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C. H. HOWARD ET AL

2,027,593

ELECTRIC TRANSFORMER

Filed April 22, 1933

Fig. 1.

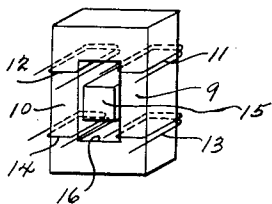


Fig. 2.

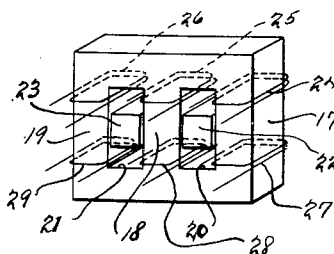


Fig. 3.

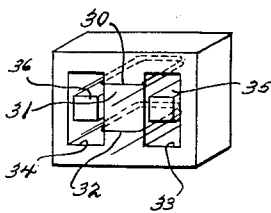


Fig. 4.

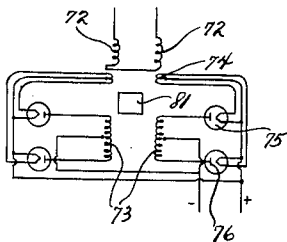


Fig. 5.

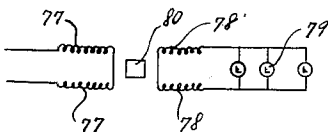


Fig. 9.

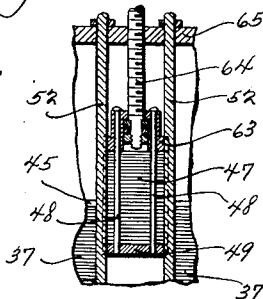


Fig. 6.

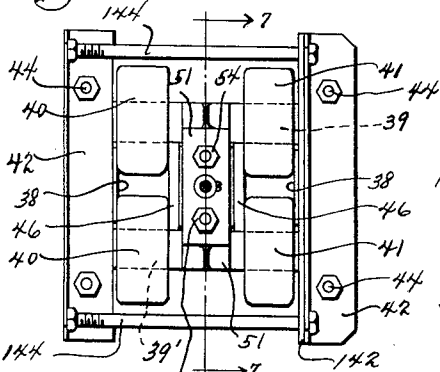


Fig. 7.

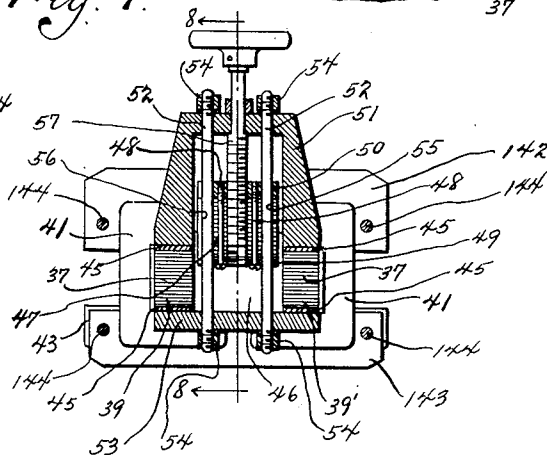
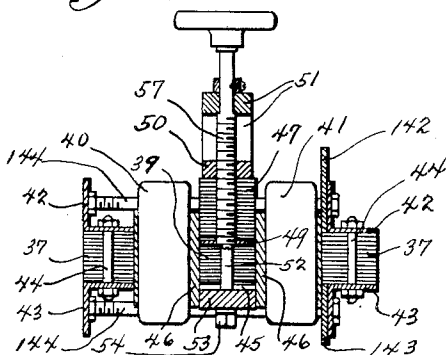


Fig. 8.



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ELECTRIC TRANSFORMER

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Application April 22, 1933, Serial No. 667,340

3 Claims. (Cl. 171-119)

Our invention relates to a new and useful improvement in an electrical transformer of the core and shell types and modifications thereof, and it is an object of the present invention to provide a structure in which accurate regulation and adjustment of voltage and current on the secondary or load side may be effected.

It is another object of the invention to provide a transformer in which voltage regulation on the secondary windings may be effected so as to have the same effect as results from the use of choke coils such as are used in arc welding or where a cushioning effect is desired, thus eliminating all choke coils and providing a very economical structure.

Another object of the invention is the provision of a voltage control of this class combined with a transformer of such windings as to permit the use of the control on double voltages in series or in single voltages in parallel.

Another object of the invention is the provision of a device of this class which will be compact, light, durable, easy and simple in operation, and of marked efficiency.

Other objects will appear hereinafter.

The invention consists in the combination and arrangement of parts hereinafter described and claimed.

The invention will be best understood by a reference to the accompanying drawing which forms a part of the specification, and in which,

Fig. 1 is a diagrammatic view showing the invention applied to a core type transformer.

Fig. 2 is a diagrammatic view showing the invention applied to a transformer with a double bridge arrangement.

Fig. 3 is a diagrammatic view showing the invention applied to a transformer of the shell type.

Fig. 4 is a diagrammatic view showing the invention as applied to tube rectifiers.

Fig. 5 is a diagrammatic view illustrating the use of the invention on a light circuit.

Fig. 6 is a side elevational view of the invention applied to the form shown in Fig. 1.

Fig. 7 is a sectional view taken on line 7-7 of Fig. 6 and turned at right angles.

Fig. 8 is a view taken on line 8-8 of Fig. 7.

Fig. 9 is a fragmentary sectional view showing a different form of the moving mechanism.

In Fig. 1 we have shown the invention used in connection with a so-called core type of transformer design in which the magnetic core is provided with a pair of spaced legs 9 and 10, around which are wound the primary coils 11

and 12 and the secondary coils 13 and 14 so as to leave between these coils a considerable space in the magnetizing circuit. Movably mounted in the space between the primary and secondary coils and bridging the gap between the two legs 9 and 10 upon which the coils are assembled is a bridge 15. This bridge or regulating plug is constructed of magnetic material and so supported and guided that it may be moved inwardly or outwardly of the space 16 either manually or be motor driven by means of a screw adjustment, a given arrangement, or other mechanical means to any desired position with respect to the depth of the core. Since this bridge 15 is formed from magnetic material, it will form a path for a portion of the magnetic flux set up in the core when the coils 11 and 12 are connected to a source of alternating current, thus deflecting and by-passing a portion of this magnetic flux so that it does not pass through the secondary coils 13 and 14.

Consequently, when the secondary coils are connected to the load, which may be any type of current consuming device, the action of this transformer may be controlled as herein set out. With the magnetic bridge or regulating plug 15 drawn entirely out of the magnetic circuit, that is, outwardly from the space 16, proportionally all of the flux set up by the current which flows through the primary coils 11 and 12 will also pass through the secondary coils 13 and 14, and induce a voltage across them which will bear the same proportion to the primary voltage as the ratio of the number of turns in each winding, except for the slight leakage flux which exists in all transformers. As the bridge or plug 15 is gradually inserted into the space 16 between the legs of the magnetic circuit, it by-passes or shunts an increasingly larger portion of the flux set up by the primary coils 11 and 12 and correspondingly reduces the flux that passes through the secondary coils 13 and 14, thus lowering the secondary voltage proportionally. Consequently by varying the position of the magnetic bridge or plug 15 in the manner indicated, the secondary voltage can be varied to the desired value. This results, because, by varying the position of the magnetic bridge or plug 15, the amount of flux by-passed through the bridge or plug 15 is varied, resulting in a proportional variation of the voltage in the secondary.

In the diagrammatic view illustrated in Fig. 2 we have shown the invention applied to the core type transformer with three legs, 17, 18, and 19, 55

leaving the space 20 between the legs 17 and 18 and the space 21 between the legs 18 and 19. Slidably projectable into the space 20 is the bridge or regulating plug 22 and a bridge or regulating plug 23 is slidably projectable into the space 21. Wound about the legs 17, 18 and 19 are the primary coils 24, 25, and 26 respectively. Wound about the legs 17, 18, and 19 are the secondary coils 27, 28, and 29 respectively. As shown, there is a space between the primary coils and the secondary coils on each leg, thus we have provided a double bridge arrangement which is applicable to a polyphase circuit or where a combination of single phase circuits may be desirable. The movement of the bridges or plugs 22 and 23 is inwardly and outwardly and this movement is effected mechanically or manually.

In Fig. 3 we have shown a diagrammatic view of the invention applied to a transformer of the shell type design, in which the primary winding 30 is around the central leg 31, adjacent one end, while the secondary winding 32 is around the leg 31 adjacent the other end. At each side of the leg 31 are the spaces 33 and 34 in which are slidably projected the bridges or plugs 35 and 36. The operation of the bridges or regulating plugs is the same in all of the forms illustrated. In the diagrammatic view shown in Fig. 4 of the drawing, we have illustrated the invention constructed in one form of transformer and as applied to filament tube rectifiers where the tubes operate in parallel on a single phase circuit. The windings 72 represent the primary windings and the windings 73 the secondary windings. The regulating plug or bridge 81 is used as indicated for the form shown in Figs. 1, 2, and 3. While the windings 74 serve to supply current to the tube filaments 75, the currents to the tube plates 76 are supplied through the secondary windings 73. For this application, the arrangement of the individual windings upon the legs of the transformer core may be such as to introduce a phase angle between the currents flowing in the secondary windings 73, thus permitting of the operation of the tubes in parallel.

This same arrangement in a slightly modified adaptation can be applied to the shell type of transformer or to polyphase transformers for the operation of rectifier tubes, connected for either single circuit or parallel circuit full-wave rectifiers. It is obvious that the invention is also adaptable for use with other types of rectifiers than the tube type.

In Fig. 5 we have illustrated the invention adapted for use as a dimmer in a lighting circuit. The primary windings 77 are spaced from the secondary windings 78. The lights 79 are connected in the circuit attached to the secondary windings 78 and the movement of the bridge 80 may be used to effect a variation of the current in the secondary circuit. In such use, the bridge or plug 80 may be used to entirely dim out the lights or may be moved to a position so as to permit full flow of the current through the secondary windings to the lighting circuit.

In Figs. 6, 7, and 8 we have illustrated a practical application of the form of the invention diagrammatically shown in Fig. 1. The core is formed from a plurality of laminations 37, as shown in Fig. 7 and Fig. 8, which are superimposed upon each other and through which extends the opening 38 to provide a substantially O-shaped construction having the oppositely dis-

posed legs 39 and 39' about which are wound the primary coils 40 and the secondary coils 41. These laminations 37 are secured together by means of the angle irons 42 and 43 which engage the outer faces of the outermost of the laminations and are clamped thereagainst by means of the bolts 44. Plates 142 and 143 are positioned at one side of the structure, and through which extend the bolts 144 which prevent spreading of the angle irons. The coils are insulated from the core laminations 37 by means of the plates 45 of insulating material, while the plates 46 serve to insulate the bridge or regulating plug from contact with the coils.

This bridge or regulating plug is formed from a plurality of laminations or plates 47 which are held together by means of the brass bolts or screws 48 projected through the end piece 49, which is also preferably formed from brass, and threaded into the end plate 50 also of brass or 20 non-magnetic material. A yoke 51 rests upon the upper face of the core and is secured in position by the bolts 52 which project there-through and extend through the brass plate 53 which engages the lower side of the core. 25 The nuts 54 serve to clamp the core securely between the plate 53 and the yoke 51. These bolts or rods 52 also serve as guide members for the regulating plug. One of these screws or rods 52 extends through the passage 55 formed 30 in the bridge, while the other engages in the groove 56 formed in the face opposite to the side at which the opening 55 is formed. Rotatably mounted on the yoke 51 and threaded through the plate 50 is the actuating screw or stem 57 35 which may be rotated manually or motor driven if desired. By rotating the screw 57 the regulating plug or bridge may be moved downwardly or upwardly so as to carry the amount of flux by-passed and thus obtain the regulation or 40 control of the voltage in the secondary circuit. The rods 52 serve as guide members for the bridge or plug in its movement, and by means of the screw arrangement a very fine adjustment can be obtained. 45

In Fig. 9 we have shown a slightly different form in which a regulating plug or bridge 63 is swivelly mounted on the end of the screw or rod 64 which is threaded through the yoke plate 65. 50

This construction is such that as the screw 64 is rotated it will also move axially, while in the forms shown in Fig. 6 the screw 57 is axially fixed and the bridge or plug threads thereon as a nut. The gradual movement of the bridge or 55 regulating plug is such that a micrometer adjustment may be effected and an infinite variation of secondary voltage obtained.

The invention is particularly adapted to electric heating applications such as annealing of 60 materials in which the material to be annealed is clamped by the conducting jaws to which the secondary leads of the transformer are connected and the temperature of the metal to be annealed raised to the proper value by adjustment of the bridge. The invention is also 65 adaptable to the resistance type of electric furnace or oven in which case the secondary coils furnish current of the proper value to the heating elements so as to develop the desired temperature in the furnace, and this current, of course, can be regulated by proper adjustment of the bridge or regulating plug. The invention is also adapted for use in the arc type electric furnace in which case the secondary coils are 75

connected directly to the electrodes and the current and voltage regulated to the proper values by means of the adjusting bridge or regulation plug. The invention is also adapted for use in alternating current arc welding, in resistance welding, butt welding, and spot welding. In each of these cases the secondary voltage may be accurately adjusted and controlled by means of the bridge.

In electrical circuits where close voltage regulation or a range of regulation up and down is desired, the invention will function most efficiently, in which case the transformer and bridge arrangement may be designed for either "buck" or "boost" or a combination of both.

The invention is also adapted for use on rivet heating machines, either when the machine is built as a single unit or as a multiple machine on which several rivets may be heated simultaneously. Accurate adjustment and close regulation of the current is possible and of course if a multiple number of units is used, a multiple number of regulating bridges or plugs will be necessary.

The invention is also admirably adapted for use in the starting of A. C. polyphase motors. In such an application the secondary windings are connected directly to the motor terminals. The voltage impressed across the motor terminals may be reduced to any desired value by means of the bridges or regulating plugs such as shown in Fig. 2 or Fig. 3. In practical use this voltage could be set to a value below that required to start the motor and then gradually and smoothly increased to the full value without breaking the circuit and without causing any switching surges.

Furthermore, since a straight transformer action is employed, a motor wound for a low voltage may be operated through this motor starting transformer directly from a high tension circuit, thereby eliminating other transformers, additional high tension line and switching equipment, and in addition freeing the motor circuit from the dangers due to lightning, switching surges, or other static disturbances. With this arrangement, the usual physical hazards of high tension motors would be eliminated.

While we have illustrated and described the preferred form of our invention, we do not wish to limit ourselves to the precise details of structure shown but desire to avail ourselves of such

variations and modifications as may come within the scope of the appended claims.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. A transformer of the class described comprising: a core having a passage formed therethrough; primary windings mounted on said core; secondary windings mounted on said core in spaced relation to said primary windings, said core having its passage formed therethrough between said primary and secondary windings; a magnetic regulating bridge insertable into said passage, for varying the voltage in the secondary windings through a by-passing of a portion of the flux set up by said primary windings; a plate engaging one face of said core and projecting across the passage therein; a yoke engaging the other face of said core and bridging said passage; guide bolts projecting through said passage and clamping said core between said plate and said yoke, said bolts serving as guides for said bridge upon its movement inwardly and outwardly of said passage; and threadable means projecting through said yoke, and adapted upon rotation for effecting movement of said bridge inwardly and outwardly of said passage.

2. In a device of the class described a magnetic regulating bridge comprising a body formed from a plurality of laminations in superimposed relation, each of said laminations having an opening formed adjacent one side and a notch adjacent the opposite edge, the openings and notches in the laminations registering to provide a passage through said bridge adjacent one side and a groove in the face of the other side.

3. In a device of the class described a magnetic regulating bridge comprising a body formed from a plurality of laminations in superimposed relation, each of said laminations having an opening formed adjacent one side and a notch adjacent the opposite edge, the openings and notches in the laminations registering to provide a passage through said bridge adjacent one side and a groove in the face of the other side; means for mounting said bridge in slidable position; and guide rods engaging in said passage and in said groove for guiding said bridge in its movements.

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