(No Model.) 2 Sheets—Sheet 1.

H. T. HARRISON.

MEANS AND APPARATUS FOR DISTRIBUTING ELECTRICITY.

No. 529,265. Patented Nov. 13, 1894.

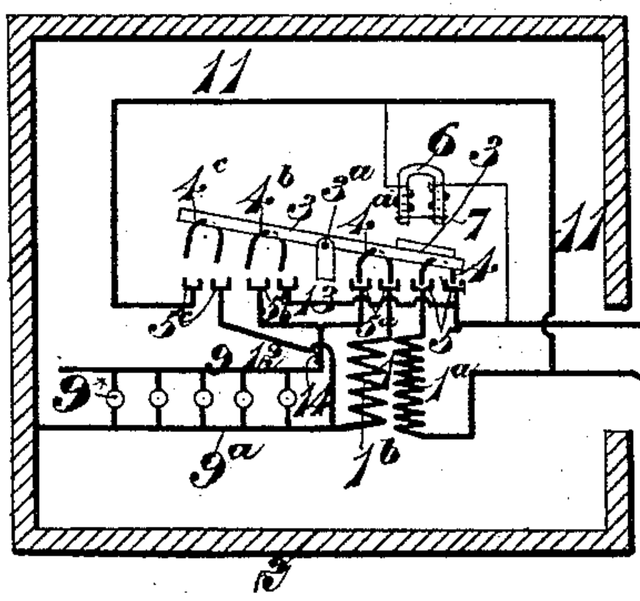

Fig. 1.

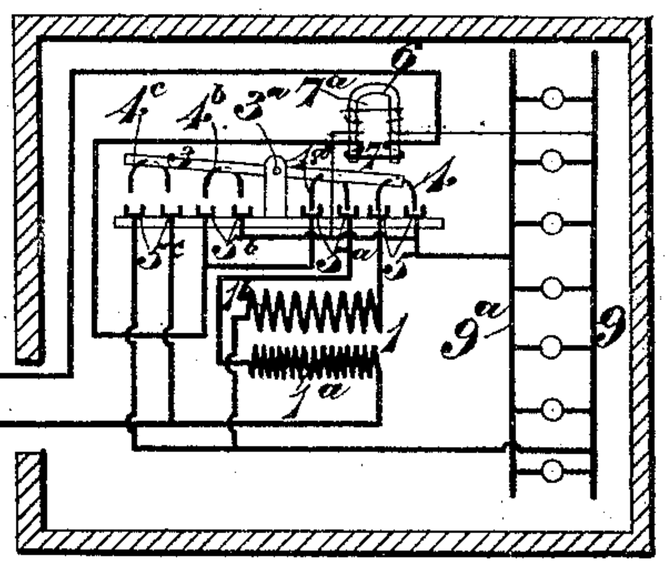

Fig. 1a.

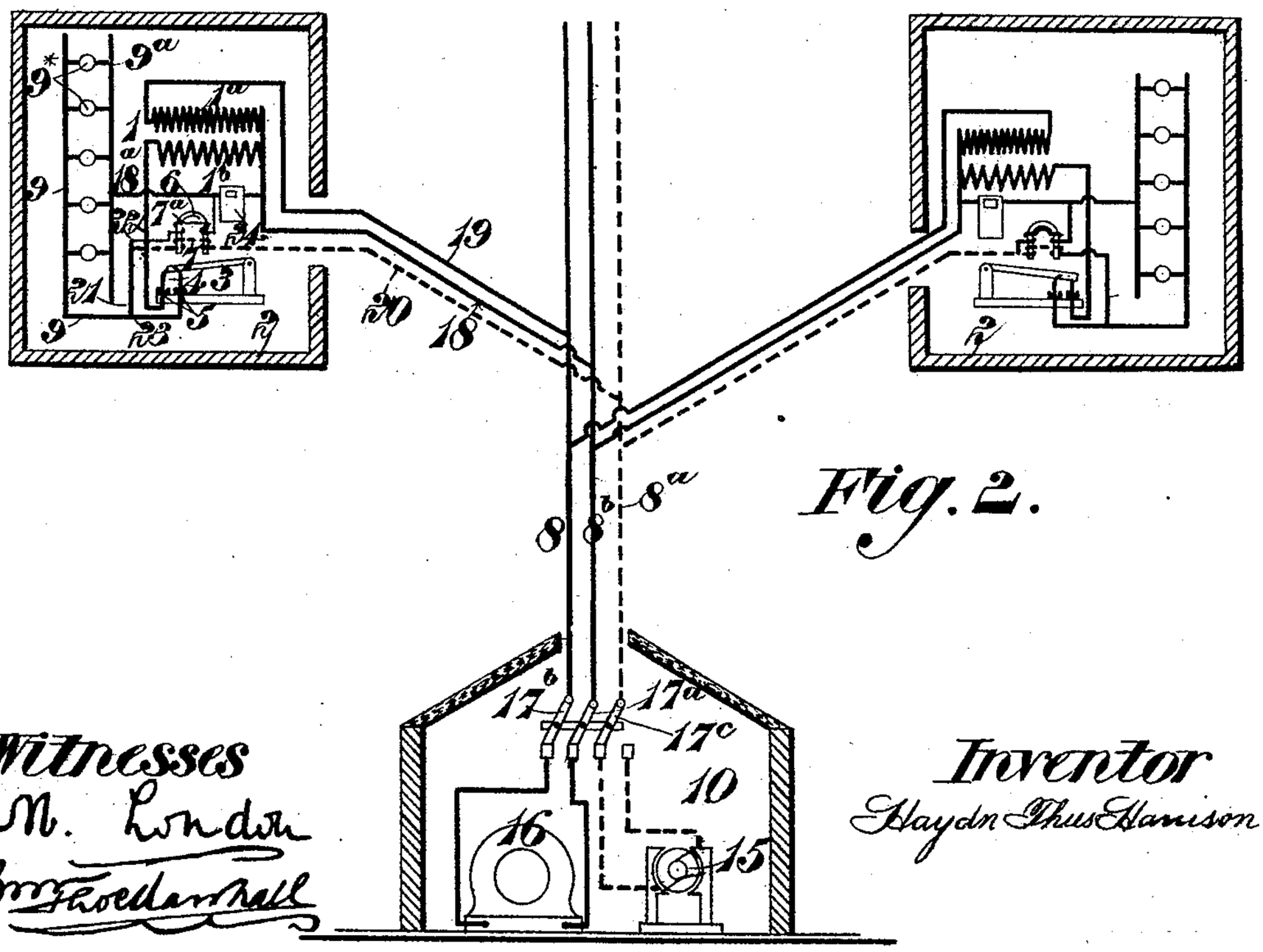

Fig. 2.

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(No Model.) 2 Sheets—Sheet 2.

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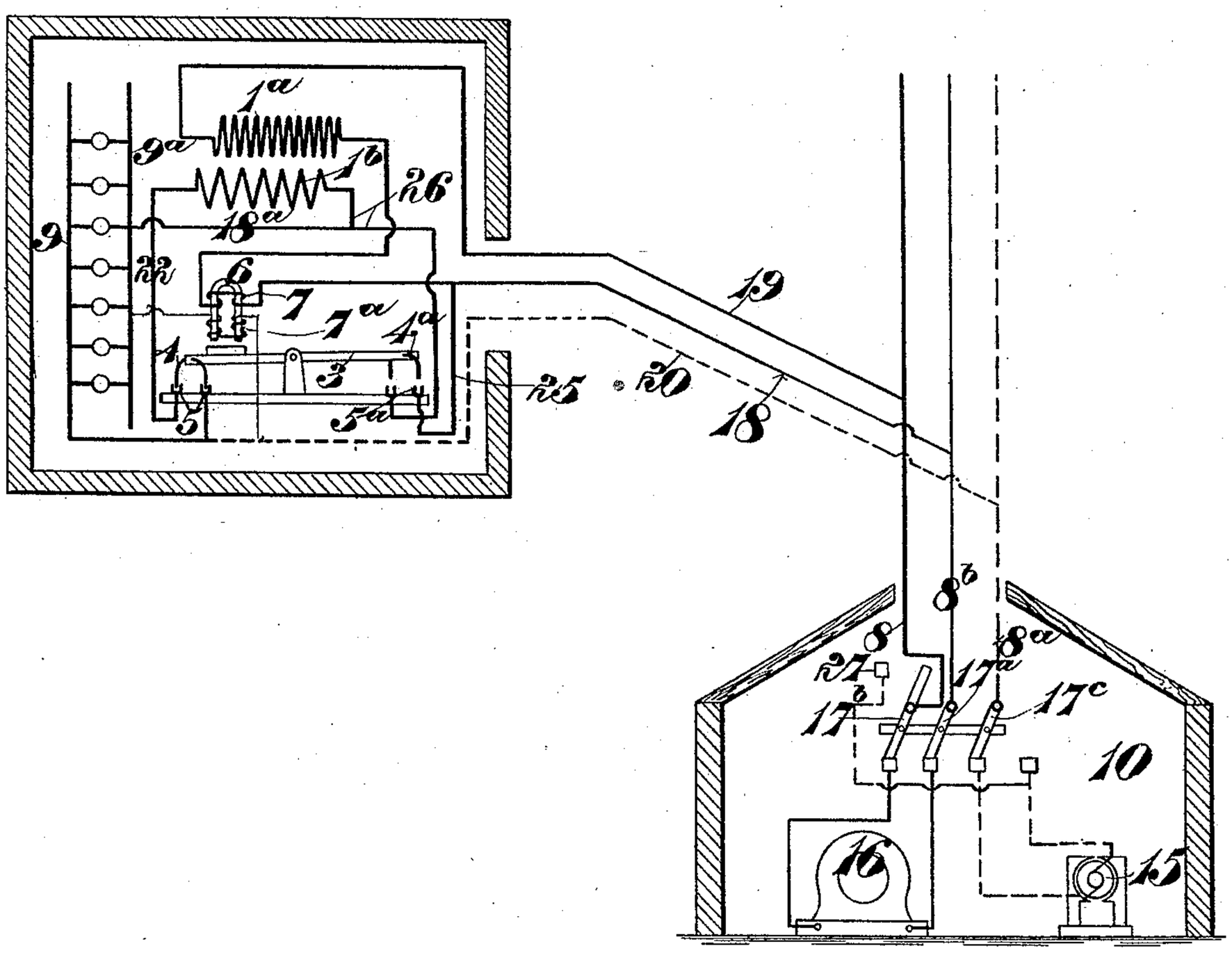
Fig. 3.



Witnesses
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UNITED STATES PATENT OFFICE.

HAYDN THIES HARRISON, OF LONDON, ENGLAND.

MEANS AND APPARATUS FOR DISTRIBUTING ELECTRICITY.

SPECIFICATION forming part of Letters Patent No. 529,265, dated November 13, 1894.

Application filed January 19, 1894. Serial No. 497,452. (No model.) Patented in England December 22, 1893, No. 23,674.

To all whom it may concern:

Be it known that I, HAYDN THIES HARRISON, a subject of the Queen of Great Britain and Ireland, residing at Dorchester Place, in the city of London, England, have invented Improvements in Distributing Electricity and Means or Apparatus for the Purpose, of which the following is a specification, and for which Letters Patent have been granted in Great Britain, dated the 22d day of December, 1893, No. 23,674.

The ordinary systems of electrical distribution (excluding the direct high tension, rarely used) may be divided into two classes, the direct low tension system and the alternating high tension (transformer) system. Each of these has its advantages and disadvantages.

An advantage of the low tension system lies in the fact that practically all the energy produced during light loads is registered on the consumers' meters, appreciable loss in the mains occurring only during heavy loads, and as the station is ordinarily running a light load on the average probably some sixteen hours out of the twenty-four, it becomes obvious that the system has a good day-load efficiency, especially as accumulators may be used during the day, and steam be shut down altogether. On the other hand the low tension system is only practicable over a comparatively small area. The conductors laid down have to be capable of carrying the maximum load, thus absorbing a large amount of capital in mains. During heavy loads much of the energy is wasted in heating these mains, and moreover, the large direct-current dynamos necessary for the system, are costly to make, and suffer considerably from wear and tear.

The alternating high tension (transformer) system has a high plant efficiency during medium and heavy loads, but during the day time there is more energy lost in magnetizing the transformers than is consumed in light by the consumers at the time. Hence, with this system, there is high efficiency during heavy loads and low efficiency during light loads. Moreover the system has the advantage that it is able to distribute its energy over a larger area, and involves less outlay of capital in mains and transformers than is involved in providing the mains of a corresponding low tension system.

Now my invention has reference to a system in which the foregoing two systems are combined, and which is adapted to admit of running, when a light load is on (for example during the day), with a low tension dynamo, or accumulators, direct on to the consumers' lights; and, when the load begins to increase, of switching over onto a high tension alternator, which will feed the consumers' lights through transformers in the ordinary manner. For these purposes, I provide in connection with the primary and secondary mains, switches adapted to automatically throw the respective transformers into circuit directly the low tension current is switched off, and before the high tension alternating current is switched on; and to cut out the transformers, and connect the consumers' or secondary mains direct on to the service or primary mains, directly the high tension current is switched off and the low tension current switched on.

In carrying out my invention, I employ automatic switches, such that the automatic changes will take place as rapidly as practicable, so as to minimize the blink in the light. In order to effect this I take advantage of the retardation of the alternating current, due to self-induction, and also of the repulsion of copper rings and short circuited coils from magnets excited by an alternating current.

In the accompanying drawings, Figures 1, 1ª, 2 and 3, are diagrammatic views illustrating three arrangements of apparatus for carrying out my invention.

In the arrangement shown in Fig. 1 each transformer 1, or bank of transformers, either in a consumer's house, or in a distributing station 2, is provided with an automatic switch comprising a lever 3 with armature 3* on which are fixed four copper connecting pieces or staples 4, 4ª, 4ᵇ, 4ᶜ two on each side of the fulcrum 3ª, and four pairs of contacts 5, 5ª, 5ᵇ, 5ᶜ for example mercury cups, so arranged (as shown), that there are two pairs on each side of the fulcrum of the lever, and so that each connecting piece or staple can, when depressed, connect up one such pair.

One arm of the lever 3 is loaded so that the

two connecting pieces 4, 4ª, on that arm will remain in the corresponding two pairs of mercury cups 5, 5ª, except when the loaded end of the lever is attracted by an electro magnet 6 placed above it. This electro-magnet is wound with very fine wire 7, and the iron forming its core is carefully laminated, so as to make it a very efficient choking coil. The magnet winding 7 is connected direct across the primary or service mains 8, 8ª as shown.

The two pairs of mercury cups 5, 5ª under the loaded end of the lever, are so connected that when the electro-magnet 6 does not attract the armature or lever 3, the connecting pieces 4, 4ª being immersed in the mercury in the said cups 5, 5ª, will respectively connect the primary 1ª of the transformer, to the primary or service main 8, and the secondary 1ᵇ of the transformer, to the secondary or consumer's main 9 through the conductors shown. The other end of the lever 3 being then raised, the connecting pieces 4ᵇ, 4ᶜ carried thereby, will be out of the two corresponding pairs of mercury cups 5ᵇ, 5ᶜ, which are insulated from each other—thus disconnecting the secondary or consumers' mains from the primary or service mains. These two pairs of mercury cups are connected up in such a way that when the connecting pieces 4ᵇ, 4ᶜ, are down, the primary or service mains 8, 8ª from the central station 10 are connected direct on to the secondary or consumers' mains 9, 9ª and the transformer is disconnected. In the example shown, this is effected by connecting one of the mercury cups 5ᶜ with the primary main 8ª by a conductor 11, and the other with the secondary main 9ª by a conductor 12 and connecting one of the mercury cups 5ᵇ with the primary main 8 by a conductor 13 and the other to the secondary main 9 by a conductor 14.

15 is a direct low tension current dynamo at the central station 10; or this dynamo may be replaced by accumulators.

16 is a high tension alternator.

17 is a double pole two-way switch by which either the dynamo 15, or the alternator 16, can be connected with the primary mains 8, 8ª.

9* are lamps or other translating devices on the secondary mains.

The action of the arrangement is as follows: Assuming the central station 10 to be running with the direct current dynamo 15 for a light load, and that the mains 8, 8ª, laid down for the high tension current, are capable of carrying the current necessary to light the lamps direct, then, when the load, as shown by the ammeter at the station, increases to a suitable amount, the high tension alternator 16 is started, and the load switched by the switch 17 from the direct low tension current generator 15 to the high tension alternating current generator 16, the switch 17 then assuming the position shown.

The action of the automatic switch at the distributing station or private house 2, or of each such switch where there are several, is as follows:—While running with a direct low tension current, the electro magnet 6 of the automatic switch will be powerfully energized, there being no retardation to the direct current passing through its winding, beyond the ohmic resistance. Consequently it will attract its armature 3* and lever 3 and connect the primary or service mains 8, 8ª direct onto the secondary or consumer's main 9, 9ª by way of the connecting pieces 4ᵇ 4ᶜ, pairs of mercury cups 5ᵇ 5ᶜ, and the conductors hereinbefore mentioned, but immediately the direct low tension from the dynamo 15 is switched off, there is a momentary break in the primary or service mains 8, 8ª which permits the weighted end of the lever to fall, and throw the corresponding transformer 1 into circuit, through the connecting pieces 4, 4ª, pairs of mercury cups 5, 5ª and conductors shown, so that directly the alternating high tension current is switched on, the secondary or consumer's main 9 9ª will be served by the transformer, the retardation of the electro-magnet 6 with alternating current being then so high, due to self induction, that it is unable to attract the loaded end of the lever 3, which serves as its armature, or which is provided with an armature 3*. The electro-magnet 6 can, if desired, be even made to repel the armature when the alternating current is on, by placing a short-circuited wire upon the armature, in a manner that will be readily understood without further description.

The arrangement hereinbefore described may be modified by winding the core of the electro-magnet 6 of the automatic switch with a second winding 7ª as shown in Fig. 1ª. In this case the winding 7 is made of thick wire and is connected in series with the primary 1ª of the transformer on the primary or service main 8 by the conductors shown. The other winding 7ª is made of thin wire, and is connected as a shunt across the secondary or consumer's main 9, 9ª as shown. In this modified arrangement, when the direct low tension current is switched on, it passes through the thick wire 7 of the electro-magnet, and through the primary 1ª of the transformer. This causes the electro magnet to attract its armature or lever 3 and lift the loaded end thereof below it, thereby connecting the secondary mains to the primary mains in the manner hereinbefore described. The fine wire 7ª being connected across the secondary mains, through which the direct low tension current will then be passing, the electro-magnet will be energized by such current and will hold the armature up. The weighted end of the lever 3 being thus raised, the primary and secondary windings 1ª and 1ᵇ of the transformer will be disconnected from the mains 8 and 9ª respectively. When the direct low pressure current is switched off, and the alternating high tension current is switched on, the armature or lever 3 will fall and connect the primary winding 1ª of the transformer to the primary or service main

8, the electro magnet not being then able to attract the armature or lever owing to the current passing through its thick winding being too weak, it being only the primary current of the transformer, while that passing through the fine wire winding on the magnet will then be an alternating current and unable to attract the loaded end of the lever for the reason hereinbefore stated. Moreover by providing the armature or lever with a short circuited coil, it will be then repelled from the said electro-magnet.

Fig. 2 is a diagrammatic view illustrating a further arrangement in which there are three primary wires 8, 8^a, 8^b from the generating station. The wire 8^b is provided at one end with a switch 17^a by which it can be connected either to one pole of the high tension alternating current dynamo 16, or to one pole of the low tension direct current dynamo 15, or accumulators, as required. This wire is also connected to one end of the primary and secondary windings 1, 1^a respectively of the transformer (or of each transformer where there are more than one) at the distributing station or consumer's house 2, by a conductor 18, and to one (9^a) of the secondary or consumers' mains 9, 9^a by a conductor 18^a. The wire 8 is connected, or as in the example shown, is adapted to be connected by a switch 17^b, to the other pole of the alternator 16, or alternators when several are used, and, by a conductor 19 is connected to the other end of the primary winding 1^a of the transformer. The third wire 8^a is connected, or as in the example shown, is adapted to be connected by a switch 17^c, to the other pole of the direct current dynamo 15, or dynamos or accumulators, and, through the conductor 20, the winding 7 of the electro-magnet in the automatic switch, and the conductor 21, is connected to the secondary or consumer's main 9. When switches 17^b and 17^c are used, they may advantageously be coupled to the switch 17^a as shown so that they can be all operated simultaneously. The electro magnet in this arrangement is also provided with a second winding 7^a of fine wire, as in the last described arrangement, connected across the secondary mains 9, 9^a. The thick winding 7 in the core can be omitted provided the winding 7^a is connected direct across the mains 18^a and 20.

22 and 23 are conductors by which the other end of the secondary winding 1^b can be connected to the secondary main 9 through the contact 4, carried by the switch lever 3, and the pair of mercury cups 5. 24 is a meter in circuit with the conductor 18^a. The automatic switch lever 3 in this construction is so arranged, as shown, that when the electro magnet 6 is energized by switching on the direct low tension current through the wires 8^b, 8^a, by means of the switch 17^a, or 17^a—17^c, the contact piece 4, one only of which need be used in this case, will be raised out of the mercury cups 5, of which there is only one pair, thereby disconnecting the secondary winding 1^b of the transformer from the secondary or consumers' main. When the switch 17^a, or 17^a—17^b is moved so as to switch on the alternating high tension dynamo, the high tension current will pass through the wires 8, 8^b, conductors 18 and 19, and primary winding 1^a of the transformer, and the armature and lever 3 will cease to be held up by the electro magnet, and in falling will connect the secondary or consumers' mains 9, 9^a, to the secondary winding 1^b of the transformer, from which they will then be supplied with electricity, the alternating current then passing through the magnet winding 7^a failing, as before, to energize the magnet and attract the switch lever.

Should it not be considered advisable that one end of the primary and secondary windings of the transformer be connected together, as shown in Fig. 2 when the high tension current is on, an extra pair of mercury cups and a connecting piece, may be introduced into the automatic switch at the opposite end of the lever 3 to the pair shown in Fig. 2 and which lever is then extended to the other side of its fulcrum, these additional mercury cups and contact piece serving only to make the connection when the direct low tension current is on, and to break the connection when the high tension alternating current is on. This modified arrangement is illustrated in Fig. 3 where 4^a is the extra connecting piece carried by an extension of the switch lever 3; and 5^a the extra pair of mercury cups, one of which is connected with the conductor 18 by a conductor 25, and the other of which is connected with the secondary winding 1^b by a conductor 26, and also with the secondary main 9^a by a conductor 18^a. In this modified arrangement the thick winding 7 of the electro-magnet 6, is connected in series with the primary 1^a of the transformer, the fine winding 7^a being connected across the secondary mains 9, 9^a as before. The switch at the central station is also slightly modified, the lever 17^b being elongated in such a way as to make connection with an extra contact 27 when the direct low tension current is switched on so that this extra contact 20 will then be connected to the main 8^a and the mains 8, 8^a connected together.

The action of the arrangement is as follows:—When it becomes advisable to switch over to the low tension direct current dynamo 15, the switch is moved over to the right thus connecting the mains 8, 8^a, to one pole of the low tension dynamo, and the main 8^b to the other pole, with the result that a considerable current will pass along the main 8 through the primary of the transformer, through the thick winding 7 of the electro-magnet 6, and along the conductor 18 and main 8^b back to the dynamo 15. The electro magnet 6 will thus be excited and caused to operate the switch lever 3 so as to cause the connecting piece 4^a to connect the conductor 18 on to the con-

sumer's main 9^a through the conductor 25, the mercury cups 5^a and the conductors 26 and 18^a. The conductor 20 being already connected to the primary and secondary mains 8^a and 9, a current will pass through the fine wire 7^a of the electro magnet 6 and continue to excite this magnet until such time as the direct current is switched off.

What I claim is—

1. A combined direct low tension and alternating high tension transformer system of electrical distribution, comprising primary and secondary mains, a transformer, direct low tension and alternating high tension current generators, a switching device for throwing said generators alternately in and out of circuit with said primary mains, and an automatically operating switch and circuit connections whereby said transformer will be rendered inoperative on said secondary mains and the primary and secondary mains will be connected together, when the primary mains are connected with said direct current generator, and will be thrown into action and be maintained in action when said primary mains are disconnected from said direct current generator and connected with said alternate current generator.

2. In a combined direct low tension and alternating high tension transformer system of distributing electricity, the combination with the primary and secondary mains and transformers, of switches adapted to automatically throw the respective transformers into circuit directly the low tension current is switched off and before the high tension alternating current is switched on, and to cut out the transformers and connect the consumers' or secondary mains direct onto the service or primary mains directly the high tension current is switched off and the low tension current switched on.

3. In a combined direct low tension and alternating high tension transformer system of distributing electricity, the combination with the primary and secondary mains and transformers, of circuit connections whereby said transformers can be thrown in and out of action, and electro-magnetic contact making devices for controlling said connections, said devices being each operative electrically when traversed by direct low tension current and inoperative electrically when traversed by an alternating current substantially as herein described for the purposes specified.

4. In a combined direct low tension and alternating high tension transformer system of distributing electricity, the combination with the primary and secondary mains and transformers, of switches each comprising a loaded lever controlling circuit connections and adapted to normally place the corresponding transformer in circuit, and an electro magnet adapted to actuate said switch lever to cut said transformer out of circuit when its winding is traversed by a continuous current and to be inoperative on said switch lever when its winding is traversed by an alternating current and to then permit said lever to place said transformer in circuit substantially as herein described.

5. In a combined direct low tension and alternating high tension transformer system of distributing electricity, the combination with the primary and secondary mains, transformers, and circuit connections, of automatic switches each comprising a switch device controlling said circuit connections and adapted when in one position to throw the corresponding transformer or bank of transformers into circuit, and an electro magnet adapted to move said switching device into its opposite position and throw said transformer or bank of transformers out of circuit, said electro magnet being provided with a winding having a large self-induction and connected across one of said pairs of mains, substantially as herein described.

6. In a combined direct low tension and alternating high tension transformer system of distributing electricity, the combination with the primary and secondary mains and transformers, of automatically operating switches each comprising a loaded switch lever, circuit connections controlled thereby and by means of which the corresponding transformer can be thrown in and out of action, and an electro magnet adapted to actuate said switch lever in one direction, said electro magnet being wound with two windings one of which is connected across the primary mains, and the other across the secondary mains substantially as herein described for the purpose specified.

7. A combined direct low tension and alternating high tension transformer system of distributing electricity, comprising three primary mains, a transformer having its primary connected across two of these mains which are to serve as the alternating high tension mains, secondary mains connected across one of said two primary mains and the third primary main, direct low tension and alternating high tension current generators, means for alternately connecting the pair of high tension mains to the alternating current generator, and one of these mains and the third main to the direct current generator, and an automatic switch adapted to place the secondary of said transformer in circuit directly the low tension current is switched off and to put it out of circuit directly the high tension alternating current is switched off and the low tension current switched on substantially as herein described.

8. A combined direct low tension and alternating high tension transformer system of distributing electricity, comprising three primary mains, a transformer having its primary connected across two of these mains which are to serve as the alternating high tension mains, secondary mains connected across one of said two primary mains and the third primary main, direct low tension and

alternating high tension current generators, means for alternately connecting the pair of high tension mains to the alternating current generator, and one of these mains and the third main to one pole of the direct current generator and the other of the two high tension mains to the other pole of said direct current generator and an automatic switch adapted to place the secondary of said transformer in circuit directly the low tension current is switched off and to put it out of circuit directly the high tension alternating current is switched off and the low tension current switched on substantially as herein described.

9. A combined direct low tension and alternating high tension transformer system of distributing electricity, comprising three primary mains, a transformer having its primary connected across two of these mains which are to serve as the alternating high tension mains, secondary mains connected across one of said two primary mains and the third primary main, direct low tension and alternating high tension current generators, means for alternately connecting the pair of high tension mains to the alternating current generator and one of these mains and the third main to the direct current generator, circuit connections whereby said transformer can be thrown in and out of action, a loaded switch lever controlling said connections and normally connecting the secondary winding of said transformer across the secondary mains, and an electro magnet adapted to actuate said switch lever and disconnect said transformer from said secondary mains, said electro magnet having two windings, one of low resistance connected across the pair of primary mains that serve as the low tension mains, and the other of high resistance connected across the secondary mains, substantially as herein described.

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

HAYDN THIES HARRISON.

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