

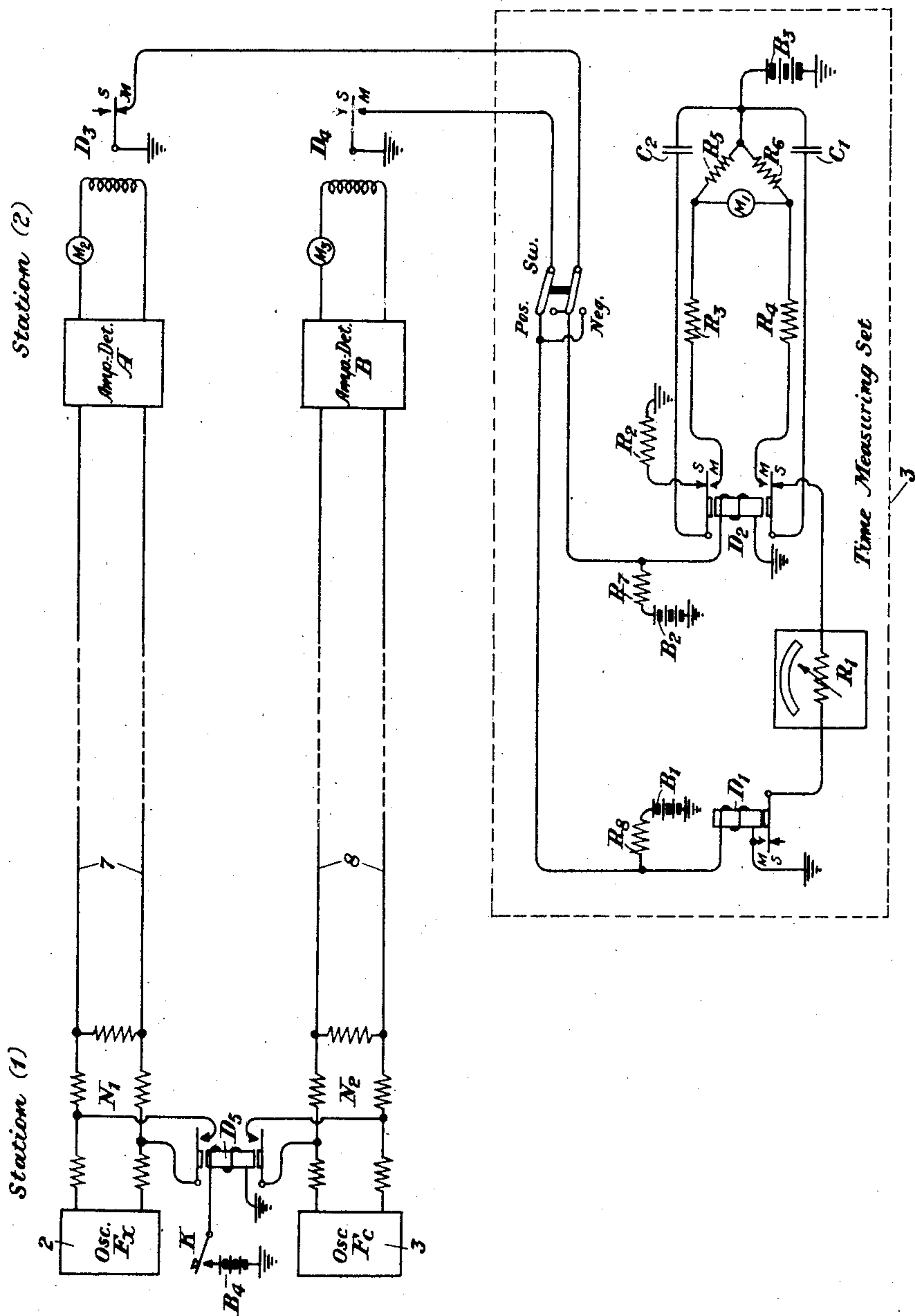
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METHOD OF AND MEANS FOR MEASURING DIFFERENCES IN TIME OF PROPAGATION
OF WAVE FRONTS OF DIFFERENT FREQUENCIES OVER A CIRCUIT

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METHOD OF AND MEANS FOR MEASURING DIFFERENCES IN TIME OF PROPAGATION OF WAVE FRONTS OF DIFFERENT FREQUENCIES OVER A CIRCUIT

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This invention relates to methods of and means for measuring the differences in the time of propagation of a wave front over a circuit with currents of various frequencies.

5 An instance wherein measurements of this character might be of value would be in the construction and design of new circuits, and more particularly with respect to the design of networks to be utilized in such circuits to
10 equalize the time of propagation thereover of currents of different frequencies. Other uses and features of the invention will appear more fully from the detailed description hereinafter given.

15 The invention utilizes the measuring device disclosed in a copending application in the name of J. Herman, filed September 2, 1926, Serial No. 136,887. In this device, the method of operation consists in charging a condenser
20 during the interval of time to be measured, discharging this condenser through an indicating means, such as a differential meter, adjusting the electrical constants of the charging circuit of the condenser by means of
25 a variable resistance, repeating the above operations until the charge accumulated on the condenser is equal to a known charge, and utilizing the values of the electrical constants of the charging circuit when the charge
30 accumulated on the condenser is equal to a known charge to determine the interval of time to be measured. In the arrangements and method of the present invention, current of any desired frequency will
35 be applied to or cut off from one end of a circuit utilized as a standard for calibration purposes. This current will operate responsive means at the other end of the circuit. This responsive means will start the charging
40 of the condenser in the time measuring set, or in other words, will start the measuring set in operation. Simultaneously, current of a certain frequency will be applied to a circuit in
45 which it is desired to measure differences in delay at different frequencies, or in other words, differences in the time of propagation of a wave front thereover at different frequencies. This current will operate responsive means at the end of said circuit. This
50 responsive means will be utilized to control

the discharging of the condenser in the time measuring set, or in other words, to stop the operation of the measuring set. The interval thus measured by the measuring set will represent the difference in delay over the two
55 circuits with respect to the definitely chosen frequency transmitted over said second circuit. The above operation will now be repeated, only a different definite frequency will be transmitted over the second circuit. A
60 comparison of the two readings will now afford an indication of the difference in the time of propagation over said second circuit of the two different frequencies utilized. In other words, the two readings of the measuring set may be subtracted to give the difference in delay at the two different frequencies over said second circuit.

The invention may be more fully understood from the following description together
70 with the accompanying drawing in the figure of which is illustrated a circuit diagram embodying a preferred form of the invention.

In the drawing is shown a circuit 8 to one end of which is connected an oscillator 3.
75 This oscillator may have a frequency F_c which may be any desired frequency. Circuit 8 will include an amplifier-detector B, a meter M_3 and the winding of a relay D_4 . A circuit 7 is also provided. It is over this circuit that it is desired to measure differences
80 in time of propagation of a wave front at different frequencies, or in other words, to measure differences in delay thereover at different frequencies. Accordingly, there will
85 be connected to line 7 an oscillator 2. This oscillator may be adjusted to transmit any one of a number of desired frequencies. Circuit 7 will include an amplifier-detector A, a meter
90 M_2 and the winding of a relay D_3 . The time measuring set 3 is substantially similar to that illustrated in the aforementioned copending application filed in the name of J. Herman, and will include a relay D_1 for closing
95 a charging circuit for the condenser C_1 through the variable resistance R_1 . It will also include a relay D_2 for discharging the condensers C_2 and C_1 through a differential meter M_1 . A double-pole switch SW is pro-
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vided for purposes to be pointed out herein-
after. The relay D_4 normally controls a
short circuit about the winding of relay D_1 ,
and the relay D_3 controls a normally closed
5 short circuit about the winding of relay D_2 .
The circuits 7 and 8 include the resistance
networks N_1 and N_2 , respectively. Bridged
across these networks are two circuits which
may be closed upon the operation of the relay
10 D_5 and which will be operated by the key K .
The closing of these two circuits will serve to
simultaneously short-circuit the outputs of
oscillators 2 and 3.

The operation of the arrangements is as
15 follows: Normally, current will be flowing
from the oscillators 2 and 3 over the lines 7
and 8 and will hold the relays D_3 and D_4 on
their M -contacts. The oscillator 2 will now
have its frequency adjusted to some desired
20 value. The key K will now be closed. This
will operate relay D_5 , which will close a
short-circuit across the outputs of both of the
oscillators. Accordingly, relays D_3 and D_4
will eventually release. The release of relay
25 D_4 will open the normally closed short-circuit
about the winding of relay D_1 . Relay D_1
will operate and close a charging circuit for
condenser C_1 through the resistance R_1 .
When relay D_3 releases, the normally closed
30 short-circuit about the winding of relay D_2
will be opened and relay D_2 will operate,
thereby discharging condensers C_1 and C_2
through the differential meter M_1 . Key K
will be opened and closed repeatedly and the
35 resistance R_1 adjusted until the meter M_1
will show no deflection. The reading of re-
sistance R_1 will then be noted. The fre-
quency of oscillator 2 will now be changed
to one of certain other frequencies which it
40 is desired to measure. The above process will
then be repeated for each frequency and the
reading of R_1 noted. The difference between
one of these readings, chosen as a reference,
and the other readings, will represent the dif-
45 ference in time of propagation over the cir-
cuit 7 of wave fronts of the different chosen
frequencies. In case it should be found that
under certain conditions the relay D_3 would
operate before the relay D_4 , the switch SW
50 is provided with two positions so that the
connections to these relays may be inter-
changed.

While the invention has been disclosed in
certain specific arrangements which are
55 deemed desirable, it is understood that it is
capable of embodiment in many and other
widely varied forms without departing from
the spirit of the invention as defined by the
appended claims.

60 What is claimed is:

1. The combination of a time measuring
set whereby a direct indication may be given
of the time interval between the operation of
two responsive devices, of two separate cir-
65 cuits each connected to one of said responsive

devices, an oscillator of a definite frequency
connected to the first of said circuits, an os-
cillator adapted to generate a plurality of
desired frequencies connected to said second
circuit, means for simultaneously controlling 70
the application of current from said oscil-
lators to said circuits, means controlled by one
of said responsive means for starting said
measuring set in operation, and means con-
trolled by the other of said responsive means 75
for stopping the operation of said measuring
set.

2. The method of measuring difference in
delay over a circuit with currents of different
frequencies, which comprises controlling the 80
application of current of a definite frequency
over a circuit to be utilized for comparative
purposes, simultaneously controlling the ap-
plication of current of one of a plurality of
desired frequencies over the circuit in ques- 85
tion, measuring the difference in delay be-
tween the current of known frequency and
the current of desired frequency over the sepa-
rate circuits, repeating the measurement in
turn with currents of other of the plurality of 90
desired frequencies over the circuit in ques-
tion, and comparing said measurements.

In testimony whereof, I have signed my
name to this specification this 1st day of De-
cember 1927.

JOSEPH HERMAN.

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