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PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION.

Electron Discharge Devices especially for Use in Wireless Communication.

I, JOHN SCOTT-TAGGART, of East Bank, Smithills, Bolton, Electrical Engineer, do hereby declare the nature of this invention to be as follows:—

The present invention relates to an electron discharge device, hereinafter to be termed a negatron, which is capable of being used as a negative resistance.

In its simplest form the negatron consists of an electron-emitting cathode such as a filament heated to incandescence, which I will term F., an anode which I will term A on one side of the cathode, a second anode, which I will call B on the other side, and a control electrode which I will term G placed between the cathode and the anode B. In one form of negatron the anodes A and B are flat plates diametrically opposed to each other and having between them a straight filament. The control electrode G is in the form of a flat grid. The distance between F and A may be made greater than the distance between F and B. The electrodes are preferably mounted in an evacuated bulb.

Between F and A I connect a battery which I will call C, so arranged as to give A a positive potential and so cause a flow of electrons from the cathode F to the anode A. This current I will term the A anode current. I also connect a battery which I will call D between F and B so arranged that B is made positive with respect to F, thus establishing normally an electron current from F to B, which current I will term the B anode current. I now connect the anode A to the grid G, preferably through a source of variable potential.

The operation of my invention will be understood from the following: If the electron discharge device simply consisted of an anode A and a cathode F, an increase in anode potential would cause an increase in anode current. My device has the opposite effect. Let us assume that by means of the above mentioned variable source of potential, the electrode G is given a potential sufficient to reduce the B anode current to a low value. There will be a steady A anode current. If now we increase the potential of A we will increase the potential of G with respect to F. Consequently, a larger B anode current begins to flow and electrons from F which normally would go to A now find it easier to go to B and consequently the A anode current decreases in proportion. Usually, the increase in the potential of A would tend to increase the A anode current, but my device, by deflecting emitted electrons, makes the deflection effect the greater one. If the device is to be used as a positive resistance, I arrange for the deflecting effect to be the lesser. By suitably balancing the two effects, a variation of the potential of A will cause no variation in the A anode current.

From the above it will be seen that in the normal case a decrease in the potential of A will decrease the potential of G which in turn will decrease the B anode current. Fewer electrons are thus deflected to the B anode and the A anode current consequently increases. We thus see that the device acts as a negative resistance.

Although I have demonstrated the action of my device, I do not desire to be confined to this especial means of carrying my invention into effect. Essentially, my device consists of an arrangement whereby a variation of potential on an anode causes a control electrode to deflect electrons from a common filament to a second electron absorbing anode, such

[*Price* 1*s*.]

absorbtion, according to its extent, varying the electron current to the first anode in such a way that a variation in the potential of the first anode may vary the electron current to that anode in an opposite sense to that experienced with an ordinary positive resistance. An important development of this simple arrangement is described later.

The deflecting effect of G may be varied in a variety of ways. For example, the varying voltage of A with respect to F may be amplified by a three-electrode electron discharge device or resistance amplifier before being applied to G. Again, the deflecting effect may be varied by altering the operating conditions or suitably modifying the relative positions of the electrodes.

My negatron is of special use in wireless telegraphy. By including an oscillatory circuit between F and A, the device will act as an oscillation generator.

If it is desired to overcome the positive resistance in a conducting circuit it is only necessary to connect such a circuit in the A anode circuit. By connecting an external resistance circuit in the A anode circuit and making the positive resistance almost equal to the negative resistance the device will act as a very efficient voltage amplifier. If the external resistance be connected in parallel with the A anode circuit, the device will act as a current magnifier. My invention may be used to compensate for losses in the anode circuit, grid circuit and aerial circuit of modern electron discharge device wireless receiving circuits. It may be used as a detector of wireless signals and also as a receiver of continuous waves. In brief, it is applicable to all cases where a negative resistance may be used.

A special modification consists in arranging a second control electrode between F and A. One use of such a modified negatron is to apply it to wireless telephony. Vocal potential variations may be applied between the second grid and F, an oscillatory circuit being connected in the A anode circuit, such oscillatory circuit energising the antenna.

For a purpose quite different, a control electrode may be placed between F and A of the four-electrode device originally described. This second control electrode may be connected, preferably through an adjustable source of potential to the anode B. When the potential on A is increased, the B anode current is increased and consequently the potential of B drops, becoming relatively negative to its former value. This negative potential is communicated to the second control electrode and further reduces the A anode current. It may be desirable to include a resistance preferably adjustable in the B anode circuit between the battery D and the anode B. The relative negative potential of B may be amplified in any well-known manner before being applied to the second control electrode.

This device may be modified by the inclusion of a third control electrode arranged suitably between F and A. The device is now analogous to the arrangement described above which was stated to be applicable to wireless telephone communication.

In all the above devices it may be desirable to use one battery in place of the two batteries C and D. It may be desirable to include an adjustable resistance between the battery supplying a positive potential to A and the anode A itself.

A suitable wireless receiving circuit may be arranged by placing the receiving oscillatory circuit in series with the A anode circuit of my negatron. In addition, a pair of telephones shunted by a variable condenser may be included in series with the circuit.

The negatron may also be connected to neutralise anode circuit losses in an ordinary three-electrode electron discharge device. A resistance and an indicating device may be connected in the anode circuit of the three-electrode device. Connections are taken from the anode and cathode of the three-electrode electron discharge device to the anode A and the positive side of C or its equivalent.

Another useful circuit is obtained by taking the leads from the positive side of C and the anode A and connecting them across the control electrode and cathode of a simple three-electrode device wireless receiving circuit. This neutralises losses in the control electrode circuit of the three-electrode device.

The development of my negatron which has been described as applicable to wireless telephony may be used as a wireless receiving circuit. A suitable arrangement consists in connecting the closed receiving circuit across the cathode and the additional control electrode between F and A of my device. In series with the A anode circuit may be connected a telephone receiver shunted by a variable condenser and also a tuned oscillatory circuit may be connected as well in series with the A anode circuit. In such a circuit the grid and antenna losses are not compensated. This may, however, be done

by connecting the additional control electrode not to the cathode F, but a suitable point on a resistance included in series with the A anode circuit. The oscillatory circuit in the A anode circuit of my device may, if desired, be omitted.

In the above descriptions, by the A anode circuit is normally meant the external path taken by electrons going to the A anode. Similarly, by B anode circuit is meant the external path taken by electrons going to the B anode.

While methods of using my negatron have herein been described, many modifications may be devised without exceeding the scope of my invention and will occur to those skilled in the art.

Dated the 17th day of September, 1919.

J. SCOTT-TAGGART.

COMPLETE SPECIFICATION.

Electron Discharge Devices especially for use in Wireless Communication.

I, JOHN SCOTT-TAGGART, formerly of Eastbank, Smithills, Bolton, in the County of Lancashire, and now of 34—35, Norfolk Street, London, W.C. 2, Electrical Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—

This invention relates to a form of electron discharge device or valve having two or more anodes, which is capable of being used as a negative resistance and which will be hereinafter referred to generally as a negatron. This negative resistance effect is obtained according to the present invention by a redistribution of the electrons passing from the cathode to the anodes which does not depend upon the liberation of secondary electrons on one of the anodes, but upon the diversion to one of the anodes of electrons emitted by the cathode which would otherwise pass to the other anode or anodes and the consequent reduction of current from the cathode to the first anode, the cathode-emitted electrons being always distributed amongst the anodes.

Thus, whereas in ordinary electron discharge devices or valves an increase in the anode potential causes an increase in the anode current, in the device which constitutes the present invention an opposite effect is obtained by means of a single valve by the use of a second anode so disposed and connected with respect to the other elements of the valve that an increase of potential of one of the electrodes, *e.g.* the first anode, causes a diversion to the second anode of electrons emitted by the cathode which would otherwise pass to the first anode and a consequent reduction of current from the cathode to the first anode. Similarly, a decrease in the potential of the first anode would result in an increased current from the cathode to this anode, the diverted current being inoperative as regards the production of changes of electromotive force in the circuit the resistance of which is to be reduced. The second anode circuit thus acts merely as a path for the diverted current.

For the better understanding of the principle of the negatron, reference is made to the accompanying drawing, which is a diagrammatic view of one form of the device.

In the drawing the two anodes A, B, which for convenience of reference will be called the first anode and the second anode respectively, are in the form of flat plates arranged parallel with each other on opposite sides of an electron-emitting cathode such as a filament F heated to incandescence and of a control electrode or grid G, all being contained in an evacuated vessel, *e.g.* an evacuated glass bulb. The anode A is preferably, as shewn in the drawing, smaller than anode B and at a greater distance from the filament.

Batteries C, D, E are connected with the various elements as shewn, the battery E being merely to give the grid G a suitable operating potential, preferably negative. The batteries C and D are so connected with the anodes and cathode as to make the former positive with respect to the latter and so cause a flow of electrons from the cathode to the respective anodes.

These electron currents will be referred to as the A (or first) anode current and the B (or second) anode current respectively. The temperature of the filament is preferably such that the sum of the A anode and B anode currents is equal to the total emission from the filament.

Instead of connecting the anode A and grid G in simple circuit with the battery E, as shewn in the drawing, they may be connected therewith in such a way that the potential applied to the grid may be varied.

If we assume that the electrode G is given by means of variable source E a potential sufficient to reduce the B anode current to a low value, there will be a steady A anode current. If now the potential of A is increased, the potential of G with respect to F will thereby also be increased. Consequently, a larger B anode current begins to flow, and electrons which normally would flow from F to A are diverted to B, and the normal A anode current is correspondingly reduced, instead of increasing as it would normally upon increase of the potential of A. The circuit ACF thus possesses negative characteristics, and any circuit having positive resistance inserted in the ACF circuit will have its effective resistance lessened or even neutralised.

The diminution of A anode current due to diversion of electrons to the B anode may more than counteract the normal increase of A anode current due to increase of A anode potential, in which case the device acts as a negative resistance as stated above.

The diversion effect may be varied by altering the operating conditions (for example, the filament temperature) or suitably modifying the relative positions of the electrodes.

The arrangement shewn might be modified by breaking the ACF circuit as indicated between the points F^1, H and connecting the grid G with the point F^1 instead of as shewn in the fig. The oscillatory circuit or other circuit the positive resistance of which is to be reduced is now connected across the points F^1, H.

If it is desired to overcome the positive resistance in a conducting circuit it is only necessary to connect such a circuit in the A anode circuit. By connecting an external resistance circuit in the A anode circuit and making the positive resistance almost equal to the negative resistance the device will act as a very efficient voltage amplifier. If the external resistance be connected in parallel with the A anode circuit, the device will act as a current magnifier.

It is to be noted that the device operates entirely on the principle of the diversion to a second anode or anodes of electrons which would otherwise pass to the first anode A, and the same effect could not be produced by the use of two valves.

It may be desirable to use one battery in place of the two batteries C and D. It may also be desirable to include an adjustable resistance between the battery supplying a positive potential to A and the anode A itself.

A suitable wireless receiving circuit may be arranged by placing the receiving oscillatory circuit in series with the A anode circuit of the negatron. In addition, a pair of telephones shunted by a variable condenser may be included in series with the circuit.

Another useful circuit is obtained by taking the leads from the positive side of C and the anode A and connecting them across the control electrode and cathode of a simple three-electrode device wireless receiving circuit. This neutralises losses in the control electrode circuit of the three-electrode device.

The chief value of the negatron is in the production of electrical oscillations. The oscillatory circuit may be connected between the anode A and the positive side of a battery which supplies both anode circuits. The anode A is connected with the grid in such manner as to avoid a high positive grid potential.

In the above description, by the A anode circuit is normally meant the external path taken by electrons going to the A anode. Similarly, by B anode circuit is meant the external path taken by electrons going to the B anode.

While some methods of using the negatron have been suggested, many applications of the device will occur to those skilled in the art.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is :—

1. An electron discharge device or valve comprising an electron-emitting cathode and two or more anodes wherein a negative resistance effect is obtained by the diversion to one of the anodes of cathode emitted electrons which would otherwise pass to the other anode or anodes and the consequent reduction of current from the cathode to the first anode, substantially as described.

2. An electron discharge device or valve according to Claim 1, wherein a control electrode produces the diversion of electron current.

3. An electron discharge device or valve comprising an electron-emitting cathode, a control electrode and two

anodes so arranged and connected that an increase of potential of one of the electrodes is accompanied by a diversion of cathode-emitted electrons and a consequent decrease of cathode emitted electron current flowing from the cathode to one of the anodes, and conversely, substantially as described.

4. A negative resistance device consisting of a valve in which is an electron-emitting cathode, two anodes positive with respect to the cathode, so arranged and connected with suitable batteries or their equivalents that an increase of the first anode voltage results in a deflection to the second anode of electron current emitted from the cathode, which would normally pass to the first anode, thereby causing a decrease of cathode-emitted electron current between the cathode and the first anode.

5. A negative resistance valve as in Claim 4, in which the first anode or other suitable point in the first anode circuit is connected with a control electrode placed so that an increase of its potential would increase the current to the second anode, substantially as described.

6. A negative resistance arrangement as in Claims 4 and 5, in which the two anodes and the control electrode are of flat form, the control electrode taking the form of a grid placed between the cathode and the second anode, substantially as described.

7. Negative resistance devices substantially as described with reference to the accompanying drawing.

Dated this 29th day of June, 1920.

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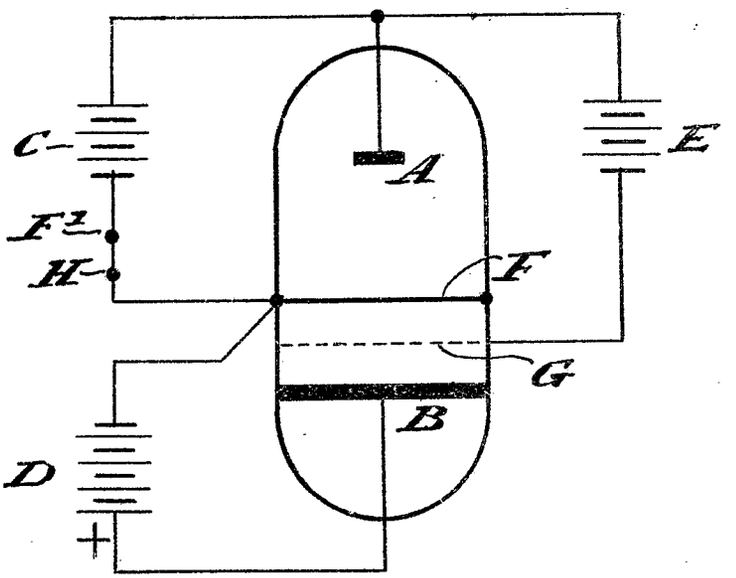

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