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W. A. DARRAH

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THERMOCOUPLE

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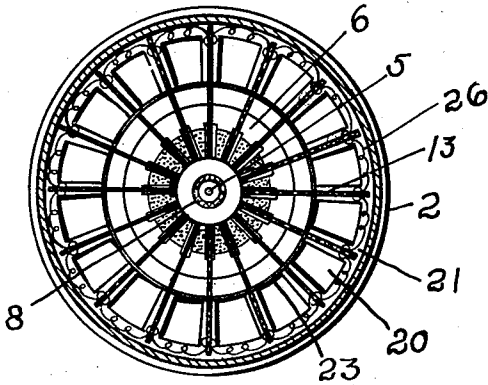


FIGURE I

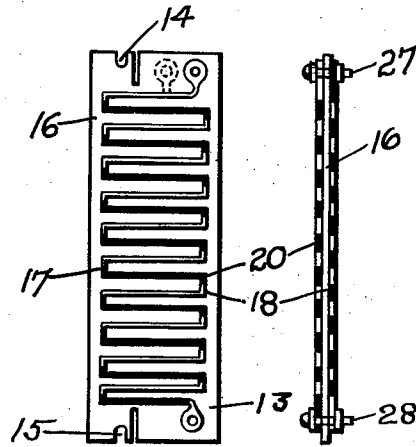


FIGURE III FIGURE IV

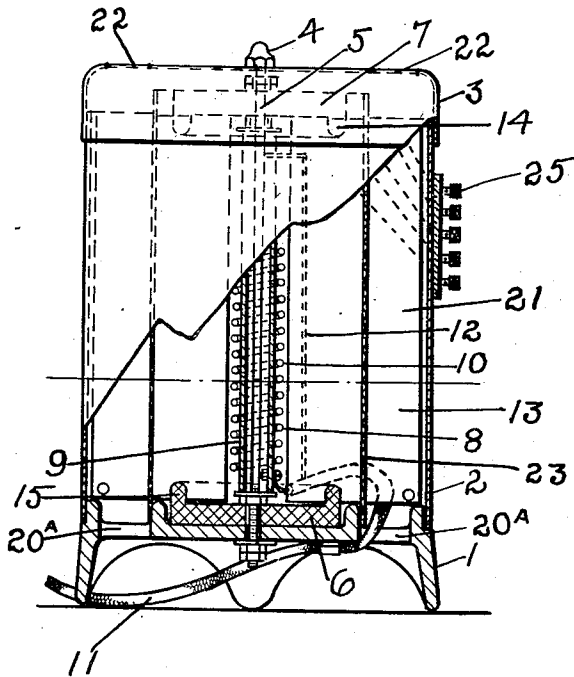


FIGURE II

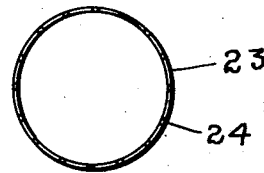


FIGURE V

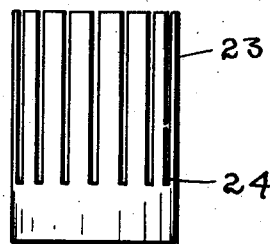


FIGURE VI

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THERMOCOUPLE.

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This invention relates to apparatus for producing electric currents from a source of heat which is preferably of electrical origin but not necessarily confined to this source alone.

The object of this invention is to provide a simple, efficient, economical equipment for producing direct currents of relatively small power, for such sources as heating the filaments of radio tubes, charging batteries, electro chemical work, etc.

The voltage and current obtainable by the device which I have invented is not limited to any particular voltage or current. This device may be produced in any size, for example, which will supply 6 volts and 2 or 3 amperes, or it may be supplied in sizes which will deliver 90 volts and smaller amperages. Much larger units may be constructed if desired, but the present large commercial demand appears to be for relatively small units.

Referring to the drawing, Figure I shows a section taken in a horizontal plane through one form of the device covered by my invention. Figure II shows a vertical elevation partly in section, of my invention. Figure III shows in more detail one of the elements used in generating the current. Figure IV shows a side elevation of the details shown in Figure III. Figure V shows a modified form of element similar to that shown in Figure III but adapted for larger currents and lower voltages, and having a lower internal resistance. Figure VI shows a plan view of a spacer element used to confine the heat in my device.

Referring to the drawing, (1) represents a frame or base, which may be made of cast iron, steel, porcelain, or other desired material. On said frame (1) is a housing (2) covered by cap (3) which is held in place by cap nut (4), threaded on rod (5), the other extremity of which is supported in base (1). A spacer member (6) is mounted on base (1) and a corresponding co-acting member (7) is mounted at the upper end of rod (5). A heating member (8) is placed centrally of base (1) and extends vertically between spacing member (6) and spacing member (7).

Heating member (8) may be constructed in any desired form but I have found it very practical to construct it from an insulating tube (9), such as porcelain, upon which a

resistance element (10) is wound. Resistance wire may be of nichrome and may be coiled into independent spirals prior to winding on tube (9). For convenience, in the form of invention which I have shown I have indicated that insulating tube (9) surrounds rod (5), although this is a detail which is not essential to the construction of my device in its broadest form. The terminals of resistance element (10) are connected to a flexible lead (11), which in turn may be connected to any source of electric power, such as a lamp socket, etc. Conductor (12) shows the return conductor from the upper end of spiral (10) to flexible lead (11).

A series of elements (13), similar to the detail shown in Figures III, IV and V, are assembled in a somewhat radial manner around heating element (8). The elements (13) may be placed exactly radial, or in case the heating element (8) should not take the form of a cylindrical tube as shown, the elements would be placed substantially perpendicular to the surface of the heating element (8) at its nearest point.

It is intended in the case of large units to have several tubes similar to the single tube (8) in this unit, placed side by side, or various other obvious configurations are possible with equally satisfactory results, the essential point being that one edge of the sheet-like element (13) shall be in close proximity to the heating element (8), and the other edge shall be as far removed from the heating element (8) as possible. The element (13) is provided with interlocking notches or grooves (14) and (15) which are made to interlock with corresponding projections on spacing elements (7) and (6) respectively, thus serving to hold the elements (13) in a definite spacial relation.

Elements (13) may conveniently be made from a sheet or card formed of asbestos, asbestos composition, millboard, transite, bakelite sheet, or even thin strips of porcelain or related material. The desirable characteristics of the material from which plate (16) of element (13) is formed, are, it should be resistant to relatively high temperatures, it should be an electrical insulator, it should be a poor conductor of heat and should have reasonable mechanical strength to retain its shape and support the thermal elements.

The insulating covering (23) shown in Figures V and VI is provided with slot (24) to permit sliding over elements (13). Element (13) is provided with terminal screws (27), (28) for connecting the desired number of elements into a series as shown in Figures I and II. Binding posts (25) are connected to these at desired points.

Element (13) comprises a series of thermo couple elements (17) mounted on a plate or sheet (16). The thermo couple elements may be made of any desired composition but for practical purposes I prefer a combination of German silver for one element and antimony for the other element. On the drawing it may be assumed that element (18) represents the German silver, and the black element (20) represents the antimony. In place of German silver I may use copper, nickel, brass, or even tinned iron, and in place of antimony I may use zinc antimony, zinc aluminum, and similar elements.

I have found that the metals used for the couples can to excellent advantage be applied by the process of spraying. Spraying is best accomplished by heating the metal to a melting temperature and throwing it with considerable velocity against the surface to be coated. There are many commercial equipments for accomplishing this result and the spraying equipment itself constitutes no part of this invention.

In some well known processes which are very effective for the purpose of my invention, the metal is conveyed into a so-called sprayer in the form of wire, where it is melted by an oxyhydrogen flame so arranged that the velocity of the gases from the flame are sufficient to forcibly blow the melted metal against the surface to be coated.

Other equipments employ electrical means for accomplishing the melting, and a stream of air for forcing the melted metal on the surface to be coated.

I have found that it is also feasible to spray the metal on the surface in the form of a lacquer, and when applied with considerable velocity the lacquer coating is conducting. I prefer, however, some of the thermal methods of the type described above.

In the spraying of the metal it is convenient to form templates or stencils which cover up all parts of the asbestos sheet on which the metal is to be placed except those portions to be coated with metal. The coating of the sheet with metal in this manner permits of securing very thin layers and also of securing excellent contact between the two metals of the couple.

As a result of this arrangement very efficient couples are produced. Some of the advantages of these couples are, long life without deterioration, unusual contact between the two metals, relatively low heat conductivity and large ratio of surface to cross

section, thus making the heat transfer through the metal a minimum. By obtaining a low heat transfer through the metal, the outer or cooler end of the metal is naturally maintained at a much lower temperature than would otherwise be possible, thus increasing the efficiency of the device.

It will of course be evident that the cost of applying metals in this manner is relatively very low, as skill is reduced to a minimum and no special mechanical equipment is necessary for bending, seaming, forming, etc.

The excellent contact which is made at the terminals of the couples gives a maximum potential and a minimum electrical resistance. This permits of the use of equipment of this type as a generator of relatively large currents, which has not previously been possible.

The means of supplying the metals in the manner described permits of a permanent, substantial support, free from the difficulties due to welded or soldered joints.

The metal applied in this manner also appears to be in a peculiarly favorable condition for the production of electrical currents, due presumably to the intimate contact obtained, and possibly to the structure.

It will be apparent, of course, that my device provides a source of heat in the central portion, which source of heat is thoroughly insulated except for the series of elements arranged on the asbestos or other supports, as shown in Figure III. The outer ends of these elements, however, are exposed to the rapid movement of a current of air, as shown in Figure II. In Figure II the air enters through the series of holes (20^A) and passes upward through the space (21) between the outside of the system of elements and the shell (2). The cooling air also passes between the various elements at their outer end, leaving by a series of ports or holes (22) in the top of the cap (3).

The moving stream of air which passes in the manner described above, serves to keep the outer edge of the elements cool, thus giving the maximum available temperature difference, which of course increases the output of the equipment.

Since the only means by which heat can pass from the central coil is through the series of elements (13), and since the main body of the element (13) is composed of a material which has relatively high insulating properties (asbestos or the equivalent) as compared to the metals themselves, it is apparent that the efficiency of this equipment will be extremely high.

A measure of the efficiency of heat transfer would of course be approximately a measure of the heat conductivity of the metal of the couple to the asbestos sheet on which the couple is placed. This statement

assumes of course that the insulation of the balance of the equipment is relatively high.

Equipment of the class described may be used to operate the well known tubes of radio sets, either for heating the filament or supplying the plate potential, depending on the design of the equipment. The equipment may also be used for any other purpose where the source of a direct current is required, and the equipment it will be noted serves as a means of converting a direct current of one potential to a direct current of another potential by means of a conversion to heat.

The provision for circulating a cooling medium around the outside of the elements is an important feature, as the heat must be removed from the elements as rapidly as it is supplied, in order to maintain the desired potential difference on the couple. In this connection again, the means of spraying the metal which produces a rough matte surface, is very advantageously used and increases the efficiency of the device.

It will be apparent that many modifications can be made of the equipment described herein and still keep within the spirit of this invention. This invention, therefore, should be limited only by the disclosures in the prior art. It will be apparent, however, that by spraying the metals in place many important advantages may be obtained which cannot readily be obtained in other ways. One advantage is the ability to produce a thin layer which is a

poor heat conductor and exposes a large surface to radiation.

It will be apparent that if desired, one of the dissimilar metals which make up the couple may be of sheet or wire, applied to the supporting plate in any desired manner, in which case the other metal of the couple may be sprayed in place in contact with the other member of the couple.

Having now fully described my invention, what I claim as new and wish to secure by Letters Patent in the United States, is as follows:

1. A thermo electric couple consisting of two metals of granular form interlocked with an insulating support.

2. A thermo electric couple consisting of two dissimilar metal surfaces of granular form and supported in contact, said metal surfaces consisting of particles of metal sprayed onto an insulating support.

3. An electric generator consisting of a source of heat, a series of metal couples of granular form supported by insulating sheets, insulation around said source of heat, a shell enclosing said generator, and a circulation passage for air within said shell and around the outside edges of said sheets.

4. In an electric generator an element consisting of a metal layer of granular form.

5. A thermo electric couple consisting of two dissimilar metals in contact, one of said elements consisting of particles of granular form onto an insulating support.

WILLIAM A. DARRAH.