April 28, 1942. R. E. SEARS 2,281,387

TAP SWITCH MECHANISM

Filed Aug. 3, 1940 2 Sheets-Sheet 1

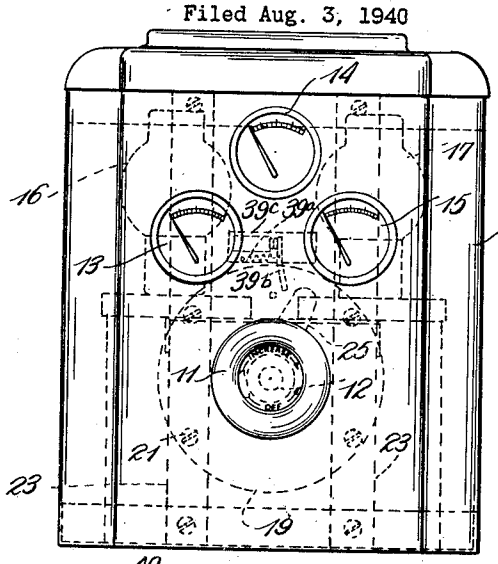


FIG. 1

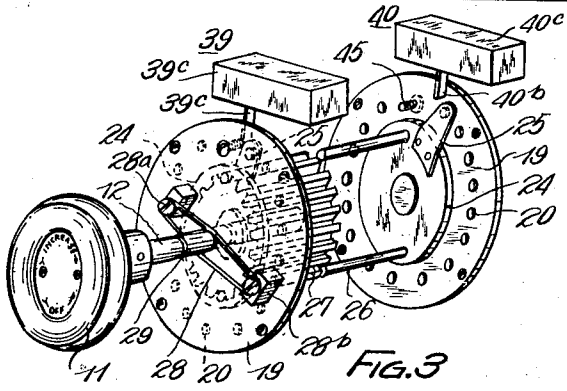


FIG. 3

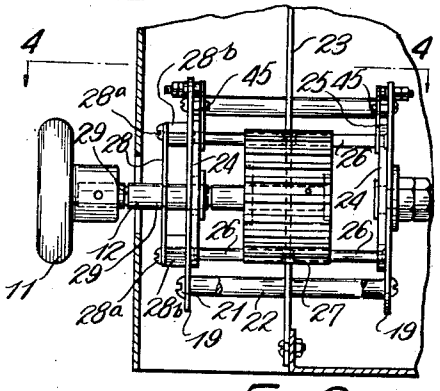


FIG. 2

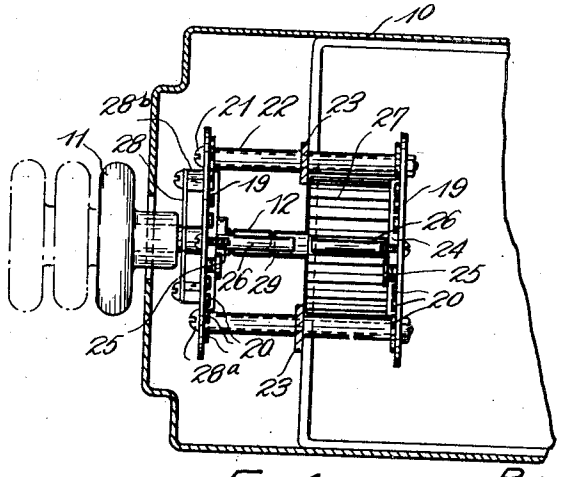


FIG. 4

INVENTOR.

BY RICHARD E. SEARS

Kwis Hudson & Kent

ATTORNEYS

April 28, 1942. R. E. SEARS 2,281,387

TAP SWITCH MECHANISM

Filed Aug. 3, 1940 2 Sheets-Sheet 2

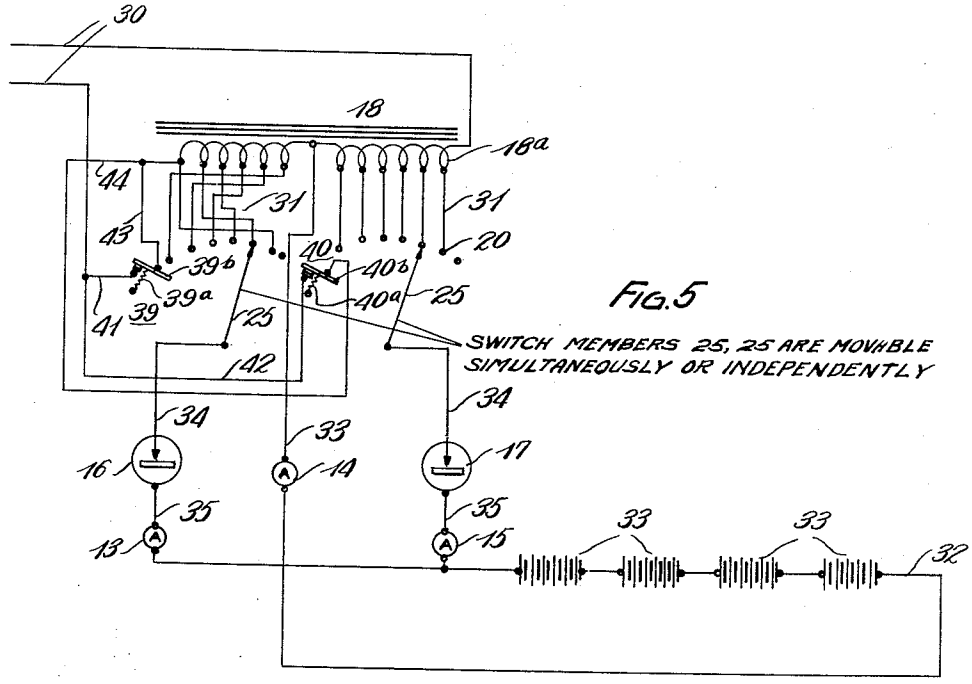


FIG. 5

SWITCH MEMBERS 25, 25 ARE MOVABLE SIMULTANEOUSLY OR INDEPENDENTLY

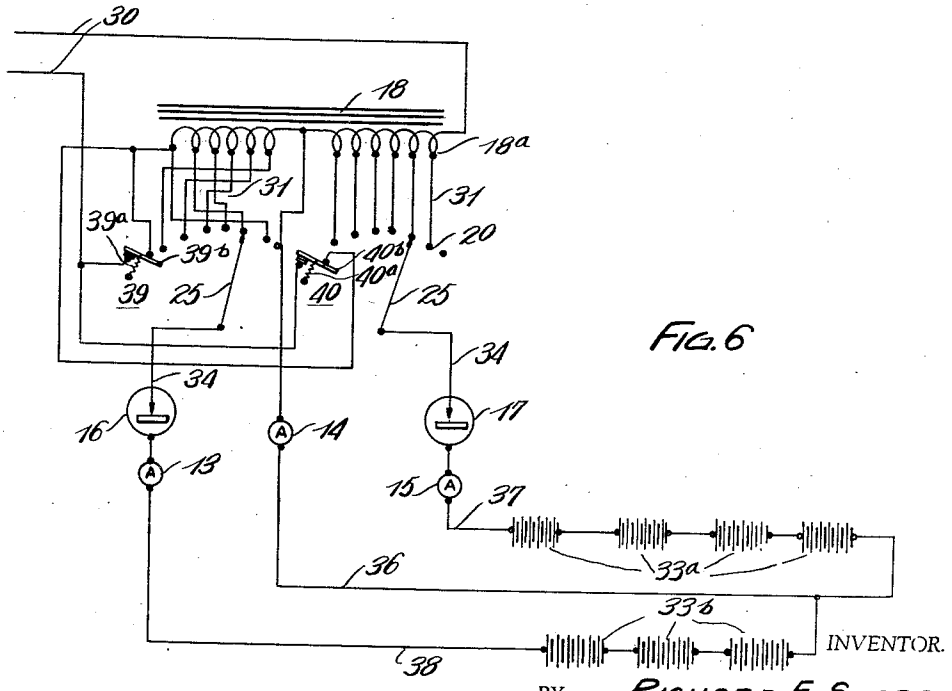


FIG. 6

INVENTOR.

BY RICHARD E. SEARS

Lewis Hudson & Kent

ATTORNEYS

Patented Apr. 28, 1942

2,281,387

UNITED STATES PATENT OFFICE

2,281,387

TAP SWITCH MECHANISM

Richard E. Sears, Cleveland, Ohio, assignor to Willard Storage Battery Company, Cleveland, Ohio, a corporation of West Virginia

Application August 3, 1940, Serial No. 350,925

9 Claims. (Cl. 171—314)

This invention relates to circuit controlling switch mechanism and particularly to switch mechanism employed in connection with battery charging systems involving the use of two rectifiers and two sets of transformer taps by which the number of transformer turns in the two rectifier circuits may be varied.

One of the objects of the present invention is to provide a highly efficient and simple switch mechanism by which the two tap switches may be operated either simultaneously or independently to maintain the desired charging rates for either full wave or half wave rectification for both of which my invention is readily adaptable regardless of differences in the characteristics of the rectifiers or unbalanced half wave load circuits.

Another object is to accomplish the above with a single operating member, thereby obtaining facility of operation and a simplified mechanism of compact form.

A further object of the invention is to reduce the likelihood of injury to the rectifiers or the blowing of fuses by so relating the control switches for the A. C. input circuit with respect to the tap switch mechanism that the control switches cannot be opened or closed when the rectifier circuit or circuits are loaded.

The first of the above objects is attained very effectively by my improved switch mechanism which includes a single knob or equivalent operating member so arranged with respect to the levers or movable switch members of the tap switches that the operating member can at will be caused to actuate the tap switches either simultaneously or independently.

In accordance with another feature of my invention, for the attainment of the second object, provision is made for both the closing and the opening of the A. C. input circuit of the transformer only when the movable switch members or lever arms of the two tap switches are in positions such that the rectifier circuits are without load or at least without sufficient load to create any likelihood of damage to the rectifiers or to any part or element of the rectifier circuits.

The invention may be further briefly summarized as consisting in certain novel details of construction and combinations and arrangements of parts which will be described in the specification and set forth in the appended claims.

In the accompanying sheets of drawings illustrating an embodiment of my invention adaptable for both full wave and half-wave rectification,

Fig. 1 is a front view of the casing of the switch mechanism showing the control knob and certain other parts by full lines and other parts on the interior by dotted lines;

Fig. 2 is a fragmentary vertical sectional view taken through the center of the operating knob, this view showing the actuator for the lever arms of the two tap switches in its mid position so that when the knob is turned both tap switches will be operated simultaneously;

Fig. 3 is a perspective view of the tap switch operating parts with the actuator moved to a position to operate the lever arm of one tap switch only, the actuator having been moved to this position by the outward endwise movement of the knob and the shaft to which it is attached, there being omitted for the sake of clearness the supporting members for the tap plates;

Fig. 4 is a fragmentary horizontal sectional view substantially along the line 4—4 of Fig. 2, the actuator being here shown in its opposite extreme position so as to actuate the lever arm of the other tap switch, the knob being shown by full and dotted lines in its three different operating positions;

Fig. 5 is a diagrammatic view of my invention applied to a battery charging system wherein the rectifiers are connected to a single battery circuit for full wave rectification; and

Fig. 6 is a similar view wherein the rectifiers are connected to two battery circuits each with half-wave rectification.

Referring now to the drawings which show my invention applied to a battery charging system, all the working parts of the apparatus are carried by or housed within a suitable casing or housing 10 which may have any desired construction. At the front of the housing is a member for operating the two tap switches, the same being shown in the form of a knob 11 which can be turned to actuate either or both of the lever arms of the tap switches and is secured to the outer end of a shaft 12 projecting through the front wall of the casing 10 and capable of being moved in an endwise direction so as to operate either lever arm independently of the other, as will be explained. Also mounted on the front wall of the casing 10 are in this instance three ammeters 13, 14 and 15 adapted to measure and give a visual indication of the current passing through different branches of the rectifier circuits. In some instances only two ammeters will be employed, the three being utilized when it is

desired that two of the ammeters measure independently the current flowing through the circuits of the two rectifiers and the third will then function to give a combined reading of the current flowing in both circuits. Located in the housing are the various parts of the switch mechanism and charging system to be described, including the rectifiers 16 and 17, two of which are employed, the transformer which is indicated diagrammatically at 18 in Figs. 5 and 6, and other parts or accessories, such as fuses, as may be necessary or desirable.

Any suitable type of rectifier may be employed, such as a tube rectifier or a disk rectifier, but the tube rectifier is preferred inasmuch as it has certain advantages, such as low heat factor. Likewise, any suitable transformer may be employed such as a standard form of transformer having a primary winding and a secondary winding or an autotransformer which is illustrated in Figs. 5 and 6.

Before describing the diagrammatic views of Figs. 5 and 6, I will explain the details of the tap switch mechanism herein illustrated. This mechanism includes two annular stationary tap plates 19 which will be insulated from each other and each of which is provided with an annular row of equally spaced tap switch contacts 20 which are suitably insulated from the plates. The two plates 19 are supported by screws 21 and spacer sleeves 22 (see Figs. 2 and 4) from two vertical rails or straps 23 shown in Figs. 1, 2, and 4. Rotatably mounted on the inner face of each tap plate 19 is a disk 24 carrying a tap switch lever arm 25 the outer end of which, when the disk 24 is rotated, is adapted to successively engage the tap contacts 20. Likewise, each disk 24 carries a pair of diametrically opposite inwardly extending actuating pins 26 which are adapted to be engaged by an actuator 27 which is secured to the inner end of the operating shaft 12. This actuator, as here shown, is in the form of a wheel having on its periphery spaced radial teeth and intervening grooves wide enough to receive the actuating pins 26 carried by the disks 24. If there is a difference of potential between the two tap switch lever arms 25, as in the circuits diagrammatically illustrated in Figs. 5 and 6, the actuator 27 will be made of insulating material. However, with other arrangements of the two sections of the transformer winding which need not be herein illustrated, there will be no difference in potential between the two tap switch arms, in which case the actuator 27 may or may not be made of insulating material.

The operating shaft 12 is slidably and rotatably mounted in a suitable bearing at the center of one of the tap plates 19, in this instance the left-hand tap plate, as viewed in Figs. 2, 3 and 4. The knob 11 has three operating positions which include the normal middle position shown in Fig. 2, the outermost position shown in Fig. 3, and the innermost position shown by full lines in Fig. 4, this view showing by dotted lines the knob in its other two operating positions. The knob 11 and the shaft 12 may be definitely located and yieldingly held in any of its three operating positions by any suitable spring actuated detainer or detent device which, in this instance, as shown in Figs. 2, 3 and 4, is in the form of a hard drawn or spring wire 28 the ends of which are held by screws 28*a* to projections 28*b* on the outer tap plate 19. The middle portions of the wire are adapted to snap into and out of annular grooves 29 located on shaft 12 in accordance with the three operating positions of the knob 11 and shaft 12.

The proportions of the parts including the spacing of the tap disks 19, the width of the actuator 27, and the length of the pins 26, are such that when the knob 11 is in its mid position, as in Fig. 2, in which case the actuator 27 will also be in its mid position, the pins 26 of both disks 24 will extend into the grooves of the actuator so that when the knob 11 is turned both tap switch lever arms will be rotated so as to cut sections or turns of the transformer winding into or out of the rectifier circuits, as will be explained presently. On the other hand, if the knob 11 is pushed inwardly to the full line position shown in Fig. 4, the actuator 27 will move out of engagement with the pins 26 of the outermost disk 24 but will of course remain in interlocking engagement with the pins of the innermost disk 24 so that when the knob in this position is rotated it will turn the tap switch lever arm 25 of the innermost tap switch only. Likewise, if the knob is pulled outward to the position shown in Fig. 3 and to the outermost dotted line position shown in Fig. 4, the actuator 27 will move out of engagement with the pins 26 of the innermost disk 24 but will remain in interlocking engagement with the pins of the outer disk so that if the knob when in the position just stated is rotated it will rotate only the tap switch lever arm of the outermost tap switch. Thus the switch mechanism herein described provides for both simultaneous and independent operation of both tap switch lever arms.

Referring now to the diagrammatic views designated Figs. 5 and 6, it will be seen that the conductors of the A. C. input circuit are designated 30 and that the winding 18*a* of the autotransformer 18 has two sets of taps 31 connected to the contacts 20 which, as shown in Fig. 3 and as before stated, are carried by the stationary tap plates 19 and are adapted to be engaged by the lever arms 25 of the two tap switches. Preferably the taps of each group span the same number of turns of the winding 18*a* so that the effect of the movement of each lever arm 25 from one contact to the next will in all instances cut in or out, as the case may be, the same increment of turns of the winding 18*a*.

It is to be noted that the two lever arms may be moved simultaneously in the same direction and that such movement will simultaneously cut into or out of each of the two transformer circuits the same number of turns of the transformer winding.

In Fig. 5 where full wave rectification is obtained by means of the two rectifiers 16 and 17, the rectifiers supply D. C. current to the charging circuit represented by the conductors 32 and in which are connected at least one and generally a group of batteries 33 which are being charged. One of the conductors 32 is connected to the middle point of the transformer winding 18*a* by a conductor 33 which is common to the two rectifier circuits each of which includes in addition to the conductor 33 a conductor 34 connecting the corresponding tap switch lever arm 25 to one of the rectifiers and also a conductor 35 connecting the rectifier to the other conductor 32 of the D. C. charging circuit. The three ammeters referred to in the description of Fig. 1 are shown in Fig. 5 as being located in the two rectifier circuits, the ammeter 14 being connected in the conductor 33 so that it will normally register or indicate the total D. C. current values delivered by the two

rectifiers. As previously stated, the ammeter **14** is not essential. In this instance, the ammeters **13** and **15** are in the conductors **35** but this is not essential as they may be connected between the rectifiers and the transformer winding.

As previously explained, the present invention comprises means by which the circuits of the two rectifiers may be controlled independently or in combination. Under certain conditions, as when the electrical characteristics of the two rectifiers are balanced, a combined operation of the tap switches will give very satisfactory results. However, if the electrical characteristics of the two circuits are not in balance, as, for example, when one rectifier is older than the other and has somewhat different characteristics as to impedance or resistance, it will be desirable to initially operate the two circuits independently in order to secure proper balance. Thereafter (for a full wave charging system as illustrated in Fig. 5) they can be operated simultaneously, the tap switches being operated to increase or decrease the current and voltage characteristics of the rectifier circuits as batteries **33** are added to or removed from the D. C. load circuit.

The ability to operate the two tap switch lever arms independently is particularly important in a charging system such as illustrated in Fig. 6 where half wave rectification is utilized for charging of batteries arranged in two different or independent rectifier circuits. As shown in Fig. 6, the system is employed for charging two groups of batteries designated respectively **33***a* and **33***b*. The batteries of the two groups are connected to one common conductor **36** connected to the middle point of the transformer winding **18***a*. The other side of the charging circuit or rectifier circuit for the group of batteries **33***a* consists of a conductor **37** which is connected to the rectifier **17**. The other side of the charging or rectifying circuit for the group of batteries **33***b* consists of a conductor **38** which is connected to the rectifier **16**. Both rectifiers are connected as before by conductors **34** to the lever arms **25** of the two tap switches. The tap switches and the transformer with the taps connected to the winding **18***a* and to the tap contacts **20** in Fig. 6 are identical with the corresponding parts of Fig. 5, and these parts need not be further described in connection with Fig. 6. The ammeters **13**, **14** and **15** are located respectively in the conductors **38**, **36**, and **37**. The ammeter **14**, as in the first instance, indicates the total D. C. current passing through the two rectifier circuits and may or may not be employed.

In a half wave rectifying system employing two rectifiers not only is the independent actuation of the tap switch lever arms important because of differences in the two rectifiers, but it has an additional very important advantage in such a system employing two rectifiers which supply current to two different battery circuits since the independent actuation is often required because the two circuits contain batteries differing in number and size or in characteristics of the batteries particularly as regards their state of charge.

It will be seen, therefore, that both the simultaneous adjustment and the independent adjustment of the tap switch lever arms are important whether the tap switch mechanism is utilized for full wave rectification in one charging circuit or for half wave rectification in two charging circuits since the desirability of balancing the rectifier circuits is the same in both instances with the additional need for independent adjustments in the second instance due to the fact that the number of batteries in the two groups being charged may or may not be the same in number, size or characteristics. Since the simultaneous actuation of the switch lever arms can be frequently used to advantage in both full wave and half wave rectification systems employing two rectifiers, and since the independent actuation of the tap switch lever arms is useful in both systems and particularly so in half-wave rectifying systems, my invention has great utility in connection with and is readily adaptable for either type of rectification.

I will next describe the second important feature of my invention by which likelihood of damage to the rectifiers or other parts of the rectifier circuits is avoided on the opening or closing of the A. C. input circuit, as might occur if the circuit were opened or closed with the rectifiers under load, i. e., with a substantial number of turns of the transformer winding in the rectifier circuits. In the attainment of this result, I associate control means for the input circuit with the tap switch mechanism in a manner such that the control means cannot be actuated to open or close the input circuit except when the turns of the transformer winding are out of the rectifier circuits. This control means consists in this instance of two switches **39** and **40** which are biased toward closed position by springs **39***a* and **40***a*. These switches are connected in parallel relation in one of the conductors **30** of the input circuit, as clearly shown in Figs. 5 and 6, the stationary contacts of the two switches being connected to said conductor **30** of the input circuit by conductors **41** and **42** while the movable blades **39***b* and **40***b* of the switches **39** and **40** are connected, respectively, to one terminal of a transformer winding **18***a* by conductors **43** and **44**.

The movable switch members **39***b* and **40***b* are so arranged with respect to the tap switch lever arms **25** that when the latter are moved to their "off" position (to the left as viewed in Figs. 5 and 6) past the last contacts **20** connected to the transformer winding **18***a*, they engage the movable switch members **39***b* and **40***b* and open the switches **39** and **40**. In Fig. 3 the lever arms **25** are on the last contacts and further movement in a counterclockwise direction will open the switches after which the lever arms engage suitable stop members **45** (see Figs. 2 and 3) carried by the tap plates **19**.

The switches **39** and **40** are arranged in switch boxes **39***c* and **40***c* shown conventionally in Fig. 3 and one shown by dotted lines in Fig. 1, these switch boxes being suitably supported in the housing **10** in proper relation to the lever arm **25**.

If one of the lever arms **25** is in advance of the other so that it reaches its "off" position before the other, it will open switch **39** or **40**, but this will not result in the opening of the input circuit since the other switch is still closed. In such case, to open the input circuit, i. e., to open the control switch which is still closed, it will be necessary for the operator to move the knob **11** in or out, as the case may be, and shift the lagging lever arm **25** until it also reaches "off" position and opens the associated switch **39** or **40**. It is not until this occurs, i. e., when (in this instance) all the turns of the transformer winding are cut out of both circuits, that the input circuit is opened. It will be understood, of course, that the control switches **39**

and 40 will be closed only on the movement of the two lever arms 25 from the stops 45 to the first contacts 26 of the two series.

It will be understood also that suitable stops will be provided to prevent forward or "on" movement of the lever arms 25 beyond the last contacts which are connected to the transformer winding so as to prevent the circuits from being opened by movement of the lever arms in the forward or "on" direction beyond the last active contacts 20 which are connected to the transformer winding. Although in the preferred embodiment of the invention the input control switches 39 and 40 are both opened and closed with no turns of the transformer winding 18a in the rectifier circuit, I regard it within the scope of my invention to open or close the input circuit at the switches 39 and 40 with small portions of the transformer winding 18a in the rectifier circuits provided there are not sufficient turns in the latter circuits to damage the rectifiers or any other parts in the circuit or to render likely the blowing of fuses.

Thus it will be seen that by the mechanism herein illustrated, I attain very effectively the objects of the invention, namely, first, the provision whereby with a single operating member the two lever arms of the tap switch mechanism may be operated simultaneously or independently, and, second, the provision whereby safety to the rectifiers and other parts of the rectifier circuits is secured by arranging the control switching means for the A. C. input circuit in a manner such that the input circuit cannot be opened or closed by the actuation of the control switching means therefor when either or both of the rectifier circuits are loaded, at least to any dangerous extent. Furthermore, these results are attained by mechanism which is simple in construction and effective and reliable in operation.

While I have shown the preferred embodiment of my invention which operates with high efficiency, I do not wish to be confined to the embodiment illustrated but aim in my claims to cover all modifications which do not involve a departure from the spirit and the scope of the invention.

Having thus described my invention, I claim:

1. Switching mechanism for two sets of transformer taps comprising two sets of tap contacts, a pair of switch members movable over the contacts, and operating means for said switch members including a member movable to a position to form an operative connection with both switch members whereby they may be moved simultaneously and movable to other positions to form separate operative connections with the switch members whereby either of the latter may be moved independently of the other.

2. Switching mechanism for two sets of transformer taps comprising two sets of tap contacts spaced apart laterally, a pair of switch members movable over the contacts, and operating means for the switch members including an actuating member movable laterally between the two sets of tap contacts, said actuating member when in one position being operatively connected to both switch members and when moved to a second position being operatively connected to one switch member only and when moved to a third position being operatively connected to the other switch member only.

3. Switching mechanism for two sets of transformer taps comprising two sets of tap contacts each set circularly arranged and spaced apart laterally, a pair of switch levers mounted for movement coaxially of the tap contacts and movable over the same, and a rotary and endwise movable actuating member adapted to be turned to actuate the switch members and also movable in an axial direction to one position in which said member is operatively connected to both switch members and to two other positions in which it is operatively connected to the switch members individually.

4. Switching mechanism for two sets of transformer taps comprising two sets of tap contacts spaced apart in an axial direction, a pair of switch members mounted for rotary movement coaxially of the contacts and each provided with an inwardly extending actuating pin, and means for operating said switch members including an actuating member supported for rotary movement between said sets of contacts and movable axially to three different positions, said actuating member when in its middle position being operatively connected to both actuating pins and when moved to the other two positions being operatively connected first to one only and then to the other only of said pins whereby the switch members may be moved simultaneously or independently.

5. In an electrical system of the character described, a transformer having input conductors connected thereto and having a winding with two sets of taps, a pair of delivery circuits, a tap switch mechanism including two sets of contacts connected with said taps, two movable switch members, and means for either simultaneously or independently moving the switch members over the contacts to connect variable portions of said winding in the delivery circuits, and switch means for said input circuit so arranged with respect to said switch members that said input circuit is opened or closed at said switch means only when each of said switch members is moved to a predetermined position.

6. In an electrical system of the character described, a transformer having input conductors connected thereto and having a winding with two sets of taps, a pair of delivery circuits, a tap switch mechanism including two sets of contacts connected with said taps and two tap switch arms movable over the contacts to connect variable portions of said winding in the delivery circuits, and means for controlling the input circuit including a pair of switches connected in parallel relation in one of the conductors of the input circuit and each arranged adjacent to the off position of one of said tap switch arms whereby both switches will be opened or closed when both of said tap switch arms have been moved to positions such that the transformer winding is substantially or entirely out of the delivery circuits.

7. In a battery charging system, an input circuit, a transformer having a winding with two sets of taps including two sets of contacts connected to the taps and two movable tap switch arms, a pair of rectifiers connected respectively to the two tap switch arms and to the battery or batteries to be charged, a single operating member for shifting said tap switch arms, and means connected to said operating member and associated with the tap switch arms whereby the latter may be moved simultaneously or separately by said single operating member.

8. In a battery charging system adapted for half wave or full wave rectification, an A. C. current supply circuit, a transformer having a

winding with two sets of taps, a tap switch mechanism including two sets of contacts connected to the taps and two tap switch arms, D. C. battery charging conductors, a pair of rectifiers connected to said conductors and each connected to one of said tap switch arms, a pair of switches connected in parallel relation in one of the conductors of said A. C. supply circuit and arranged adjacent to said tap switch arms when in off position whereby said switches will both be opened or closed by said tap switch arms when the current delivered to the battery charging conductors is minimized.

9. In a battery charging system adapted for half wave or full wave rectification, an A. C. current supply circuit, a transformer adapted to be connected to said supply circuit and having a winding with two sets of taps, a tap switch mechanism including two sets of contacts connected to the taps, two tap switch arms adapted to be moved over said taps and means by which the tap switch arms may be actuated simultaneously or independently, D. C. battery charging conductors, a pair of rectifiers connected to said conductors and each connected to one of said tap switch arms, and a pair of switches connected in parallel relation in one of the conductors of the A. C. supply circuit and each arranged adjacent to a portion of one of said tap switch arms when said tap switch arm is in off position whereby each of said switches will be opened or closed by the corresponding tap switch arm of the tap switch mechanism when there is no load on the rectifier connected to said tap switch arm.

RICHARD E. SEARS.