

No. 846,672.

PATENTED MAR. 12, 1907.

F. J. KOCH.

HIGH PRESSURE ELECTRICAL APPARATUS.

APPLICATION FILED JAN. 24, 1906.

2 SHEETS—SHEET 1.

Fig. 1.

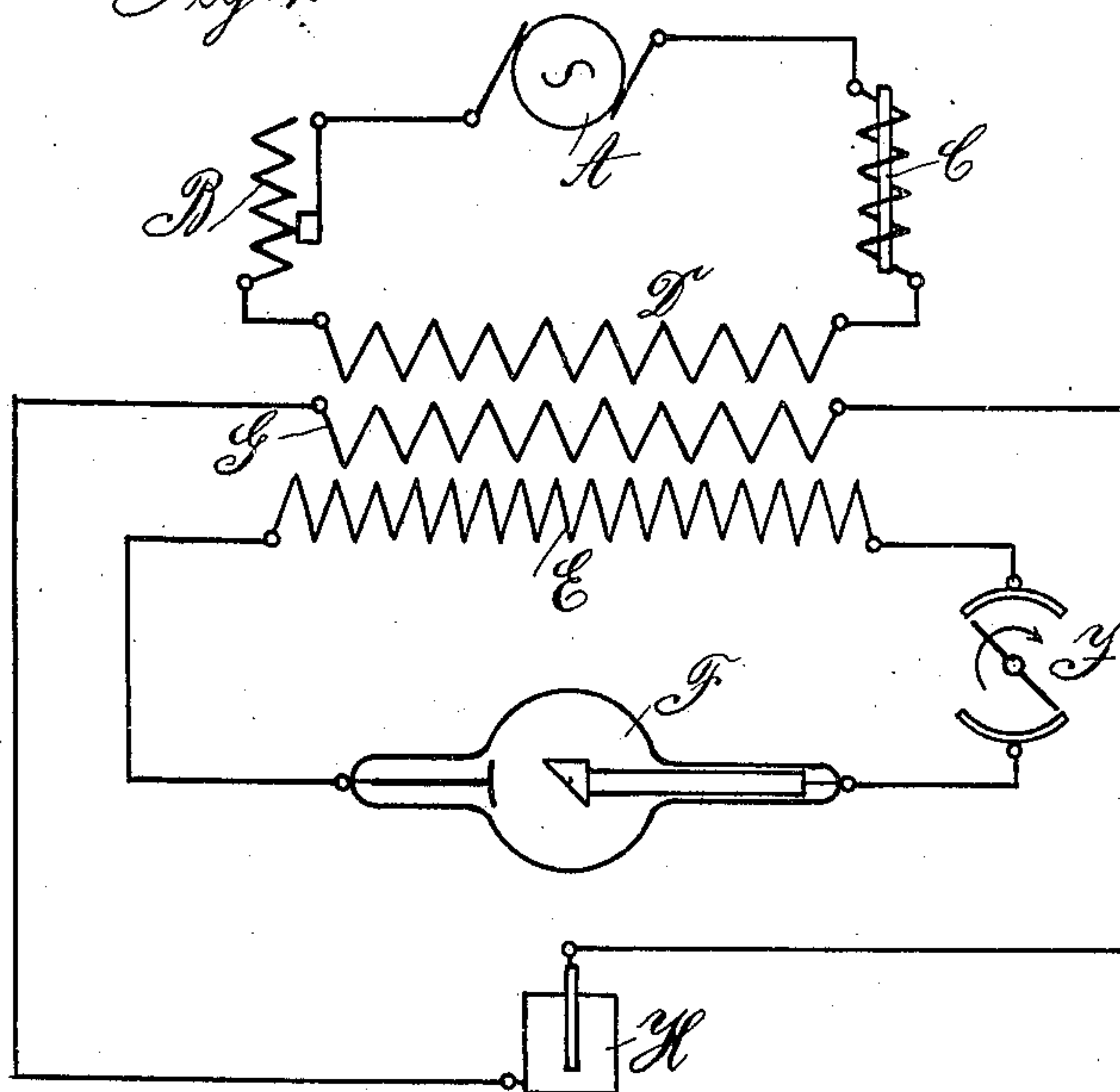
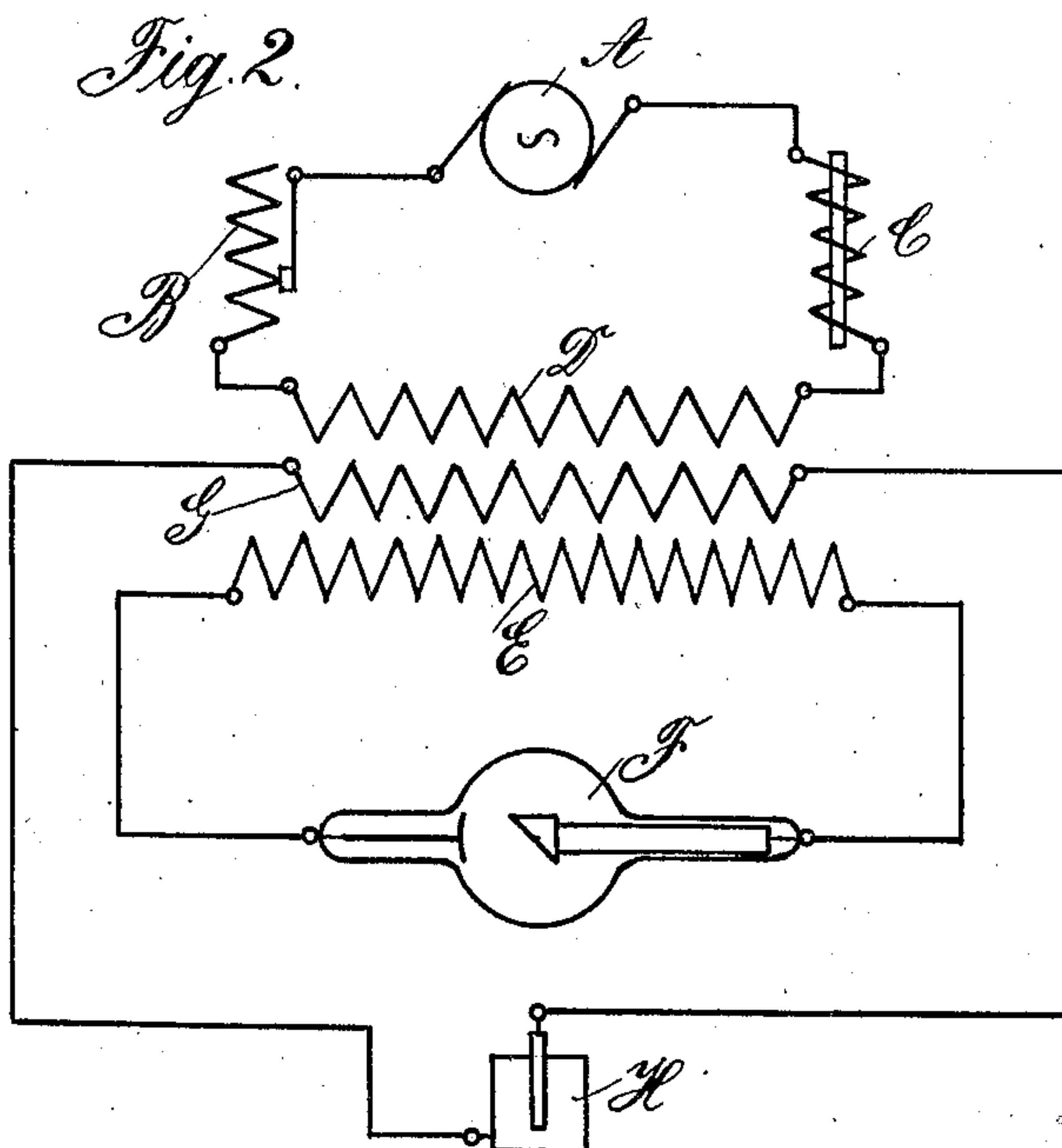


Fig. 2.



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2 SHEETS—SHEET 2

Fig. 3.

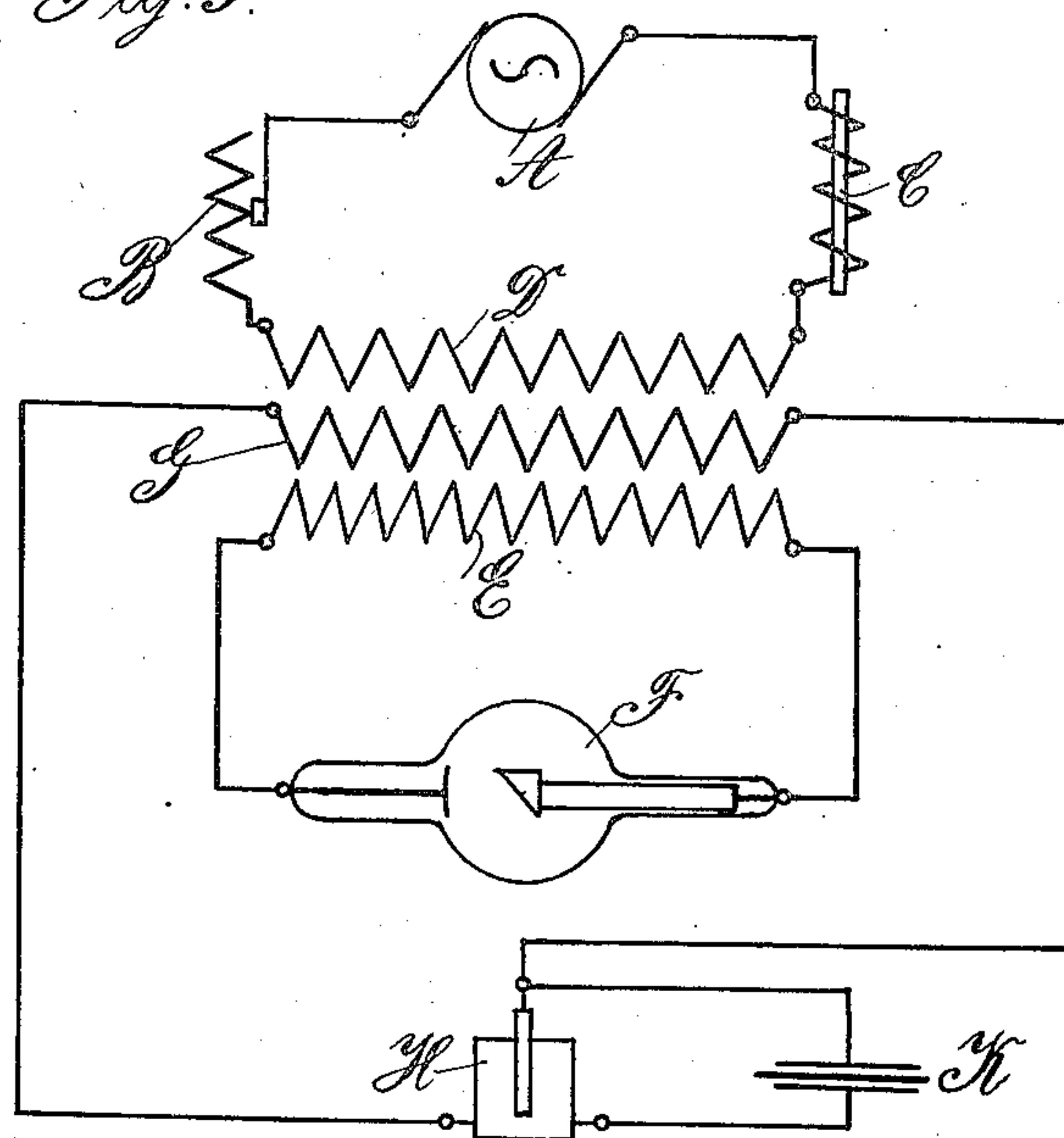
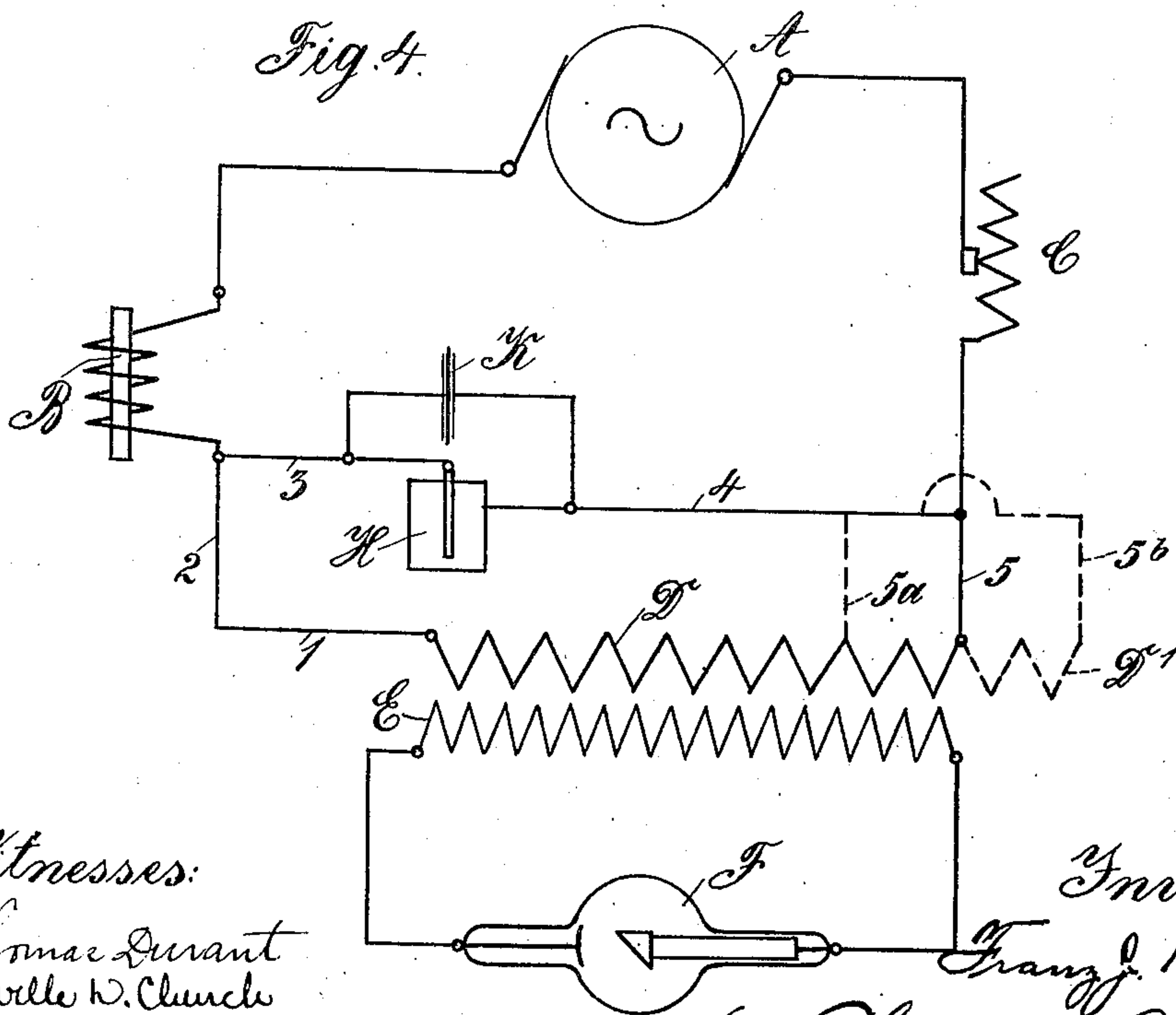


Fig. 4.



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HIGH-PRESSURE ELECTRICAL APPARATUS.

No. 846,672.

Specification of Letters Patent.

Patented March 12, 1907.

Application filed January 24, 1906. Serial No. 297,713.

To all whom it may concern:

Be it known that I, FRANZ JOSEPH KOCH, a subject of the King of Saxony, and residing at Dresden A., Saxony, in the Empire of Germany, have invented certain new and useful Improvements in High-Pressure Electrical Apparatus, of which the following is a specification.

When high-pressure apparatus, more particularly Rontgen tubes, are worked by means of sections of the same sign of an alternating current obtained by high-transfer motion in such manner that by means of a synchronous mechanical high-pressure interrupter or by means of a valve device, (for instance, the so-called "valve-cell,") or by means of a Rontgen tube, specially arranged for the purpose in the secondary high-pressure circuit, every second wave is omitted, then during the second omitted wave free pressures are produced, the upper point of which passes far beyond that of the pressures utilized. These free pressures not only decompose air by radiation and put a very high strain on the insulation of the wires, but they also put greater demands on the interrupter or on the valve device, as in both kinds of devices not only the pressures desired, but also the free pressures far exceeding the same have to be considered. If a rotating high-pressure interrupter is used, the consideration of the free pressures makes it necessary considerably to increase the diameter in order to obtain sufficiently large gaps between the contact parts, reliably preventing their jumping by the free pressures. When a valve device is used, it is clear that a great demand is placed on the valve action—that is to say, on the differential behavior—as regards pressures of different signs if the pressure to be kept out is higher than the pressure that is to be allowed to pass. This of course applies also when a Rontgen tube of special construction is to be used as a valve.

In order to work with purely continuous current, apparatus driven by primary continuous current and spark-inductor have already been provided with a secondary auxiliary circuit in order rhythmically to short-circuit it by means of a mechanical interrupter at the periods of rest of the secondary consumption-circuit. This secondary auxiliary circuit has not, however, been used yet with alternating current for suppressing or reducing the free pressure in such manner

that the secondary auxiliary circuit is opened and closed by a synchronously - working interrupter. It has, however, been found that this was not possible, owing already to the fact that the interrupter could not follow the fluctuations of the angle of phase due to the load on the secondary consumption-circuit and to the size of resistances switched at times into the primary circuit, and required continuous regulation of its angle of phase relatively to the pressure in the circuit, which, however, was not practically possible. Without such a regulation, owing to the premature closing and more particularly opening, light-arcs would be produced which owing to the small pressure and correspondingly great intensity of current would have an injurious action on the contact parts. It is, however, necessary to work with small pressure and correspondingly large intensity of current in the auxiliary circuit if it is desired to avoid the complication and expense of a second high-pressure winding for the auxiliary circuit.

This invention enables the free pressures of undesired sign to be reduced, while the construction remains a practical one, by means of auxiliary secondary circuit in alternating-current working by closing the auxiliary secondary circuit over an electric valve device, (preferably an electrolytic valve-cell.) The valve device, the use of which would again be impossible in the continuous current and inductor working, as, apart from other reasons, it could not act, on account of the great differences in pressure, makes a perfect working possible in this case, owing to the absence of such differences of pressure in the auxiliary circuit, as it automatically adapts itself to the fluctuations of the angle of phase. It works; moreover, with smaller loss of energy in the working periods of the auxiliary circuit.

The working of the auxiliary circuit controlled by the valve device is such that by short-circuit loading of the transformer during the period of the non-desired current-waves, the pressure at the terminals of the primary coil, and in accordance with the ratio of transformation, also of course the (injurious non-desired) pressure induced in the secondary coil of the consumption-circuit, are considerably reduced. This action takes place only if an ohm or inductive resistance or both kinds of resistances are

switched into the primary coil of the transformer. Without a resistance it would be impossible temporarily to reduce the pressure of the primary coil in spite of the heavy load of the transformer, as the pressure would be maintained by the circuit, which in this connection has to be considered as inexhaustible. On the contrary, the resistance switched in enables, as is well known, the primary pressure of a transformer to be temporarily reduced by putting on the latter the load due to the shifting in the distribution of the fall of pressure in the primary circuit taking place when this is done. As the injurious free pressures are reduced the radiation and the difficulties of the insulation in the auxiliary consumption-circuit are reduced.

If a synchronously-working high-pressure interrupter (with metallic contact or rhythmically-changing spark-gaps) is used in the consumption-circuit, it can be made much smaller, as it is no longer necessary to take into consideration the free pressures. It must be pointed out with reference to what has been said as to the uselessness of a mechanical interrupter in the auxiliary circuit that the difficulties in question disappear when the said interrupter is used in the consumption-circuit, as owing to the very high pressure and negligibly small intensity of current any light-arcs formed would be harmless, so that it is possible to use a high-pressure interrupter without metallic contact. If instead of the mechanical interrupter a valve device is used in the secondary consumption-circuit, the valve action will become all the more reliable, owing to the reduction of the undesired pressure. By means of the auxiliary device, according to this invention, the pressures of undesired sign can, however, be reduced to such an extent that they would not pass at all through the consumption apparatus (Röntgen tube) built for a given initial or breaking-through pressure. In this way it is no longer necessary to use at all synchronous interruption in the consumption-circuit. No mechanical interrupter nor any special valve device are necessary in this high-pressure circuit, and all difficulties of excluding the undesired pressure disappear. It is only necessary to have a valve device in the auxiliary secondary circuit. For these reasons this invention is useful not only where current-waves of one and the same sign can be used in the consumption-circuit—that is to say, where the current-waves of undesired sign must be excluded. It can also be used, owing to its simplicity, in many cases in which hitherto currents of both signs were used and the waves of one sign were rectified by a rather complicated construction.

The invention thus far described can, however, be modified also in such way that not

only free pressures of undesired sign will be reduced, but also the useful pressure in the consumption-circuit increased. This increase of the useful pressure in the operative periods of the secondary consumption-circuit is effected by resonance action, the auxiliary circuit in coöperation with the self-induction device (choking-coil) switched into the primary circuit as resistance being utilized for producing this resonance action. To that end either the valve-cell, switched into the auxiliary circuit, is converted into a resonant capacity by suitable tuning—that is to say, by corresponding dimensioning of the size of the electrodes, or a separate capacity (condenser) is switched into the auxiliary secondary circuit parallel to the valve device. The invention can also be carried out in such way that a separate secondary coil for the auxiliary circuit will become unnecessary, the valve-cell or the valve-cell and the condenser being switched over the primary coil.

The accompanying drawings show some constructions according to this invention in the usual diagrammatic way.

Figure 1 shows connection with a high-pressure interrupter in the secondary consumption-circuit. Fig. 2 is a connection diagram without separate interruption in the secondary consumption-circuit. Fig. 3 is a connection diagram with a resonant capacity in the auxiliary circuit; Fig. 4, a connection diagram without separate secondary coil for the auxiliary circuit and with resonant capacity in the auxiliary circuit.

Throughout these figures, A is a source of alternating current, B an ohm-resistance, C an induction-resistance (self-induction arrangement choking-coil) in the primary circuit, D the primary coil, E the secondary coil of the consumption-circuit, F the consumption apparatus, (Röntgen tube,) G secondary coil of the auxiliary circuit, (in as far as there is such one,) H the valve-cell in the auxiliary circuit. The valve-cell H is arranged in all the cases in such manner that it does not let through current of the sign not desired in the secondary consumption-circuit—that is to say, short-circuits the auxiliary circuit during the passage of a current of a sign which is not desired in the consumption apparatus F. In this way, with the simultaneous existence of the resistances B and C (or only one of them) in the primary circuit, the transformer is strongly loaded by the short-circuiting of the secondary auxiliary circuit and the terminal pressure of the primary circuit reduced. This reduction of the terminal pressure of the primary coil D has also for its result that the undesired pressure induced in the secondary coil E of the consumption-circuit and passing into the consumption apparatus is considerably reduced.

As shown in Fig. 1, the synchronously-rotating mechanical interrupter J is switched into the secondary consumption-circuit, so that the consumption-circuit is opened during the passage of pressure of the undesired sign. The interrupter J could be replaced by a high-pressure valve or a Rontgen tube acting simultaneously as a valve in the consumption-circuit. A mechanical interrupter or a high-pressure valve could, however, be entirely done away with, as shown in Fig. 2. For the Rontgen tube is impermeable for pressures which are below a given limit, (breaking-through pressure.) If, therefore, the undesired pressure is reduced according to this invention to such an extent that it is below the breaking-through pressure of the consumption apparatus, there is not need for any separate valve device for the consumption-circuit. This applies, of course, also to consumption apparatus other than Rontgen tubes, provided, however, that they admit current only after it exceeds a certain pressure.

As shown in Fig. 3, a capacity (or condenser) K is arranged in shunt on the valve-cell H. As long as the valve-cell H admits current of the sign which is not desired in the consumption-circuit—that is to say, the secondary coil G of the auxiliary circuit is loaded—the capacity K remains short-circuited, and the pressure between the terminals of the primary coil D falls to a considerable extent, owing to the inductive resistance of the choking-coil C. During the passage of current of the opposite sign—that is to say, of the sign which is desired in the consumption-circuit, which current does not pass through the valve-cell H—there is no consumption of energy by the secondary coil G. As the secondary coil E of the consumption-circuit remains temporarily—that is to say, until the future moment at which the breaking-through pressure of the Rontgen tube F will be overcome without a load on it and only the idle working current passes through the choking-coil C, a very small fall of pressure takes place between the terminals of the primary coil D. Under the circumstances a resonance action takes place, assuming, of course, that the capacity, magnetically coupled and connected in series with the choking-coil C, is adjusted in such manner that it can harmonize with it. Owing to this resonance, the pressure between the terminals of the primary coil D is considerably increased, and consequently there is also a considerable increase of the pressure induced by the primary coil D in the secondary coil E. In many cases the switching in of a separate capacity is, however, superfluous, as it is possible to give the electrolytic cell H, by suitable dimensioning of the size of its electrodes, such capacity relatively to the choking-coil D that the valve-cell is resonant in the man-

ner desired. The suitable proportion must be of course partly calculated and partly determined empirically in every single case.

The object of the invention can also be attained by the use of the so-called "economical" connection, as illustrated in Fig. 4. This connection in addition to the reduction of the cost of the device, has even the advantage that the desired secondary continuous-current effect is attained in a still better and more perfect manner. By the suppression of the auxiliary secondary winding G the ohm resistance and with it the weakening of the electric oscillation system becomes considerably smaller.

If we follow at first the full lines in Fig. 4 we shall see that shunted over the terminals of the primary coil D there is the valve-cell H and then parallel to H the capacity K. The primary coil D serves, therefore, simultaneously as a secondary coil for the auxiliary circuit formed by the wires 1 2 3 4 5. Instead of the full primary coil a portion of the windings can be got into this auxiliary circuit, as shown by dotted connection-wire 5^a. Conversely the primary coil could be increased by additional windings D', which are not operative in the primary circuit, but are drawn into the auxiliary circuit by the connection-wire 5^b. It depends on the size of the electrodes which of the three contingencies is used.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In high-pressure electrical apparatus the combination of a primary alternating-current circuit, a primary coil in said circuit, resistance in the primary circuit, a secondary consumption-circuit, a secondary coil in said secondary circuit an electrical apparatus to be worked said apparatus having a certain breaking-through pressure, a secondary auxiliary circuit, a secondary coil in said auxiliary circuit and means for letting through current not desired in the secondary consumption-circuit said means stopping the current of the sign desired in the consumption-circuit.

2. In high-pressure electrical apparatus the combination of a primary alternating-current circuit, a primary coil in said circuit, resistance in the primary circuit, a secondary consumption-circuit, a secondary coil in said secondary circuit, a high-pressure valve device arranged in the secondary consumption-circuit, an electrical apparatus to be worked said apparatus having a certain breaking-through pressure, a secondary auxiliary circuit, a secondary coil in said auxiliary circuit and means for letting through current not desired in the secondary consumption-circuit said means stopping the current of the sign desired in the consumption-circuit.

3. In high-pressure electrical apparatus the combination of a primary alternating-

current circuit, a primary coil in said circuit a self-induction device in the primary circuit, a secondary consumption-circuit, a secondary coil in said secondary circuit, an electrical apparatus to be worked said apparatus having a certain breaking-through pressure, a secondary auxiliary circuit, a secondary coil in said auxiliary circuit and an electric valve device adapted to coöperate with the self-induction device of the primary circuit and increase the pressure in the secondary consumption-circuit during the passage of current of desired sign and to reduce the pressure during the passage of current of undesired sign.

4. In high-pressure electrical apparatus the combination of a primary alternating-current circuit, a primary coil in said circuit, a self-induction device in the primary circuit, a secondary consumption-circuit, a secondary coil in said secondary circuit, an electrical apparatus to be worked said apparatus having a certain breaking-through pressure, a secondary auxiliary circuit, a secondary coil in the auxiliary circuit, an electric valve device in the auxiliary circuit and a condenser in said circuit adapted to coöperate with the self-induction device in the primary circuit and increase the pressure in the secondary consumption-circuit during the passage of a current of the desired sign and reduce the pressure during the passage of current of undesired sign.

5. In high-pressure electrical apparatus the combination of a primary alternating-current circuit, a primary coil in said circuit, resistance in the primary circuit, a secondary consumption-circuit, a secondary coil in said

secondary circuit, an electrical apparatus to be worked said apparatus having a certain breaking-through pressure, a secondary auxiliary circuit, a secondary coil in said auxiliary circuit, said coil consisting of windings of the primary coil and adapted to form a by-path and means for letting through current not desired in the secondary consumption-circuit said means stopping the current of the sign desired in the consumption-circuit.

6. In high-pressure electrical apparatus the combination of a primary alternating-current circuit, a primary coil in said circuit, resistance in the primary circuit, a secondary consumption-circuit, a secondary coil in said secondary circuit, an electrical apparatus to be worked said apparatus having a certain breaking-through pressure, a secondary auxiliary circuit, a secondary coil in said auxiliary circuit, said coil consisting of windings of the primary coil and adapted to form a by-path, an electric valve device in the auxiliary circuit and a condenser in the said auxiliary circuit adapted to coöperate with the self-induction device in the primary circuit and increase the pressure in the secondary consumption circuit during the passage of the current of the desired sign and reduce the pressure during the passage of the current of undesired sign.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

FRANZ JOSEPH KOCH.

Witnesses:

CARL GREIERT;
C. F. HUGO DUMMER.