

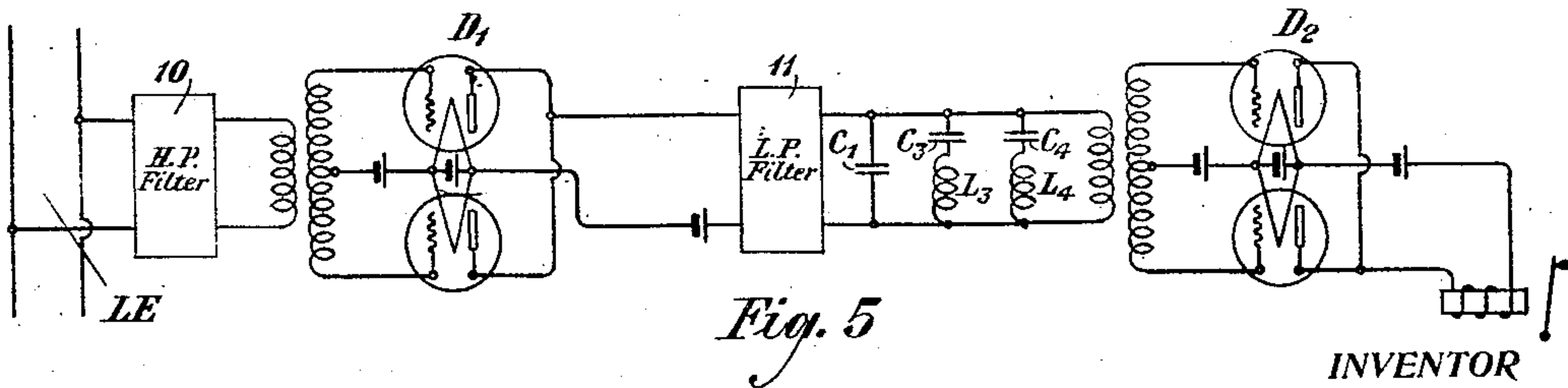
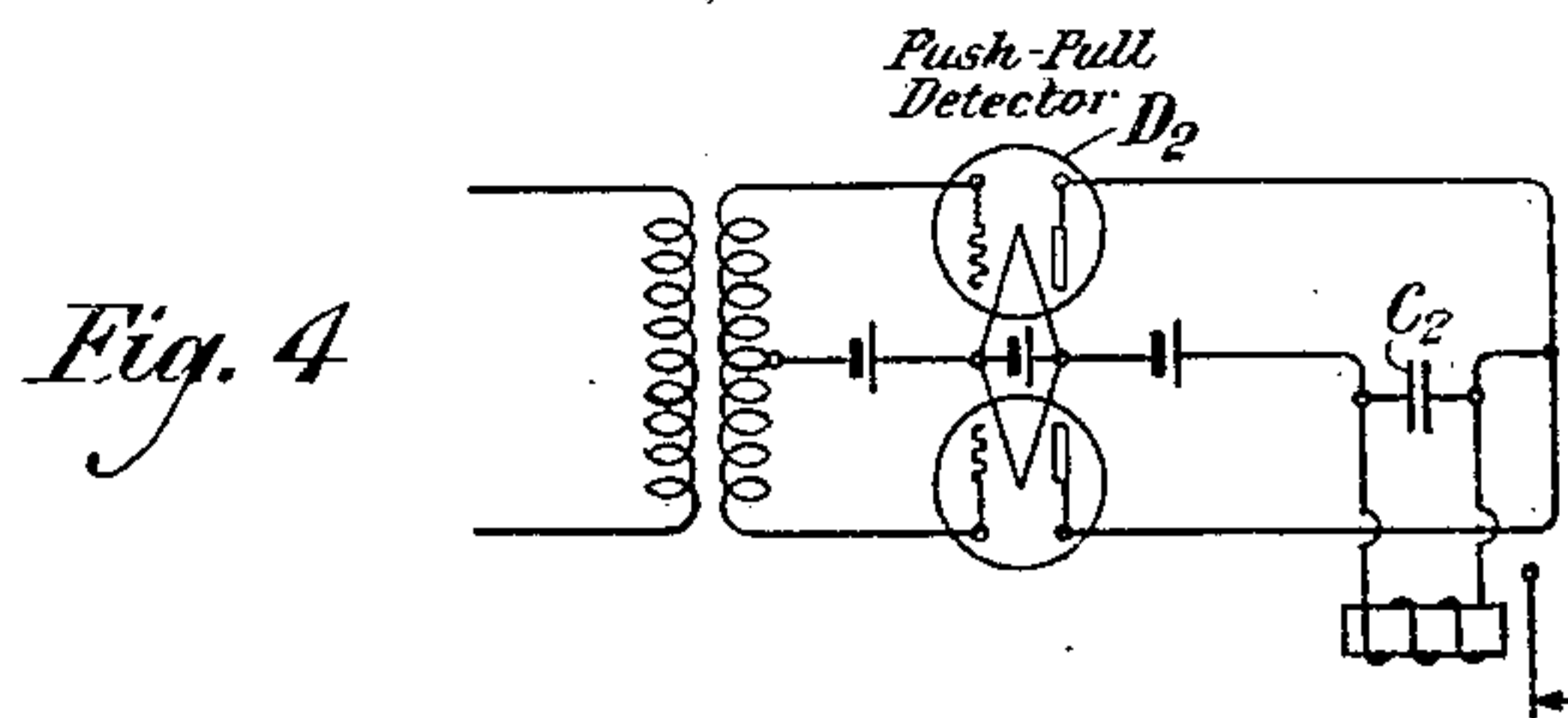
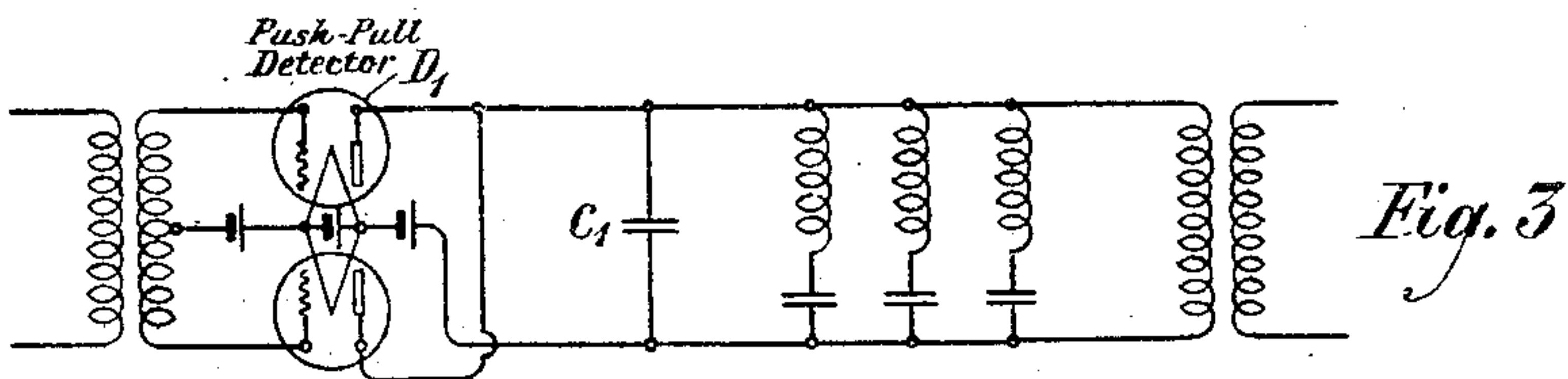
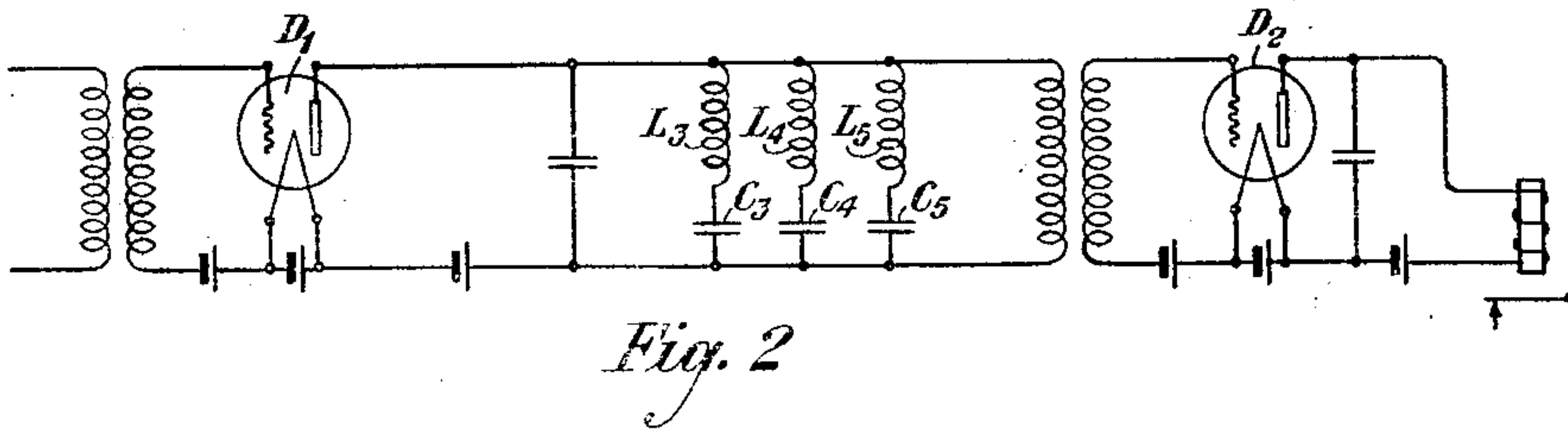
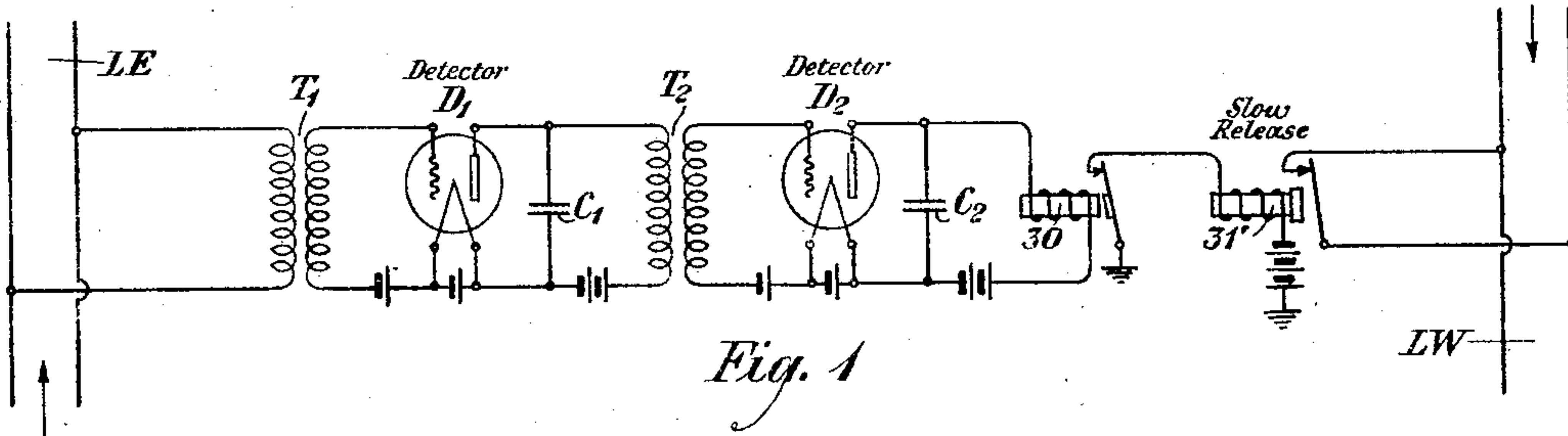
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VOICE OPERATED RELAY EQUIPMENT

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# UNITED STATES PATENT OFFICE

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## VOICE-OPERATED RELAY EQUIPMENT

Application filed July 12, 1926. Serial No. 120,215.

This invention relates to voice-operated relay circuits of the type used in echo suppressing equipment, voice-operated repeater circuits, and the like, and is a continuation in part of my application, Serial No. 67,406, filed November 6, 1925.

Tests have shown that steady alternating currents, such as those set up in telephone circuits by induction from power lines and other adjacent circuits are a serious limitation on the sensitivity at which a voice-operated circuit such as an echo suppressor can be worked. The seriousness of this difficulty becomes apparent when it is considered that the sensitivity of an echo suppressor, for example, is limited by the noisiest circuit which may be connected to the echo suppressor at any given time, although for a large number of other connections a greater sensitivity would be possible.

One of the objects of this invention is to provide a voice-operated relay circuit which will be substantially non-responsive to steady noise currents, but which will be quite sensitive to voice currents even though the voice currents be of very small magnitude. The invention takes advantage of the fact that the noise currents are steady and continuous, whereas the voice currents which are intended to operate the relay are fluctuating currents.

This and other objects of the invention are attained by means of the arrangements set forth in detail in the following description and illustrated in the accompanying drawing, in which Figure 1 illustrates a simplified form of carrying out the purpose of the invention, and Figs. 2 to 5 show various modified forms of circuits to more completely carry out that purpose.

Referring to Fig. 1, LE and LW represent two one-way paths of a 22-type repeater or of a four-wire transmission circuit. When circuits of this type are to be operated, it is common to provide each path with an echo suppressor equipment for disabling the path transmitting in the opposite direction whenever voice currents are being transmitted over the first path. In the drawing, echo suppressing equipment is shown associated with the path LE and arranged to disable the path

LW. It will be understood, of course, that the path LW is provided with similar equipment to disable the path LE under appropriate conditions.

The echo suppressor equipment illustrated in the figure is bridged across the circuit LE through an input transformer  $T_1$  associated with the input circuit of a detector  $D_1$ . A second transformer  $T_2$  has its primary winding connected in the output circuit of the detector  $D_1$ , and its secondary winding connected in the input circuit of a second detector  $D_2$ . The winding of relay 30 is included in the output circuit of the detector  $D_2$ . The relay 30 in turn controls a slow releasing relay 31' for closing a short-circuit across the path LW.

The detector  $D_1$  has a capacity  $C_1$  bridged across its output circuit, and similarly the detector  $D_2$  has a capacity  $C_2$  bridged across its output circuit. These capacities form by-passes for the alternating components of the detected currents, with the result that substantially only the direct current components of the detected current flowing in the output circuits of the two detectors will pass through the primary winding of the transformer  $T_2$  and the winding of the direct current relay 30, respectively.

If continuous alternating noise current is impressed upon the circuit, substantially steady direct current will flow through the primary winding of the transformer  $T_2$ , because the alternating current components which may comprise numerous harmonics introduced by the detector will be passed through the condenser  $C_1$ . This continuous direct current can not be transmitted through the transformer  $T_2$  to the input circuit of the detector  $D_2$ , and consequently the steady noise current produces no effect upon the relay 30. However, when voice currents which are generally of short pulses, but of varying magnitude, are applied to the detector  $D_1$ , the detected component flowing through the primary winding to the transformer  $T_2$ , over which voice current falls, will be a varying pulse of one-way current. This varying pulse of one-way current sets up a correspondingly varying voltage in the secondary winding of



the transformer  $T_2$ , and thereby causes a corresponding space current to flow in the winding of the relay 30, which is in the output circuit of the detector  $D_2$ . This current operates the relay 30, which in turn operates the slow release relay 31' to short-circuit the path LW. The path LW will remain short-circuited due to the slow releasing action of the relay 31' as long as the rectified pulses of voice current continue at sufficiently short intervals, just as in the case of the ordinary voice-operated relay circuit. Obviously, the above arrangement discriminates between irregularly pulsating currents, such as voice currents, and steady alternating currents such as noise currents due to power lines. Therefore, the detecting circuits may be set to the desired sensitivity with respect to voice currents without causing them to respond to noise currents of the kind referred to.

Fig. 2 is a circuit differing from Fig. 1 in that additional means are provided for eliminating the effects of the sustained alternating currents. If, for example, the main disturbing currents come from a power line of say 60 cycles, it will be appreciated that the characteristics of the transformers and other parts of the telephone circuit are such as to discriminate strongly against the fundamental of 60 cycles, but that the overtones, which are mainly the odd harmonics, may enter into the telephone circuit to a considerable extent. The characteristics of the first detector  $D_1$  are such as to develop in its output circuit mainly the even harmonics starting especially with that of 120 cycles. Fig. 2, then, shows special selective by-pass circuits for such frequencies, and a suitable form which these circuits might take would be an inductance  $L_3$  in series with a condenser  $C_3$ . This particular circuit might be tuned to a particular frequency, such as 120 cycles, while the circuit  $L_4 C_4$  would be tuned to some other disturbing frequency, such as 240 cycles.

It may also be desirable in some cases to make use of the peculiar properties of a push-pull detector. Such a circuit is shown in Fig. 3, in which the first detector is of the push-pull type. In this Fig. 3, the first detector  $D_1$  only is shown, for the reason that the second detector may take on the form shown in Figs. 1 and 2, or some other suitable form without calling for definite modification of the first detector. The advantage of this circuit is that, if properly balanced, whatever alternating currents may be impressed on the input of this detector, those alternating currents will not appear in the output, but harmonics and sum and difference frequencies only will appear.

Instead of using the push-pull detector for the first circuit, it may be used in the second circuit, as shown in Fig. 4 at  $D_2$ . In this figure, the first detector has not been shown, for

it is to be understood that this first detector may take on the forms of Figs. 1, 2 or 3. Here, again, the push-pull detector, if properly balanced, will eliminate the alternating currents which are impressed on its input, and in its output there will appear only harmonics and sum and difference frequencies of the impressed currents.

Fig. 5 shows still a further modification in which a push-pull detector is used in both circuits, with the obvious advantages. In addition, Fig. 5 shows, in the input circuit of the first detector, a high-pass filter 10, and, in the output circuit, a low-pass filter 11. While these filters would naturally be given cut-off values determined by the particular disturbance characteristics of the circuit with which it is to be used, it might well be that the filter 10 would have a cut-off frequency at about 800, in which case all frequencies below this will be completely suppressed, whereas the frequencies which are most frequently present in speech currents will be transmitted. On the other hand, the low-pass filter might have a cut-off of say 500 cycles which would thus eliminate all high frequencies, but would transmit the relatively low frequencies corresponding to the fluctuations in amplitude of the speech current. As a further precaution against the transmission of undesired frequencies, it would still be desirable to include in the output circuit of the first detector the by-pass condenser  $C_1$  offering a low impedance to high frequency currents, and also the tuned circuits  $L_3 C_3$ , etc.

While in this Fig. 5 a number of elements have been included to make more effective the discrimination in favor of the transients or effects produced by the voice currents, it is to be understood that any one of these elements may be omitted with, of course, the loss of its accompanying utility.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated, without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a voice-operated relay circuit, a path over which alternating voice currents and continuous alternating currents may be transmitted, tandem detectors associated with said path, a relay controlled by the second detector, a transformer for coupling the output of the first detector to the input of the second, and means to render said transformer responsive only to currents corresponding to the envelope of the voice currents.

2. In a voice-operated relay circuit, a path over which alternating voice currents and relatively sustained alternating currents may be transmitted, tandem detectors associated with said paths, a relay controlled by the second detector, and means in the first detector



circuit for discriminating in favor of the voice current transients and passing these on to the second detector.

3. In a voice-operated relay circuit, a transmission path over which alternating voice currents and continuous alternating currents may be transmitted, tandem detectors associated with said path, a relay in the output circuit of the second detector, a transformer for coupling the output circuit of the first detector to the input circuit of the second, and a by-pass condenser across the output circuit of each detector to substantially by-pass alternating current components and tuned circuits across the output of the first detector to by-pass harmonics of the continuous alternating currents and both permitting transmission through the transformer of currents corresponding to the envelope of the voice currents.

4. In a voice-operated relay circuit, a path over which fluctuating voice currents and relatively sustained alternating currents may be transmitted, tandem detectors associated with said path, one of these being a push-pull detector, a relay controlled by the second detector, and means associated with the first detector for discriminating in favor of the voice current transients and passing these to the second detector.

In testimony whereof, I have signed my name to this specification this 1st day of July, 1926.

HARRY NYQUIST.