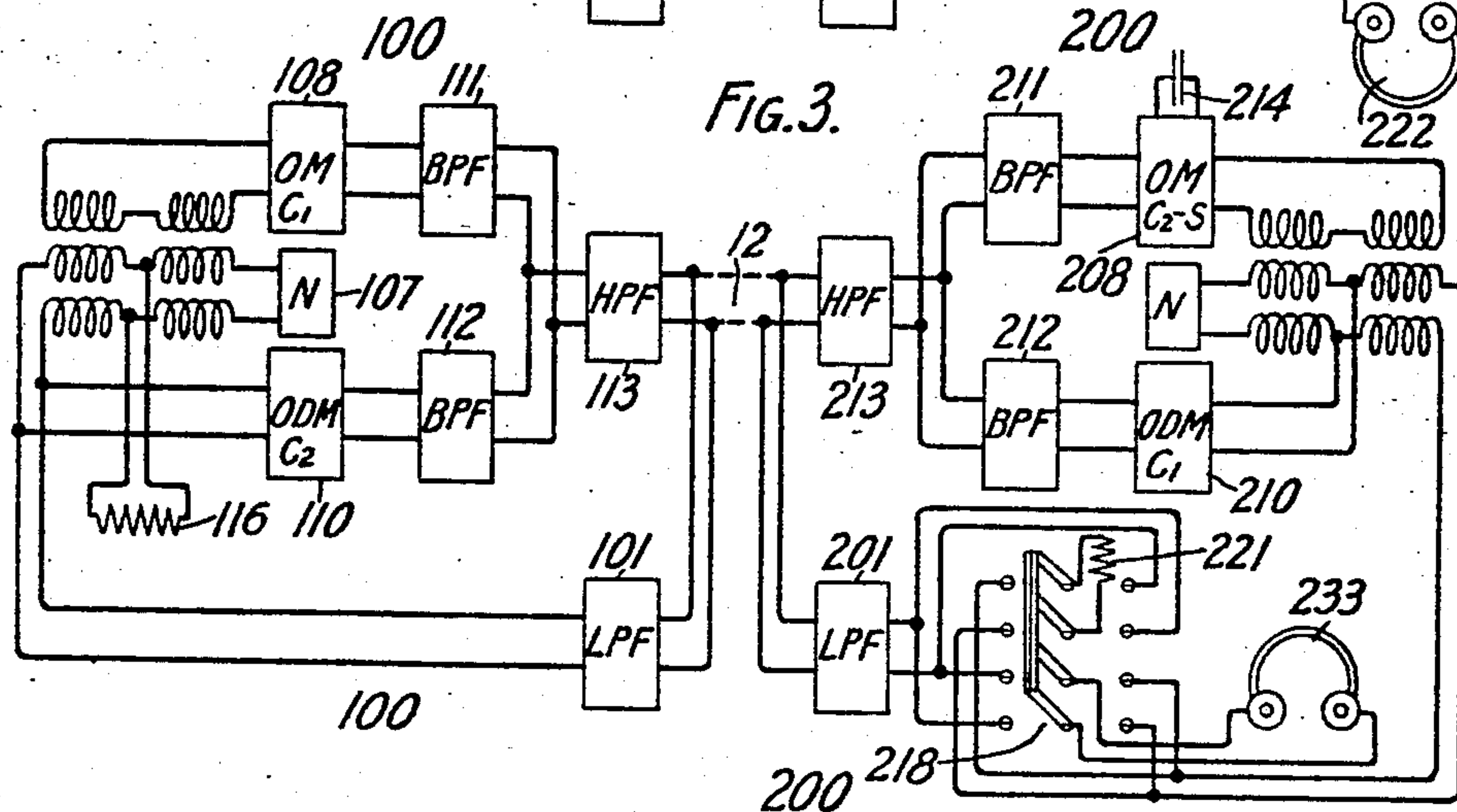
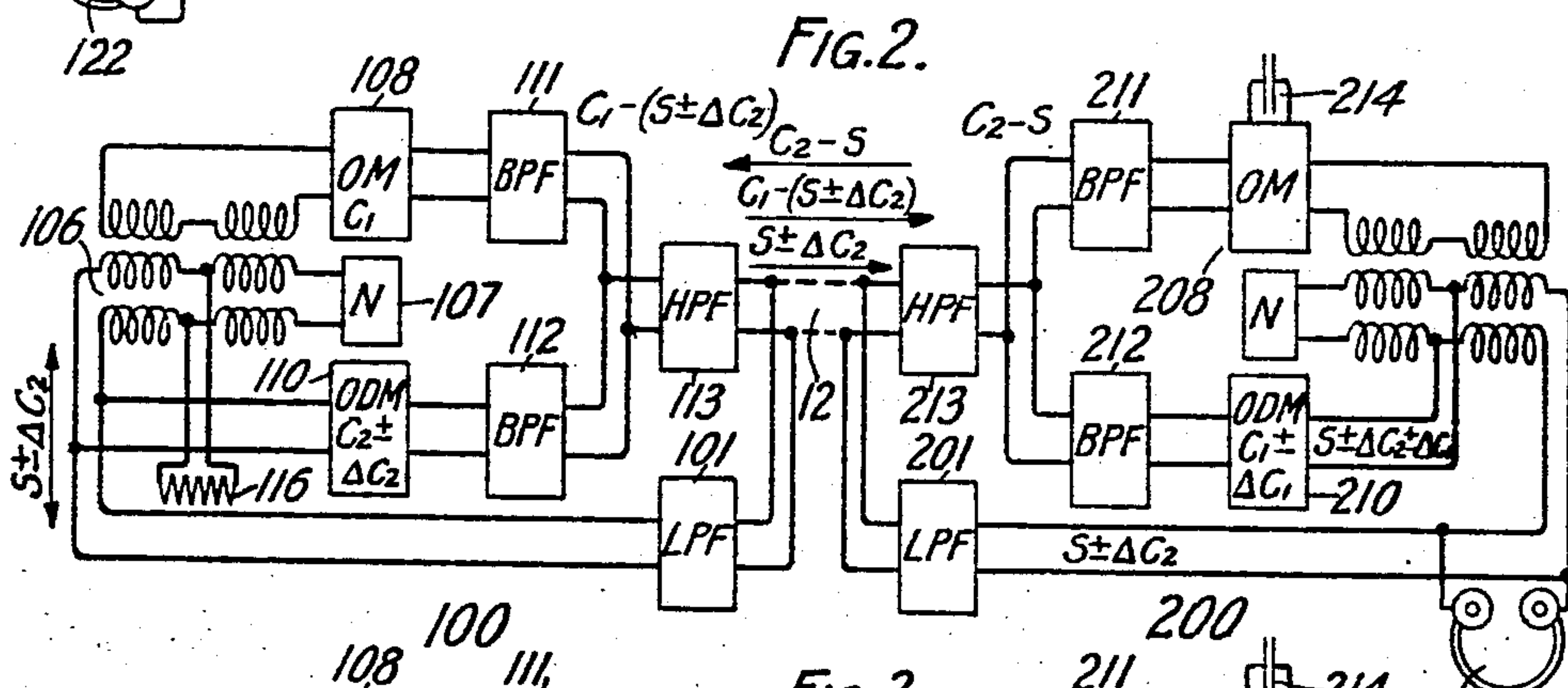
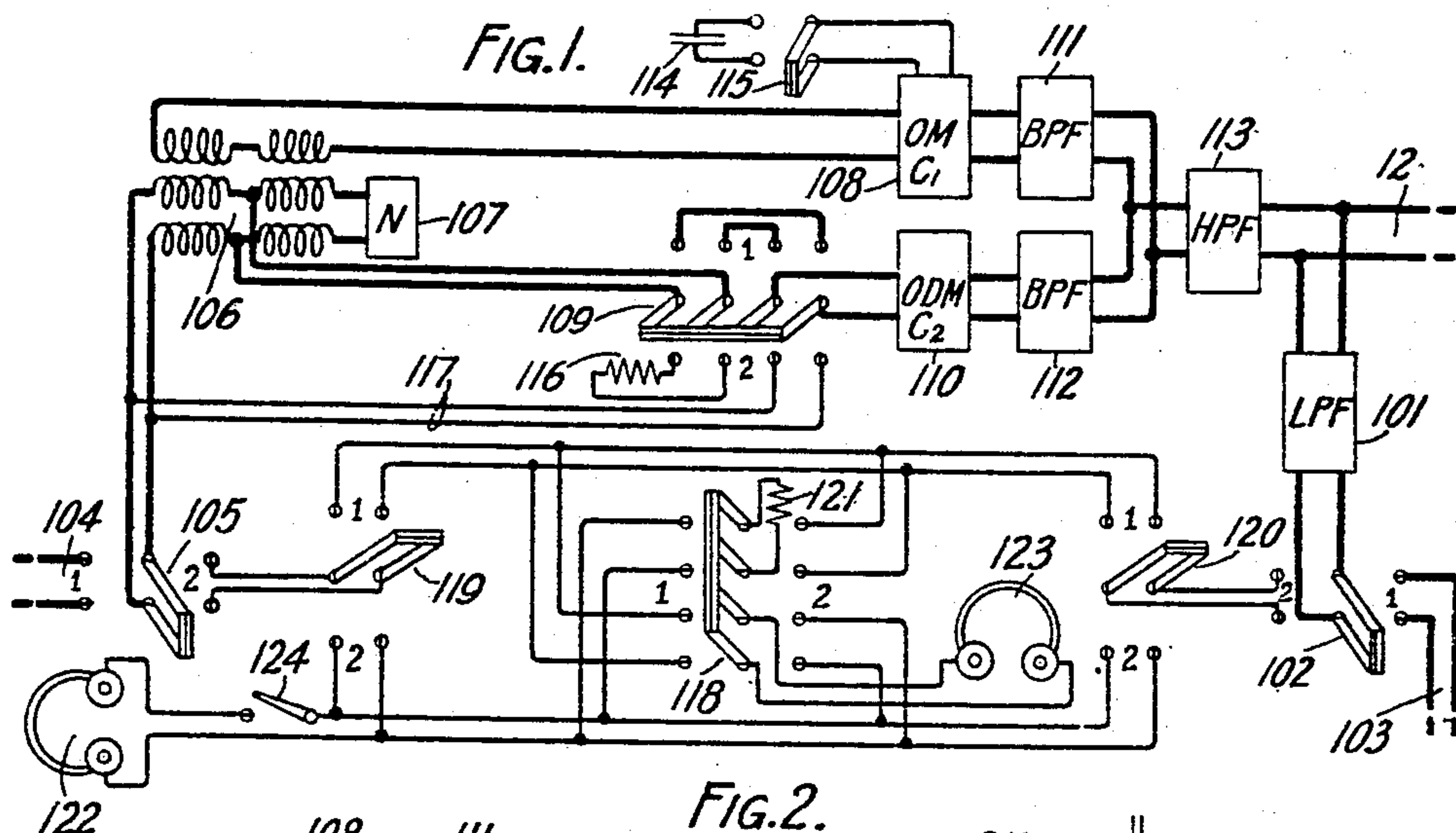
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CARRIER SYSTEM TESTING METHOD AND CIRCUIT

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CARRIER-SYSTEM-TESTING METHOD AND CIRCUIT

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This invention relates to testing circuits and methods, particularly for carrier signaling systems.

An object of the invention is to provide a simple method and circuit arrangement for synchronizing the carrier sources of the same frequency at communicating stations of a carrier signaling system, as for example, the carrier impressed upon a modulator of a carrier system in which the unmodulated carrier is suppressed and the carrier source supplying current to the demodulator at the receiving station.

A further object of the invention is to provide a simple method and circuit arrangement for measuring the overall transmission efficiency of a carrier signaling system.

In carrier signaling systems of the so-called carrier suppression type in which only a side band is transmitted and the carrier wave is supplied to the demodulator at the receiving station, it is necessary that the carrier wave supplied be of the same frequency as that used in the modulator. The carrier sources at the modulator and demodulator are sometimes synchronized by transmitting two side bands from the modulator of the channel under test and adjusting the demodulator so that no beat frequency appears in its output. Such a system requires a source of low frequency waves and is not well adapted for use with some systems because of their circuit arrangements.

This invention provides a simple and effective method for synchronizing carrier sources of a corresponding modulator and demodulator of a carrier signaling system. In the embodiment which has been selected for detailed description in this application, by way of example, the carrier frequency (C_2 on the drawing) of the modulator at the station at which the demodulator of the carrier channel under test is located is changed to give a wave of side band frequency ($C_2 - S$), for example by operating a portion of the calling circuit. This wave is transmitted to the other station where it is demodulated to produce a low frequency output wave ($S \pm \Delta C_2$). This wave is impressed directly on the transmission line and on the

modulator of the carrier channel under test where a side band [$C_1 - (S \pm \Delta C_2)$] is produced. The low frequency wave ($S \pm \Delta C_2$) and this side band are simultaneously transmitted back to the first station where the side band is demodulated in the demodulator of the carrier channel under test producing an output wave ($S \pm \Delta C_2 \pm \Delta C_1$) which is compared with the received low frequency wave ($S \pm \Delta C_2$) with respect to frequency. The frequency of the carrier source associated with the demodulator of the channel under test may then be adjusted so that the frequencies of the two waves are the same, (that is, so that ΔC_1 is zero). The modulator and demodulator carrier sources will then be synchronized.

The proper functioning of this method is independent of the adjustment of the carrier sources of the modulator at the first terminal station which is used for transmitting the wave of side band frequency and the corresponding demodulator at the other terminal station, as any discrepancy in the frequency of these carrier waves appears in the same way in both the low and high frequency waves received at the first terminal station. As described this method may be easily employed in carrier systems in which the carrier frequency of the modulator is changed to produce a calling or ringing signal.

The broad feature of this method according to which a wave of side band frequency is transmitted from one terminal and demodulated at the other to produce a low frequency wave which may be simultaneously transmitted to the first terminal station through the low frequency channel and through a carrier channel may be used for making other tests, for example, to measure the overall transmission efficiency of the system in which case the amplitudes of the two waves are compared rather than their frequencies as hereinafter described in detail.

This invention is illustrated in the accompanying drawing in which;

Fig. 1 shows diagrammatically one terminal station of a carrier telephone system with the necessary switching arrangement for

making synchronization and transmission efficiency tests according to this invention;

Fig. 2 shows diagrammatically two terminal stations of a carrier telephone system connected for making a synchronization test;

Fig. 3 shows diagrammatically two terminal stations of a carrier telephone system connected for making a transmission efficiency test.

The terminal station of Fig. 1, by way of example, is shown as being of the type employing a self-oscillating modulator and a self-oscillating demodulator as described in United States Patent to H. S. Black 1,653,837, dated December 27, 1927. The connections for operating the system for transmitting two conversations, one at the ordinary voice frequencies and the other at carrier frequencies, are illustrated by the heavy lines. The connections for arranging the equipment to make the synchronization and transmission efficiency tests of this invention are illustrated in light lines.

The transmission system proper comprises a transmission line 12 to which is connected one set of terminals of a low pass filter 101. The other set of terminals of this filter is connected to the arms of a DPDT switch 102, so that when the switch is closed in position 1, a low frequency line 103 is connected to the transmission line 12 through the low pass filter 101. A second low frequency line 104 is connected to one set of terminals of a DPDT switch 105, so that when the switch is closed in position 1, the line is connected to one series arm of the hybrid coil, or balanced transformer 106. The other series arm of the hybrid coil is terminated in an impedance balancing network 107. One shunt arm of the hybrid coil is connected to the input terminals of an oscillator-modulator 108. The other shunt arm of the hybrid coil is connected to one set of arms of a 4PDT switch 109. The other arms of switch 109 are connected to the output terminals of an oscillator-demodulator 110 so that when the switch 109 is closed in position 1, the output of the oscillator-demodulator 110 will be connected to the shunt arm of the hybrid coil 106. The output of the oscillator-modulator 108 and the input of the oscillator-demodulator 110 are connected to one set of terminals of the band pass filters 111 and 112, respectively. The other set of terminals of these filters are connected in parallel to one set of terminals of the high pass filter 113, which is connected in parallel with the low pass filter 101 to the transmission line 12. Thus, when switches 102, 105 and 109 are closed in positions 1, the system is connected for operation to transmit and receive one conversation between the low frequency line 104 and the carrier channel and a second conversation from the low frequency line 103 over the voice channel.

A condenser 114 may be connected through a switch 115 to the oscillator-modulator 108. The effect of this condenser is to change the frequency of the carrier wave generated by the oscillator-modulator 108 from C_1 to $C_1 - S$ which lies in the range of the side band to be transmitted. This arrangement is part of the calling circuit as described in United States Patent to Pruden No. 1,624,506, patented April 12, 1927. This same effect may be produced by impressing a wave of frequency S on the input of the modulator. A resistance 116 is connected to one set of terminals of the switch 109 and another set is connected through leads 117 to the series arm of the hybrid coil 106, so that when the switch 109 is closed in position 2, the output of the demodulator 110 is connected to the series arm of the hybrid coil and the shunt arm is terminated in resistance 116, the value of which is such as to maintain the balance of the hybrid coil. A second 4PDT switch 118 and other DPDT switches 119 and 120 are arranged in connection with resistance 121, receivers 122 and 123 and switch 124 so that the circuit may be arranged for making the tests as described below.

Fig. 2 shows a system comprising two stations 100 and 200, each identical to the station shown in Fig. 1 and having their elements correspondingly numbered (elements indicated by last two digits, stations by first digit), with their switches arranged to make the circuit connection shown for synchronizing the oscillator-modulator 108 and the oscillator-demodulator 210. The arrangement of switches at station 100 is as follows:

Switch	Position	
102-----	2	
105-----	2	105
109-----	2	
115-----	Open	
118-----	Neutral	
119-----	1	
120-----	1	110
124-----	Open	

The position of the switches at station 200 is:

Switch	Position	
202-----	2	
205-----	2	
209-----	1	
215-----	Closed	
218-----	Neutral	120
219-----	2	
220-----	2	
224-----	Closed	

With this circuit arrangement the oscillator-modulator 208 produces a wave of frequency $C_2 - S$ in the output of the band pass filter 211. This wave is transmitted over the line 12 to station 100 where it is demodulated in the oscillator-demodulator 110 which oscil-

lates at a frequency $C_2 \pm \Delta C_2$ giving an output wave of frequency $S \pm \Delta C_2$. This wave divides between the low pass filter 101 and the series arm of the hybrid coil 106. That portion going to the low pass filter 101 is transmitted directly by the line 12 to the station 200. That part going to the hybrid coil 106 is modulated by the oscillator-modulator 108 which oscillates at a frequency C_1 giving a wave of frequency $C_1 - (S \pm \Delta C_2)$ which is also transmitted to the station 200 over the line 12. The low frequency wave $S \pm \Delta C_2$ is transmitted through the low pass filter 201 to the receiver 222. The high frequency wave $C_1 - (S \pm \Delta C_2)$ is impressed upon the input of the oscillator-demodulator 210 which oscillates at a frequency $C_1 \pm \Delta C_1$ giving an output wave of frequency $S \pm \Delta C_2 \pm \Delta C_1$ which is also impressed on the receivers 222. These two waves give a beat in the receiver of a frequency ΔC_1 , and the frequency of the oscillator-demodulator 210 may be adjusted so that this beat is zero in which case the oscillator-modulator 108 and the oscillator-demodulator 210 are synchronized. The positions of the switches for stations 100 and 200 may then be reversed and the oscillator-modulator 208 and the oscillator-demodulator 110 be synchronized.

The circuit arrangement may be variously modified for making the synchronization test, for example instead of disconnecting the output of the demodulator from the shunt arm of the hybrid coil the circuit may merely be unbalanced by disconnecting the network 107.

After the synchronization test has been made, the circuits may be arranged for comparing the overall transmission efficiency of the carrier channel with that of the voice frequency channel. For this test the switches are closed to make the connections shown in Fig. 3. This test is similar to the synchronization test except that in this case the amplitudes of the received low frequency wave and the low frequency output wave of the oscillator-demodulator 210 are compared, rather than their frequencies. For this test the arrangement of switches at station 100 is the same as that for the synchronization test. The arrangement of switches at station 200 is:

Switch	Position
202-----	2
205-----	2
209-----	1
215-----	Closed
218-----	=
219-----	2
220-----	1
224-----	Open

The amplitudes of the two low frequency waves may then be compared in the receiver 223 by flipping the switch 218 back and forth, and the level of the carrier channel adjusted until it is equal to that of the voice channel,

which is the condition usually desired. The transmission efficiency of the other carrier channel may be measured by reversing the positions of the switches at stations 100 and 200.

What is claimed is:

1. A method of testing which comprises transmitting a wave of side band frequency from one station, demodulating said wave at another station, simultaneously transmitting the demodulated wave to the first station through separate channels, and comparing the waves as received at the first station over said separate channels.

2. A method of testing a carrier signaling system which comprises transmitting a wave of side band frequency from one station, demodulating said wave at another station and simultaneously transmitting the demodulated wave to the first station through the low frequency channel and through a carrier channel.

3. The method of testing according to the next preceding claim in which the received low frequency wave is compared with the low frequency output of the carrier channel at said first terminal station.

4. The method of synchronizing the carrier sources of a corresponding modulator and demodulator of one channel of a carrier signaling system of the carrier suppression type which comprises transmitting a wave of side band frequency from the station at which the demodulator of the channel under test is located, demodulating the wave at the station at which the modulator of the channel under test is located, simultaneously transmitting the demodulated wave to said first station through a low frequency channel and through the carrier channel under test, and comparing the low frequency output of said carrier channel with the wave received through the low frequency channel at said first station.

5. The method of synchronizing according to the next preceding claim, in which the demodulator under test is adjusted to give a zero beat between its output and the wave received over the low frequency channel.

6. The method of synchronizing the carrier sources of a corresponding modulator and demodulator of one channel of a carrier signaling system of the carrier suppression type which comprises operating a modulator at the station at which the demodulator of the channel under test is located to produce a wave of side band frequency, transmitting said wave to the station at which the modulator of the channel under test is located, demodulating said wave at said second station, simultaneously transmitting the demodulated wave to said first station through a low frequency channel and through the carrier channel under test, and comparing the low frequency output of said carrier channel with

the wave received through the low frequency channel, at said first station.

7. A station for a carrier signaling system comprising a modulator, a demodulator, a high pass filter, a low pass filter, connections between one set of terminals of each of said filters, connections from the other set of terminals of said high pass filter to the output terminals of the modulator and to the input terminals of the demodulator, and connections from the output terminals of the demodulator to the other set of terminals of said low pass filter and to the input terminals of the modulator.

8. In a carrier signaling system, a station comprising a modulator, a demodulator, a high pass filter, a low pass filter, connections between one set of terminals of each of said filters, connections from the other set of terminals of said high pass filter to the output terminals of the modulator and to the input terminals of the demodulator, and connections from the output terminals of the demodulator to the other set of terminals of said low pass filter and to the input terminals of the modulator, a transmission line having one set of terminals connected to the common connection of said high pass and low pass filters, and a second station comprising a high pass filter, a low pass filter, connections from one set of terminals of each of said filters to the other set of terminals of said line, a demodulator having its input terminals connected to the other set of terminals of said high pass filter, and means for comparing the wave in the output of said demodulator with the wave at the other set of terminals of said low pass filter.

9. A carrier signaling system, according to the next preceding claim, and means at said second station for impressing a wave of side band frequency on said line.

10. The method of comparing the overall transmission characteristic of one channel of a carrier synchronizing system, with the transmission characteristic of a low frequency channel which comprises transmitting a wave of side band frequency from one station, demodulating said wave at another station, simultaneously transmitting the demodulated wave to said first terminal station through the low frequency channel and through the carrier channel under test, and comparing the amplitude of the low frequency output of said carrier channel with the wave received through the low frequency channel at said first terminal station.

11. A method of operating a carrier system which comprises transmitting a wave of high frequency from one station, demodulating said wave at another station, transmitting the demodulated wave back to the first station through a plurality of separate channels, one of which is a carrier channel, and controlling the system to make the waves re-

ceived at the first station substantially alike.

In witness whereof, I hereunto subscribe my name this 28th day of February A. D., 1927.

ALTON C. DICKIESON.

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