Oct. 17, 1950 L. H. PECK 2,525,938

ELECTROCHEMICAL APPARATUS WITH ADJUSTABLE ELECTRODE

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FIG. 1.

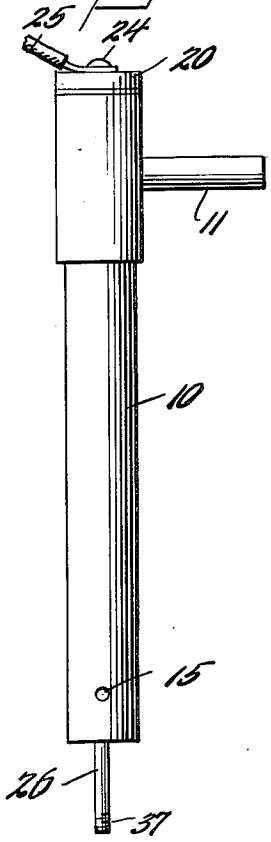


FIG. 3.

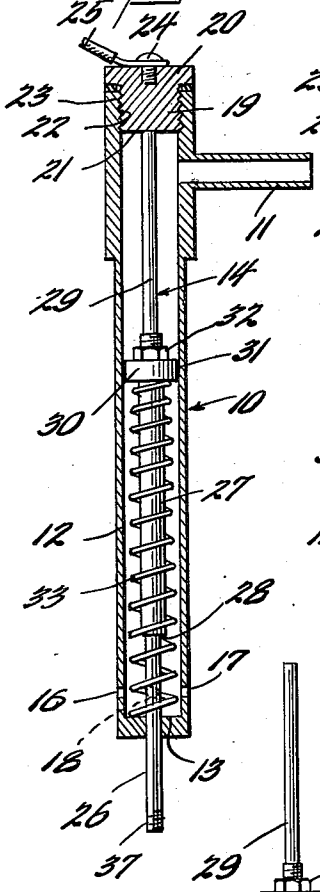


FIG. 5.

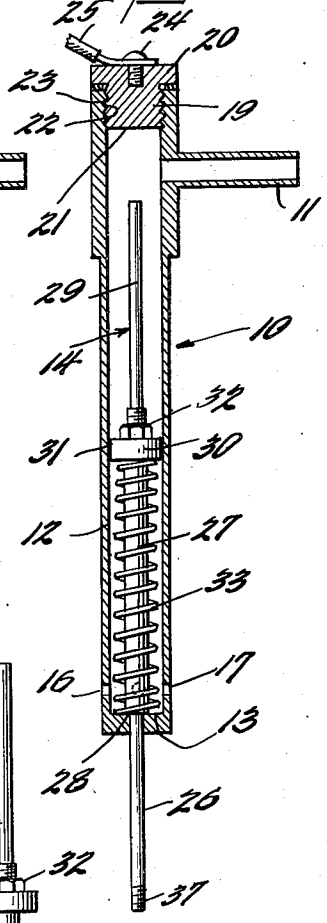


FIG. 2.

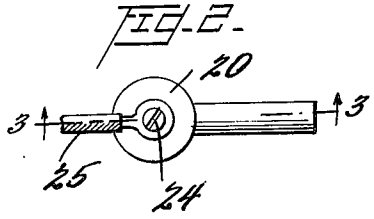
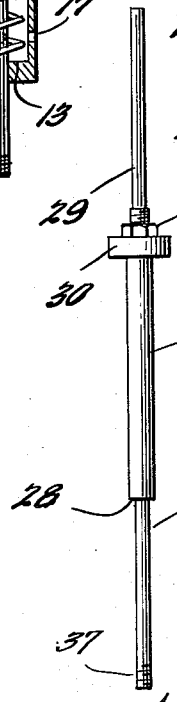


FIG. 4.



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ELECTROCHEMICAL APPARATUS WITH ADJUSTABLE ELECTRODE

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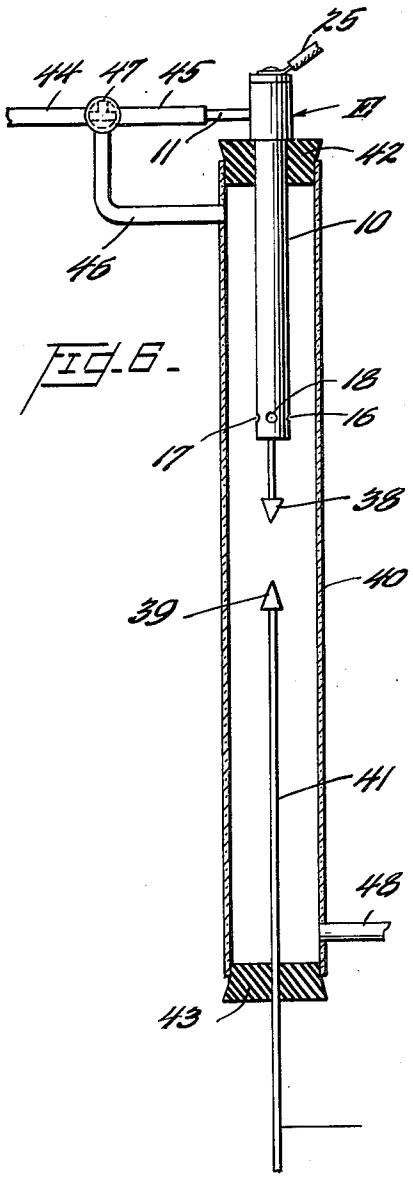


FIG. 6.

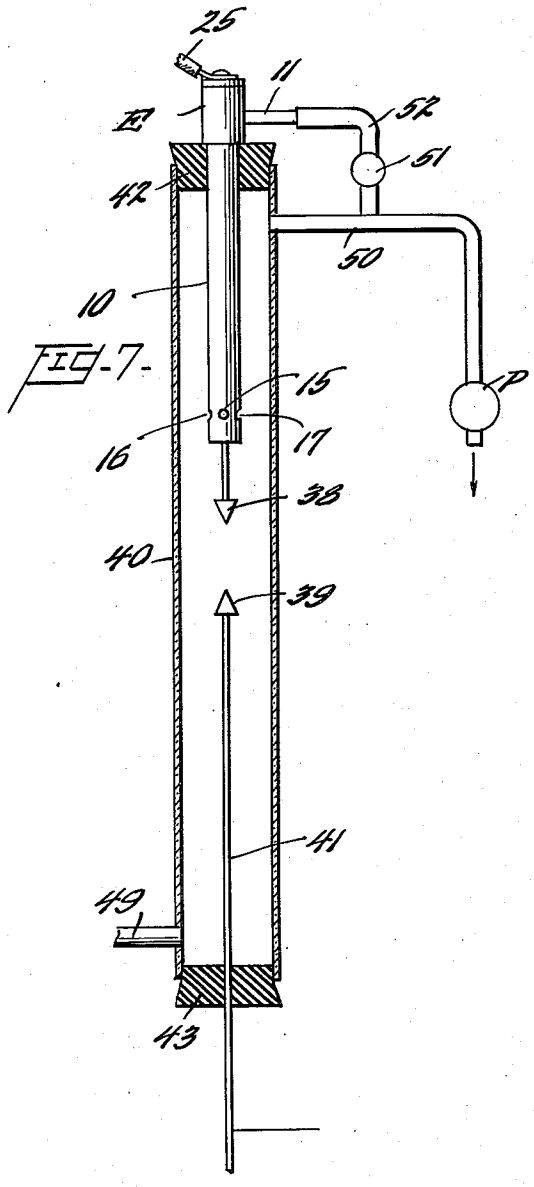


FIG. 7.

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ELECTROCHEMICAL APPARATUS WITH ADJUSTABLE ELECTRODE

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Application November 1, 1946, Serial No. 707,066

12 Claims. (Cl. 204—326)

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The present invention relates to an automatic or semi-automatic device for use in the striking or initiating of electrical discharges.

In the electrochemical transformation of a gaseous medium in the presence of an electrical discharge between a single pair of electrodes, it is necessary to strike or initiate the discharge using an appropriate striking voltage; for example, with a high frequency discharge of 2.1 megacycles, the striking voltage for a 17 mm. (millimeter) gap may be approximately 18,000 volts; whereas, after the discharge has been struck the active operating voltage is only about $\frac{1}{10}$ thereof or about 1800 volts. The figures given are for the production of hydrazine from ammonia in which the electrochemical transformation of the ammonia is carried out at super-atmospheric pressures, as for example, 770 mm.

In the manufacture of nitric oxide from atmospheric air at sub-atmospheric pressures, as for example, at 335 mm. pressure, for a 17 mm. gap, the striking voltage may approximate 2500 to 3000 volts. After the discharge is once struck, the active operating voltage may vary approximately between 1000 and 1200 volts.

It is well known that other conditions remaining constant, the striking voltage or breakdown voltage in a gaseous discharge is approximately proportionate to the gap distance, that is, the distance between cooperating electrode terminals between which the discharge is initiated. Therefore, if the gap between a cooperating pair of electrodes can be temporarily decreased at the time the discharge is struck, the striking voltage may be proportionately decreased, and if the gap be decreased so that the striking voltage does not exceed the normal operating voltage, the electrode discharge gap after the discharge is struck may be lengthened or drawn out to a desired predetermined gap which is the original electrode gap.

The principal object of the present invention is to provide a device for automatically or semi-automatically first decreasing the electrode gap between a pair of cooperating electrodes by causing the electrodes to be brought closer together, and then, thereafter, after the discharge has been struck, restoring the electrodes to their original predetermined position and to the original electrode gap predetermined to be the most desirable electrode gap for the particular material being electrochemically transformed under the other conditions of transformation.

Another object of the present invention is to provide a gas discharge apparatus for effecting

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the electrochemical transformation of a gaseous medium comprising the combination of a reactor vessel, a pair of electrode terminals positioned respectively on a pair of electrode members, said electrode members being capable of effecting an electrical discharge in said reactor, one of said electrode members and its electrode terminals being mounted on a piston provided with a plunger held in an initial predetermined position by any suitable means, as for example, spring means, said piston and plunger reciprocating in a casing to shorten the electrode gap between said electrode terminals and to restore the movable electrode terminal to its initial position or any other predetermined position, means being provided for introducing a gaseous medium into said casing while maintaining a relatively higher pressure above the plunger than therebelow to move the piston and its electrode terminal closer to the cooperating electrode and shorten the electrode gap between the electrode terminals so that the discharge therebetween may be effected under operating voltage instead of under higher striking voltage, there also being provided means for reducing the pressure differential between the pressures above and below the plunger to substantially zero, whereupon the returning means returns the reciprocating electrode to a predetermined position.

It is an additional object of the invention to provide means to leak gaseous medium from above the plunger to below the plunger to equalize the pressure above and below the plunger whereupon the returning means returns the reciprocating electrode to a predetermined position. While spring means may be employed to return the adjustable or reciprocating electrode other equivalent means may be employed.

It is an additional object of the present invention to provide an apparatus of the character set forth wherein the adjustable electrode is caused to reciprocate to shorten the electrode gap between its cooperating electrode by the application of a super-atmospheric pressure which may be just slightly above atmospheric pressure or may be considerably higher.

It is an additional object of the present invention to utilize a pressure lower than atmospheric to cause the adjustable electrode of the apparatus to reciprocate to shorten the electrode gap.

The invention will be described in connection with the accompanying drawing wherein

Figure 1 is the front elevation of the electrode gap adjusting device.

Figure 2 is a plan view thereof.

Figure 3 is a longitudinal cross sectional view taken on line 3—3 of Figure 2.

Figure 4 is a detail view of the plunger of the electrode gap adjusting device.

Figure 5 is a longitudinal sectional view showing the piston member of the electrode gap adjustor in its depressed condition adapted to position the electrode for the shortest electrode gap.

Figure 6 is a view partly in section of the electrode gap adjustor assembled with an electrical discharge reactor adapted to effect electrochemical transformation of a gaseous medium under super-atmospheric pressure.

Figure 7 is a similar view wherein the electrochemical transformation of the gaseous medium is effected at sub-atmospheric pressure.

Referring to the drawing, the electrode adjustor comprises a casing **10** provided with a member **11** which functions as an inlet member when operating under super-atmospheric pressure and as an outlet member when operating at sub-atmospheric pressure. The casing **10** is provided with an inner wall **12**, and at its lower extremity, it is provided with a bottom wall **13**, the latter acting to limit the travel stroke of the plunger **14** in a manner as hereinafter set forth. The casing adjacent its lower extremity is provided with a series of apertures **15**, **16**, **17**, and **18**, adapted to allow the gaseous medium which operates the device to escape from the casing while the piston **14** has been depressed. The casing at its upper portion is provided with a conductive cap **19** provided with a top wall **20** and a lower wall **21**, the latter functioning to limit the upward stroke of the piston **14**. The cap, which is externally threaded at **22** is screwed into the upper end of the casing which is provided with threads **23**. A binding post **24** adapted to receive the electrical connector **25** is connected with the upper wall member **20**.

The piston rod **14** is provided with a lower cylindrical portion **26**, an intermediate enlarged cylindrical portion **27**, and a top cylindrical portion **29**. The cylindrical portion **27** is provided with a shoulder **28** at its juncture with the piston rod portion **26**. The shoulder portion **28** serves as a stop to limit the downward stroke of the piston rod **14**.

Adjustably mounted on the piston rod **14** is the piston or plunger **30** which is held in a predetermined position by the screw nut **32**. The piston rod **14** below the plunger **30** is provided with a coil spring **33**. It is to be noted that the coils of the spring **33** are not of the same diameter throughout the spring, but that the coils of smaller diameter are at the top portion of the spring, and the coils gradually increase in diameter from the upper portion of the spring towards the lower portion of the spring. This is the preferred type of spring as it operates to exert its pressure at and adjacent the center of the plunger **30** instead of adjacent the periphery of the plunger **30**. When the spring pressure is exerted at and adjacent the periphery portion of the piston or plunger **30** there is a tendency for the piston to jam in the casing, and this is eliminated by the employment of a spring of the character set forth.

It is to be noted that preferably there is a small clearance between the outer surface **31** and the interior wall of the casing **10**. This clearance should be sufficient to allow the escape or leakage of gases past the piston plunger after the gas has acted to effect movement of the piston either in a downwardly or upwardly direction, depending on whether the activating gas is at super-atmospheric pressure or at sub-atmospheric pressure, respectively.

The lower portion of the piston member **26** is threaded at **37** and is adapted to receive the electrode terminal **38**. The piston rod **14**, including the lower portion **26**, acts as one electrode for the reactor **40** in which there is positioned a co-operating electrode terminal **39** and an electrode **41**.

The upper end of the reactor **40** is provided with an apertured closure member **42** preferably of a non-conducting material in which the electrode adjustor E is mounted. The lower end of the reactor is provided with a non-conducting closure member **43**.

Means are provided to introduce the gaseous medium to be electrochemically transformed into the reactor **40**, a suitable inlet means such as the conduit **44** being provided.

Connected to the inlet conduit **44** are branch lines **45** and **46**. At the junction of conduits **44**, **45**, and **46**, there is provided a three-way valve **47**. The conduit **45** is connected to the conduit **11** of the electrode adjustor E.

For operation under super-atmospheric conditions the hookup set forth in Fig. 6 is suitable. In starting operations the normal operation voltage, as for example 1800 volts, suitable for the production of hydrazine from ammonia is applied to the electrode terminals **38** and **39**. Thereafter the valve **47** is positioned so as to allow the gas to be transformed, such as ammonia, to pass by the way of the conduit **45** and conduit **11** into the interior of the electrode adjustor E where it acts upon the plunger **30** causing the piston rod **26** to move downwardly to the position shown in Figure 5 where the electrode terminal **38** is closely adjacent the electrode terminal **39**.

In the specific case set forth the electrode terminal **38** has been moved 16 mm. inwardly to within 1 mm. of the terminal **39**. With this shortened electrode gap the discharge strikes at a very low voltage, as for example, for the production of ammonia from hydrazine, at 1800 volts instead of 18,000 volts. As soon as the discharge has been effected the valve **47** is turned to cause the incoming gas to flow through the conduit **46** into the interior of the reactor **40** whereupon the pressure within the reactor causes the gas to flow through the small apertures **15**, **16**, **17**, and **18** into the interior of the casing **10** below the plunger **30**, thereby equalizing the pressures below and above the plunger **30**. When this occurs, the spring **33** forces the plunger upwardly and thereby causes the rod **26** to move upwardly and restore the electrode terminal **38** to its original predetermined position 17 mms. from the electrode terminal **39**, or to any other desired position.

In the above form of the invention when utilizing super-atmospheric pressure the operation is semi-automatic, and it is not necessary to have any substantial clearance between the exterior surface **31** of the plunger **30** and the interior wall of the casing **10**. However, in the form of the invention shown in Figure 7, the electrode gap adjustor may be made to function fully automatically by providing and utilizing a clearance space. The electrochemically transformed product passes from the reactor **40** through the conduit **50**.

Referring to Figure 7, the electrochemical transformation of the gaseous medium is carried out under sub-atmospheric pressure, as for ex-

ample, under a pressure of 335 mm. when electrochemically transforming atmospheric air to nitrogen oxide.

The reactor 40 is provided with an inlet conduit 49 and an outlet conduit 50 connected to the vacuum pump P. A by-pass conduit 52 is connected to the conduit 11 of the electrode adjustor E and to the outlet 50 via the valve 51.

In operation the normal operating voltage, as for example, 1000 to 1200 volts, is applied to the electrode connector 25 and the electrode 41. The applied voltage is, as stated, the operating voltage of 1000 to 1200 volts, and not the striking voltage of 5000 to 6000 volts which would be required if the electrode adaptor E were not utilized.

Thereafter, the vacuum generated by the vacuum pump P is applied to the conduit 50, the valve 51 being so set as to disconnect the by-pass conduit 52. As soon as this vacuum is established, atmospheric air to be transformed enters the reactor 40 by means of the conduit 49, and the vacuum is communicated to the interior of the casing 10 via the apertures 15, 16, 17, and 18. The gaseous medium under a vacuum pulls the plunger downwardly compressing the spring 33 and forcing electrode terminal 38 inwardly 16 mms. to within 1 mm. of the electrode terminal 39. After the discharge has been struck, the electrode 38 is brought back to its predetermined normal position in the following manner which is automatic.

As previously stated, there is a clearance between the periphery of the piston 30 and the interior wall of the casing 10. The air in the casing 10 above the plunger 30 before the plunger moved downwardly under the action of the vacuum is at atmospheric pressure and is at all times at a pressure higher than that existing in the gaseous medium below the plunger. As soon as the plunger 30 is pulled downwardly on application of the vacuum the discharge strikes, and the leakage of the gaseous medium from the space above the plunger to the space below the plunger is initiated, thus starting the reverse or upward movement of the plunger. The time for the reversal is dependent upon the tension of the spring and the clearance of the plunger.

When operating as herein set forth, the time of reversal may take about 10 seconds. It is desired to point out, however, that it is not desired to be limited to this time period as the time period can be adjusted to any desired reversal time by the tension of the spring and the clearance between the plunger 30 and the interior wall of the casing 10.

It is to be noted that the operation as above set forth is fully automatic and the valve 51 remains positioned as shown in Figure 7. If a quick reversal is required the valve 51, which is normally closed, is momentarily opened, whereupon the pressures above and below the plunger are rapidly equalized as, for example, in a fraction of a second. In this case the operation is semi-automatic.

Referring to Figure 6, a gaseous medium under a pressure varying from 770 mm. to 800 mm. is introduced into the casing 10 above the plunger 30, and then the arc is struck at the normal operating voltage which as stated, is much lower than the usual striking voltage. Thereafter, the same gas or a different gas is introduced by a conduit 46 and passes through the openings 15, 16, 17, and 18 into the casing below the piston. Upon the pressure being equalized, the piston 30 is caused to travel upwardly under the influence of the spring 33 which has been compressed during the downward stroke of the piston. Instead of using the same pressures above and below the piston 30 to operate the piston in the manner above set forth after the plunger 30 has once been depressed, the gas introduced below the piston may have a higher pressure in pounds per sq. in. than the gas above the piston which had been previously introduced via conduits 45 and 11. The point is that in order to bring the electrode terminal to its initial position the pressure below the piston must be equal to or higher than the pressure above the piston.

When operating under a vacuum in accordance with the form of the apparatus shown in Figure 7, the casing 10, before operations are started, has air or other gas present therein at atmospheric pressure, and the valve 51 is closed. The operations are started, and the normal operating voltage is applied between the electrode terminals 38 and 39. Thereafter with the valve 51 closed, the vacuum is applied in the manner hereinbefore set forth.

It is desired to point out that in the form of the apparatus shown in Figure 7, instead of having a gas at atmospheric pressure in the casing 10 above the plunger 30, the gas may be at below atmospheric pressure and a gas at a pressure still lower than the pressure of the gas in the casing above the piston may be introduced into the casing below the piston to cause the piston to operate. The point, again, is that even when operating under a vacuum all that is necessary is that there be a difference in pressure above and below the piston in order to activate the piston and shorten the electrode gap. After the electrode gap has been shortened, the pressure is equalized, and upon equalization, the spring 33 effects return of the adjustable electrode to a predetermined position.

The difference in pressures must be sufficient to overcome the pressure exerted by the upward thrust of the spring.

I claim:

1. In an electrode gap adjustor, the combination of a casing having an interior chamber, a top end wall, and an apertured lower end wall, a piston carrying a plunger intermediate its upper and lower end, the latter being provided with an electrode terminal, said piston reciprocating in said chamber through the apertured lower end member, stop means on said piston and reciprocating therewith, auxiliary cooperating stop means in said casing for limiting the forward stroke of the piston to the distance it is desired to move the electrode terminal, spring means in said casing positioned to assist in returning the plunger, the piston, and the electrode terminal after completion of the forward stroke of the piston, means to limit the upward travel of the piston and the electrode terminal, and means for effecting reciprocation of the plunger in the chamber casing including an opening in the casing below the plunger.

2. In an electrode gap adjustor, the combination of a casing having an interior chamber, a top end wall, and an apertured lower end wall, a piston carrying a plunger intermediate its upper and lower end, the latter being provided with an electrode terminal, said piston reciprocating in said chamber through the apertured lower end, a clearance space between said plunger and the interior wall of the casing chamber, stop means on said piston and reciprocating therewith, auxiliary cooperating stop means in said casing for limiting the forward stroke of the

piston to the distance it is desired to move the electrode terminal, spring means in said casing positioned to assist in returning the plunger, the piston, and the electrode terminal after completion of the forward stroke of the piston, means to limit the upward travel of the piston and the electrode terminal, and means for effecting reciprocation of the plunger in the chamber casing including an opening therein.

3. In an electrode gap adjustor, the combination of a casing having an interior chamber, a removable upper cap having an interior bottom wall and an apertured lower end wall, the interior wall of which acts as a stop member, a piston carrying a plunger intermediate its upper and lower end, the latter being provided with an electrode terminal, said piston reciprocating in said chamber through the apertured lower end wall, stop means on the piston and reciprocating with the piston, said stop means abutting the interior lower end wall and limiting the forward stroke of the piston the distance it is desired to move the electrode terminal, spring means positioned in said casing below said plunger to assist in returning the plunger, the piston, and the electrode terminal after completion of the forward stroke of the piston, means to limit the upward travel of the piston and electrode terminal comprising the interior bottom wall of the cap member, and means for effecting reciprocation of the plunger in the chamber casing, including an opening in the casing below the plunger.

4. In an electrode gap adjustor, the combination of a casing having an interior chamber, a removable upper cap having an interior bottom wall and an apertured lower end wall, the interior wall of which acts as a stop member, a piston carrying a plunger intermediate its upper and lower end, the latter being provided with an electrode terminal, said piston reciprocating in said chamber through the apertured lower end wall, stop means on the piston and reciprocating with the piston, said stop means abutting the interior lower end wall and limiting the forward stroke of the piston the distance it is desired to move the electrode terminal, spring means positioned in said casing below said plunger to assist in returning the plunger, the piston, and the electrode terminal after completion of the forward stroke of the piston, means to limit the upward travel of the piston and electrode terminal comprising the interior bottom wall of the cap member, and means for effecting reciprocation of the plunger in the chamber casing, including a plurality of small openings positioned circumferentially of the casing adjacent its lower end.

5. In an electrode gap adjustor, the combination of a casing having an interior chamber, a removable upper cap having an interior bottom wall and an apertured lower end wall, the interior wall of which acts as a stop member, a piston carrying a plunger intermediate its upper and lower end, the latter being provided with an electrode terminal, said piston reciprocating in said chamber through the apertured lower end wall, stop means on the piston and reciprocating with the piston, said stop means abutting the interior lower end wall and limiting the forward stroke of the piston the distance it is desired to move the electrode terminal, spring means positioned in said casing below said plunger to assist in returning the plunger, the piston, and the electrode terminal after completion of the forward stroke of the piston, means to limit the upward travel of the piston and electrode terminal comprising the interior bottom wall of the cap member, means for effecting reciprocation of the plunger in the chamber casing, including an opening in the casing below the plunger, and means to leak gaseous medium from above the plunger to below the plunger to equalize the pressure above and below the plunger.

6. In an electrode gap adjustor, the combination of a casing having an interior chamber, a removable upper cap having an interior bottom wall and an apertured lower end wall, the interior wall of which acts as a stop member, a piston carrying a plunger intermediate its upper and lower end, the latter being provided with an electrode terminal, said piston reciprocating in said chamber through the apertured lower end wall, stop means on the piston and reciprocating with the piston, said stop means abutting the interior lower end wall and limiting the forward stroke of the piston the distance it is desired to move the electrode terminal, spring means positioned in said casing below said plunger to assist in returning the plunger, the piston, and the electrode terminal after completion of the forward stroke of the piston, means to limit the upward travel of the piston and electrode terminal comprising the interior bottom wall of the cap member, means for effecting reciprocation of the plunger in the chamber casing, including a plurality of small openings positioned circumferentially of the casing adjacent its lower end, and means to leak gaseous medium from above the plunger to equalize the pressure above and below the plunger.

7. In a gas-discharge apparatus for effecting electrochemical transformation of a gaseous medium under super-atmospheric pressure, the combination of a reactor vessel, a pair of electrode terminals positioned respectively on a pair of electrode members, said electrode terminals being capable of effecting an electrical discharge in said reactor, one of said electrode members and its electrode terminal being mounted on a piston reciprocating in a casing to vary the electrode gap between said electrode terminals, means for introducing a gaseous medium under pressure into said casing to move said piston and its electrode terminal closer to the cooperating terminal and initiate a discharge between the electrode terminals at a lower operating voltage than is required in the absence of the shortening of the electrode gap, means for introducing a gaseous medium to be transformed into the reactor vessel under super-atmospheric pressure, means including an opening in the casing for returning the reciprocating electrode to a predetermined position, and means for removing the transformed reaction product from the reactor vessel.

8. In the gas-discharge apparatus for effecting the electrochemical transformation of a gaseous medium under super-atmospheric pressure, the combination of a reactor vessel, a pair of electrode terminals positioned respectively on a pair of electrode members, said electrode members being capable of effecting an electric discharge in said reactor, one of said electrode members and its electrode terminals being mounted on a piston provided with a plunger held in an initial predetermined position by spring means, said piston and plunger reciprocating in a casing to shorten the electrode gap between said electrode terminals, means including an opening in the casing for introducing a gaseous medium under pres-

sure into said casing to move said piston and its electrode terminal closer to its cooperating terminal, and shorten the electrode gap between said terminals and initiate a discharge between the electrode terminals at a lower operating voltage than is required in the absence of the shortening of the electrode gap, means including an opening in the casing for introducing a gaseous medium into the reactor vessel under super-atmospheric pressure and into the casing below said plunger whereupon the pressure below and above the plunger becomes equalized and the spring means returns the reciprocating electrode to a predetermined position, and means for removing a gaseous product from the reaction vessel.

9. In the gas-discharge apparatus for effecting the electrochemical transformation of a gaseous medium, the combination of a reactor vessel, a pair of electrode terminals positioned respectively on a pair of electrode members, said electrode members being capable of effecting an electric discharge in said reactor, one of said electrode members and its electrode terminals being mounted on a piston provided with a plunger held in initial predetermined position by spring means, said piston and plunger reciprocating in a casing to shorten the electrode gap between said electrode terminals, means for introducing a gaseous medium under a vacuum into the reactor vessel, an opening in said casing for introducing gaseous medium therein to move said piston and its electrode terminal closer to the cooperating electrode terminal and shorten the electrode gap between said electrode terminals and initiate a discharge between the electrode terminals at a lower operating voltage than is required in the absence of the shortening of the electrode gap, means for equalizing the pressure of the gaseous medium above and below the piston plunger, means acting upon said equalization of pressure for returning the reciprocating electrode terminal to a predetermined position, and means for removing the gaseous product from the reactor vessel.

10. In a gas-discharge apparatus for effecting the electrochemical transformation of a gaseous medium, the combination of a reactor vessel, a pair of electrode terminals positioned respectively on a pair of electrode members, said electrode members being capable of effecting an electric discharge in said reactor, one of said electrode members and its electrode terminals being mounted on a piston provided with a plunger held in an initial predetermined position by spring means, said piston and plunger reciprocating in a casing, to shorten the electrode gap between said electrode terminals, means for introducing a gaseous medium under a vacuum into the reactor vessel, an opening in said casing for introducing gaseous medium therein, to move said piston and its electrode terminal closer to the cooperating electrode terminal and shorten the electrode gap between said electrode terminals and initiate a discharge between the electrode terminals at a lower operating voltage than is required in the absence of the shortening of the electrode gap, means for removing the gaseous product from the reactor vessel, means to leak gaseous medium from above the plunger to below the plunger to equalize the pressure above and below the plunger whereupon the spring means returns the reciprocating electrode to a predetermined position, and means for removing the gaseous product from the reactor vessel.

11. In a gas-discharge apparatus for effecting the electrochemical transformation of a gaseous medium, the combination of a reactor vessel, a pair of electrode terminals positioned respectively on a pair of electrode members, said electrode members being capable of effecting an electric discharge in said reactor, one of said electrode members and its terminals being mounted on a piston provided with a plunger held in an initial predetermined position by spring means, said piston and plunger reciprocating in a casing to shorten the electrode gap between said electrode terminals, an opening in said casing, means for introducing a gaseous medium through said opening into said casing, while maintaining a relatively higher pressure above the plunger than below, to move the piston and the electrode terminals against the spring means and bring said electrode terminal closer to its cooperating terminal, to thereby shorten the electrode gap between said terminals and initiate a discharge between the electrode terminals at a lower operating voltage than is required in the absence of the shortening of the electrode gap, means for reducing the pressure differential above and below the plunger to substantially zero, whereupon the spring means returns the reciprocating electrode to a predetermined position, and means for removing the gaseous product from the reactor vessel.

12. In the gas-discharge apparatus for effecting the electrochemical transformation of a gaseous medium, the combination of a reactor vessel, a pair of electrode terminals positioned respectively on a pair of electrode members, said electrode members being capable of effecting an electric discharge in said reactor, one of said electrode members and its electrode terminals being mounted on a piston provided with a plunger held in initial predetermined position by spring means, said piston and plunger reciprocating in a casing to shorten the electrode gap between said electrode terminals, means for introducing a gaseous medium into the reactor vessel, an opening in said casing for introducing gaseous medium therein while maintaining a relatively higher pressure above the plunger than below, to move said piston and its electrode terminal closer to the cooperating electrode terminal and initiate a discharge between the electrode terminals at a lower operating voltage than is required in the absence of a shortening of the electrode gap, means for equalizing pressure of the gaseous medium above and below the piston plunger, means acting upon said equalization of pressure for returning the reciprocating electrode terminal to predetermined position and means for removing a gaseous product from the reactor vessel.

LEE H. PECK.

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