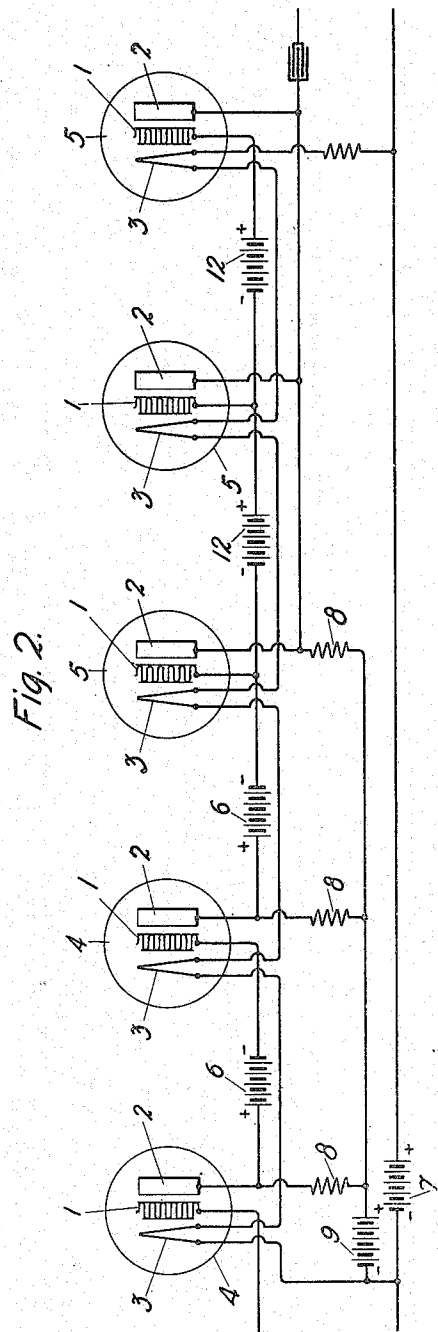
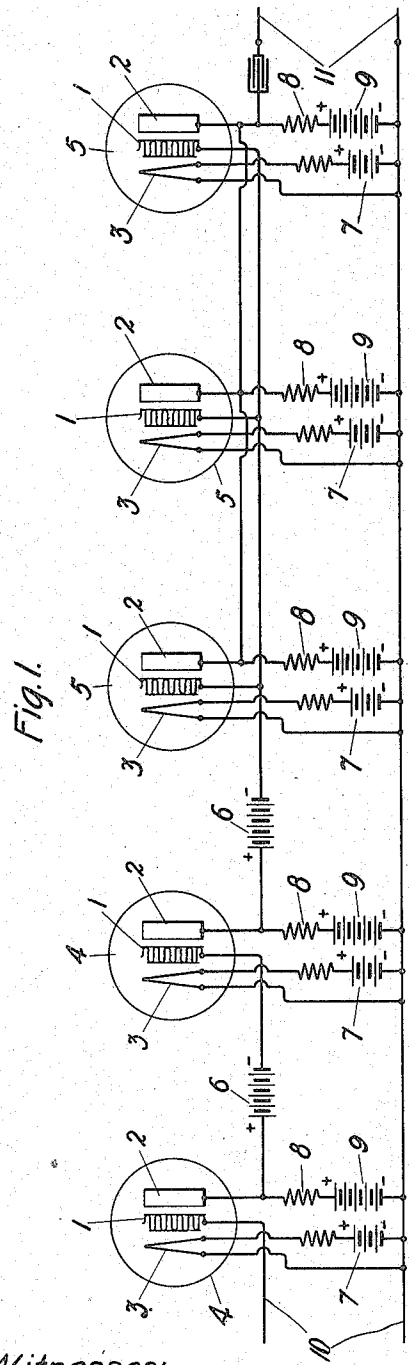


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 GASEOUS REPFATER IN CIRCUITS OF LOW IMPEDANCE,  
 APPLICATION FILED MAY 28, 1914.

1,129,943.

Patented Mar. 2, 1915.



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# UNITED STATES PATENT OFFICE.

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## GASEOUS REPEATER IN CIRCUITS OF LOW IMPEDANCE.

1,129,943.

Specification of Letters Patent.

Patented Mar. 2, 1915.

Application filed May 28, 1914. Serial No. 841,569.

*To all whom it may concern:*

Be it known that I, HAROLD DE FOREST ARNOLD, a citizen of the United States, residing at East Orange, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Gaseous Repeaters in Circuits of Low Impedance, of which the following is a full, clear, concise, and exact description.

This invention relates to the use of thermionic repeaters, such as the audion, as amplifiers without transformers, and more particularly to the use of thermionic repeaters for securing amplification of current in circuits of low impedance.

In many instances it is necessary or desirable, for securing the best results, to exclude transformers from the circuit. Such is the case, for example, in those circuits in which the frequency is so low that efficient transformers are costly and difficult to design, as is the case in telegraph circuits in general and especially in submarine and wireless telegraph circuits. It is particularly desirable to exclude transformers from circuits in which an exact reproduction of wave form is necessary for legibility, as, for example, in submarine cable circuits. It is also desirable to exclude transformers from circuits in which undistorted amplification must be secured over a wide range of frequencies, as, for example, in the reproduction of speech and music.

Heretofore it has been necessary to employ transformers in circuit with the audion in order to secure efficient amplification of current by the audion, and this is especially true where the amplification is desired in circuits of low impedance. This is due to the fact that the impedance of the input circuit of an efficiently operating audion of the usual type is very high, at least 100,000 ohms and in general as high as 10 megohms. Hence, in a circuit of low impedance if no transformer is used, the larger part of the possible current amplification by the audion is lost. For example, if the impedance of the input circuit of the audion is only 100,000 ohms and the input circuit of the audion is connected, without the use of transformers, in a line of 1000 ohms impedance, at least 90% of the possible cur-

rent amplification is lost. Moreover, in the case of audions of the prior art, the impedance in the output circuit of the audion is always so great that a considerable additional loss of possible amplification must occur if the output circuit of the audion is connected without the use of a transformer in a circuit of low impedance.

It has been discovered that audions may be so constructed that without the use of transformers, they will step up the input voltage of either direct current or alternating current of any frequency in one step to as much as thirty times its original value, all in two successive steps to as much as 500 times its original value. The voltage amplification thus secured is entirely free from wave distortion whatever may be the initial frequency and wave form. It has been discovered that the output voltage of one of such audions or of a plurality thereof in tandem may be stepped down and the resultant current greatly amplified by having such audion or plurality of audions work into a plurality of similar audions in multiple, with the output of each going to a common circuit. This common output will be an amplified current of relatively low voltage. It has been discovered that a combination of one or more of such audions working into a sufficiently large number, for example from fifty to one hundred, of similar audions in multiple, with a common output, will operate, without transformers, from a line of low impedance, for example 250 ohms, into a like line with a resultant current much greater, fifty or more times as great, than would flow in the second circuit if it were directly connected to the first circuit. The present invention is directed to such combination of audions. A system designed to secure the same result and employing a single audion of a special type, in lieu of such audions in multiple, forms the subject-matter of another application for patent in my name, Ser. No. 841,568 filed of even date herewith.

The present invention may be more readily understood by reference to the accompanying drawings in which—

Figure 1 shows a circuit arrangement embodying this invention in which a plu-

ality of audions in tandem work into a plurality of similar audions in multiple, the output going to a common circuit; and Fig. 2 shows a simplified circuit arrangement giving the same result as in Fig. 1.

Like reference characters refer to like parts in both of said figures of the drawings.

The several audions may be of the usual construction, but to secure most efficient results the input electrode may be in the form of a grid 1, preferably made of very fine wire with a fine mesh or the like, and the output electrode or plate 2 is placed at a considerable distance from the filament 3. The filament, grid and plate are as usual sealed in an evacuated bulb. In order to secure best results, the grid should be near the filament, the plate should be distant from the filament, and the grid should present a finely meshed or discontinuous surface between the filament and the plate. This type of audion is adapted to give an amplification with low current and high voltage in its output circuit.

In Fig. 1, two audions 4, 4 in tandem are shown working into three audions 5, 5, 5 in parallel. The number of audions 4 in tandem employed will depend upon the amount of amplification desired. In case more than one audion 4 is used, they are, as shown, connected in tandem. Likewise the number of audions 5 in parallel will depend upon the characteristics required in their common output circuit, an increasing number of such multiplied audions 5 giving a decreasing voltage and increasing current. The batteries 6 are preferably of such value as to make each of the input electrodes or grids 1 normally about five volts negative with respect to its adjacent filament 3. The several filaments are heated by the respective batteries 7. The output circuit of each audion includes its output electrode or plate 2, a high resistance 8, a battery 9 and the filament of the audion. The resistance 8 should be, for example, 100,000 ohms or more. The input circuit of the first audion of the group is directly connected to the input line 10. The input voltage on the grid of the first audion 4 causes an increase in the voltage of the current flowing in the output circuit of said audion, thereby developing a voltage change on the grid of the next audion 4 in series. As a result of such construction and arrangement of these audions, the voltage in the input circuit of the second of the two audions in tandem is much greater than that impressed upon the first, although the current in the interconnecting circuit is small. The audions 5 work into a common output line 11 and being connected in parallel act to step down the voltage and correspondingly increase the current. This presents to the common output line 11 an impedance inversely proportional to the number of the

multiplied audions. Hence for the most successful operation into a line of low impedance, for example, 500 ohms, a large number of audions in parallel would be required to provide in their common output line 11 an impedance approximately equal to the impedance of the line to which direct connection is to be made. By combining two or more audions in tandem working into a number of audions in multiple, for example, from ten to one hundred, the combined system will operate, without the use of transformers, from an incoming line of low impedance into an outgoing line of like impedance with a resultant current of more than fifty times that which would flow in the outgoing line if the latter were directly connected to the incoming line.

Fig. 2 shows a simplification of the system illustrated in Fig. 1, in that a common battery 7 furnishes current to all the filaments, said filaments being connected in series with the battery. The batteries 12, 12 are introduced to compensate for the voltage drop through the filaments. A common battery 9 serves for all of the output electrodes 2.

As applied to submarine cable work for amplifying the feeble current at the receiving end, the invention is of special importance. The large amplification attained makes it possible to operate over such cables at greatly increased speed. Furthermore, less delicate recording devices will suffice as a substitute for the ordinary siphon recorder. Moreover, the high amplification secured renders possible the direct repetition from one section of a cable to another or from submarine to land telegraph lines. The invention is also particularly adapted for use in circuits where especially pure or loud reproduction of speech or music is desired. In general in the art of submarine, land and wireless telegraphy, the invention is of importance with reference to recording, high-speed working and direct repetition from one type of system to another type of system.

What is claimed is:

1. The combination of a plurality of thermionic repeaters in multiple having a common output line, and a thermionic repeater working into said multiplied repeaters.

2. The combination of a set of thermionic repeaters in multiple having a common output line, and a set of thermionic repeaters in tandem working into said first mentioned set of repeaters.

3. The combination with a line of low impedance, of an audion having its input circuit directly connected to said line, and a plurality of audions in multiple into which said first mentioned audion works, said multiplied audions having a common output line.

4. The combination with an incoming and an outgoing line of low impedance, of a set of audions in tandem directly connected to said incoming line, and a set of audions in  
5 multiple into which said first mentioned set works, said last mentioned set being directly connected to said output line.

In witness whereof, I hereunto subscribe my name this 25 day of May A. D., 1914.

HAROLD DE FOREST ARNOLD.

Witnesses:

E. EDLER,  
K. L. STAHL.