E. L. WIEGAND.

EMBEDDING PROCESS.

APPLICATION FILED JUNE 21, 1920.

1,398,410. Patented Nov. 29, 1921.

Fig. 1

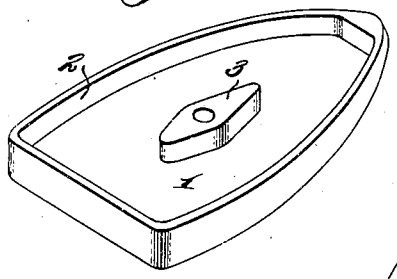


Fig. 2

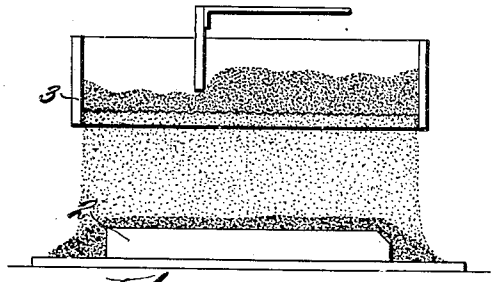


Fig. 3

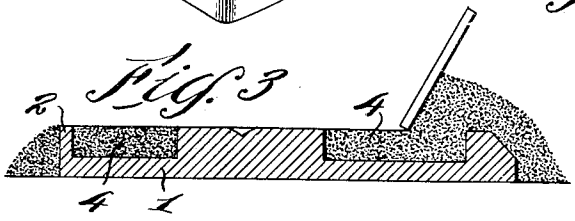


Fig. 4

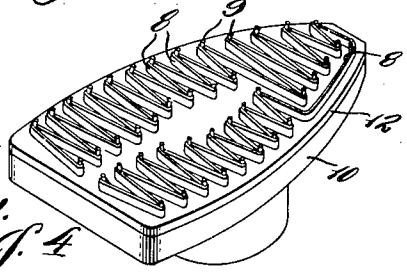


Fig. 5

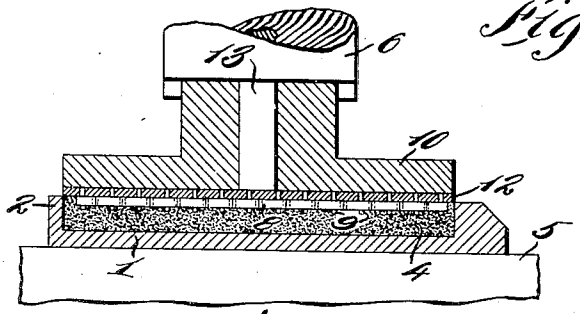


Fig. 8



Fig. 6

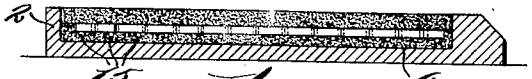


Fig. 9

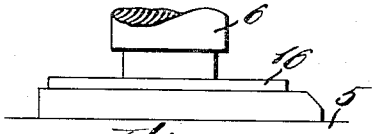


Fig. 10

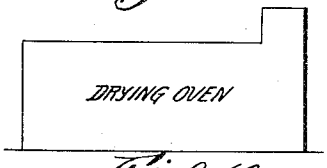


Fig. 11

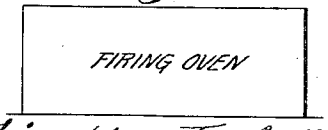
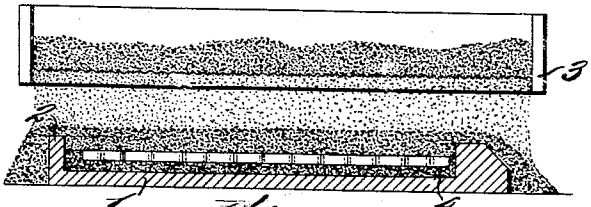


Fig. 7



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UNITED STATES PATENT OFFICE.

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EMBEDDING PROCESS.

1,398,410. Specification of Letters Patent. Patented Nov. 29, 1921.

Application filed June 21, 1920. Serial No. 390,392.

To all whom it may concern:

Be it known that I, EDWIN L. WIEGAND, a citizen of the United States, residing at Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a certain new and useful Improvement in Embedding Processes, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings.

This invention relates to a novel process of embedding elements in impressionable material, an example of its use being found in the production of electrical heating devices such as sad-iron, hot-plates, electric ranges, rheostats, and the like, for embedding the conducting member or resistor element in a supporting and insulating matrix and for reducing the latter to its permanent and final condition. The objects of the invention are the provision of a process of producing such devices which shall result in a final product of greater uniformity than heretofore, the avoidance of air pockets in the embedding material, and the securing of close contacts between such material and the resistor elements at all points; the provision of a process whereby the consistency of the embedding material can be more accurately controlled and its segregation prevented; the provision of a process which can be performed at higher speed, by more mechanical means, and with less reliance on the individual judgment and manual skill of the workman; the provision of a process wherein the steps follow each other immediately and without intervening change in the conditions of temperature or moisture; the securing of a better control of the amount of embedding material employed in connection with each unit; the provision of a process which facilitates the forming and embedding of large and massive elements; while further objects and advantages of the invention will become apparent as the description proceeds.

In the drawings accompanying and forming a part of this application, I have illustrated certain apparatus and procedures whereby my improved process may be practised, although it will be understood that I do not restrict myself to the precise steps or the precise order of such steps or the exact apparatus herein set forth. In these drawings, Figure 1 is a perspective view of an empty sad iron base into which an element is to be embedded by means of my improved process; Fig. 2 represents the preferred mode of applying the embedding material thereto; Fig. 3 represents the second step, namely of leveling the surface of such material; Fig. 4 is a perspective view of the winding form with the resistance element in place thereon; Fig. 5 illustrates the third step in the process, namely the inserting of the resistance element in the embedding material; Fig. 6 is a sectional view showing the element in place in the base; Fig. 7 illustrates the step of applying the final layer thereon; Fig. 8 the succeeding step of removing the excess material; Fig. 9 illustrates the final pressing or compacting; Fig. 10 represents the step of drying; and Fig. 11 the step of firing the dry units.

I have chosen for illustration herein the construction of a common domestic sad-iron of the electric type, although this is intended as typical of the manufacture of any electrically heated or other device to the making of which my process is adapted. The heating element is contained in a hollow metal shell or casing which here takes the form of the sad-iron base and is formed with a flat bottom 1 and a surrounding wall 2. The central boss 3 herein illustrated is used solely for the purpose of attaching the top parts of the iron and has no part in the present invention excepting to indicate how conveniently my process adapts itself to irregularities and special conditions. I first preferably moisten the interior of the recess by dipping or spraying with water, and then having emptied out all the water which will pour therefrom I set the base upright and fill it full of embedding material lightly sifted thereon from the sieve 3. While I do not restrict myself to any single embedding material, I preferably employ one consisting essentially of granular aluminum oxid as a base mixed with a small amount of binder which is ordinarily some kind of refractory clay. In general that material is chosen which exhibits the highest possible electrical resistivity at the different working temperatures for which the apparatus is designed and which shows the minimum decline in resistivity with increase of temperature. I prefer to use a binder that will mature or to some extent vitrify at the firing temperature and at the same time possess after firing an electrical resistivity equal to

that of the base. In quantity the binder and granular base should be so proportioned that the percentage of binder will be the minimum necessary to secure a completely graded mixture and to produce a finished unit with the necessary mechanical properties and a minimum of porosity. I preferably employ a granular base of about 180 mesh and with this I find that from about 12 per cent. to about 20 per cent. of binder constitutes a satisfactory composition, possessing a very small hygroscopic tendency and a very high thermal conductivity. This material is first carefully dampened with water to a uniform consistency which will permit it to be grated through a sieve having a mesh of about 12 to 16 wires per inch, and without balling. In this way all segregation of the ingredients is prevented and the moist material is broken up into a uniformly impressionable state, being uniformly mixed with air so as to form a soft mass.

As soon as the entire base has been thus loosely filled to overflowing with the sifted material, I level off the top by means of a scraper as shown in Fig. 3, leaving a light, uniform, porous, damp mass of embedding material indicated at 4. I now set this base upon the platen 5 of a hydraulic or other suitable press and by means of the movable member 6 thereof I insert the resistor element in the material and simultaneously compact said material so as to expel the air and firmly retain the resistor. In order to effect this the resistor, generally in the form of a flat ribbon wire 8, is wound upon a series of pins 9—9 of a form of the nature shown in my earlier Patent No. 1,133,347, and illustrated herein conventionally by the block or die 10 adapted for application to the member 6 of the press. Between the resistor and the face of the block or die there is interposed the movable stripper plate 12 which is apertured for the pins. The die 10 and press part 6 are equipped with means, such as an iron rod 13, which when forced against the stripper plate shall prevent it from accompanying the die when the latter is raised, thereby removing the resistor from the pins and leaving it embedded in the material 4 as shown in Fig. 6. In this way the resistor is first introduced into the embedding material when the latter is uniformly soft and impressionable, while the comparatively small amount of water contained in that material, coupled with the high pressure obtainable by the press, enables the same to be compacted so solidly as to secure a very close and heat-conducting contact at every point both of the base and of the wire, and to hold the latter firmly in place even though it possess a large amount of resiliency. Subsequent to the raising of the die, the stripper plate is removed.

The upper edge of the resistor is however still exposed and the withdrawal of the pins 9—9 has left a number of small cavities 15—15 adjacent the conductor which if not filled might produce hot spots in the latter and thus shorten its life. Accordingly, the base is again filled to overflowing with more of the same disintegrated material as shown in Fig. 7, after which the excess is removed by a scraper as shown in Fig. 8, and the material is finally compacted by the use of a plain die 16 operated between the platen 5 and plunger 6 of a hydraulic or other suitable press as shown in Fig. 9.

The unit is then transferred to a suitable drying oven where it is subjected to a gradual heating, preferably a current of air and beginning with a temperature below boiling and rising very slowly to a temperature of 400° to 500° F. As a result of the rather small size of the grains employed and the high pressure with which they are compacted the porosity of the mass is very small, which necessitates the removal of the water very gradually and without any such heating as would tend to disrupt the integrity of the mass or open additional pores. The time consumed for this drying operation depends upon the size and thickness and porosity of the unit and generally requires at least five to ten hours even with a small unit. When the highest temperature is reached the elements are transferred to a high temperature oven for the final firing. Preferably between these two steps the elements are tested electrically to ascertain the condition of the insulation and the presence of any appreciable moisture, but I prefer not to allow the elements to cool appreciably at this period.

The final firing is effected at the lowest temperature at which the binding material will become properly matured or partially vitrified but within the limit set by the nature of the various substances comprising the unit. It will be understood that the embedding material is not necessarily thoroughly vitrified by this operation inasmuch as the manner in which the embedding material is affected at the permissible temperature depends primarily upon the nature of the embedding material employed and only secondarily upon the operation performed. After cooling the units are ready to receive the different attachments generally employed therewith.

As material for the resistance unit, for application where the element is fired or used at a temperature of 1000° F. or over where exceptional durability is desired, I prefer to use one of the chromium alloys, such as chromium and nickel, or chromium and iron, although for applications where more moderate temperatures are encountered a simple nickel-steel alloy is frequently sufficient. I prefer to use these resistors in

ribbon form although round or other special shapes may be used. I do not restrict myself to the formation of the resistors into the design shown in my drawings, but any arrangement of wires may be employed. The embedding material should be one which has no chemical action upon the resistor at any temperature encountered in manufacture or use. I do not restrict myself to the employment of any given size or kind of press, since for small articles a common hand press is sufficient. My improved process is not restricted to sad irons but is equally applicable to electrical devices of all kinds operating wholly or partly on the conducting principle, for example contact and surface heaters, hot plates, electric ranges, melting pots, rheostats, etc., besides having application to things not electrical, when it is desired to embed an element in impressionable material. I do not restrict myself to a sifting of the embedding material into the casing inasmuch as the same result is secured in case the material is pre-sifted (or otherwise mixed uniformly with air) and then introduced into the casing in any suitable manner. I do not restrict myself to the use of the same kind of insulating material above the resistor as is employed beneath the same, nor to its introduction in the same manner as the first portions even when the same kind of material is used. My improved process is not limited to any one kind or nature of embedding material although to comply with the statutory requirements I have described one which will work perfectly but without intent to restrict myself thereto or in any other wise except as specifically recited in my claims.

Having thus described my invention, what I claim is:—

1. The process of producing an electrical heating element which contains the steps of first, introducing into a suitable receiver a uniformly impressionable mass of non-fluid embedding material, second, introducing into said mass a previously formed resistance element and simultaneously subjecting the mass to high pressure so as to compact the same and hold said resistance element in place, third introducing additional embedding material to cover said resistance element, next drying the mass, and finally bringing the same to a stable condition by the application of heat.

2. The process of producing an electrical heating element which contains the steps of preparing a non-fluid mixture of a liquid and a granular electrically non-conducting material which is insoluble therein, disintegrating said material and mixing the same with air so as to produce a uniformly impressionable mass, introducing into said mass a previously formed metallic resistance element, and compacting said mass under pressure to expel the air and integrate the material.

3. The process of producing an electrical heating element which contains the steps of preparing a non-fluid mixture of a liquid and a granular electrically non-conducting material which is insoluble therein, disintegrating said material and mixing the same with air so as to produce a uniformly impressionable mass, introducing into said mass a previously formed metallic resistance element, and simultaneously compacting said mass so as to expel the air and embed said resistance element firmly in the solidified material.

4. The process of supplying a receiving casing with an electrical heating element which contains the steps of first preparing in said casing a uniform non-fluid mixture containing liquid, gas and solid components each of which is insoluble in the other, and the solid component being a non-conductor of electricity, introducing into said mixture a previously formed resistance element and simultaneously subjecting the same to a sufficiently high degree of pressure to expel the gaseous constituents, and force the solid constituents into close contact with the element, the casing walls and each other, removing the liquid portions by evaporation, and curing the solid constituents by the aid of heat.

5. The process of forming an electrical heating element inside a receiving casing, which contains the steps of first dampening with liquid a pulverized, insoluble, embedding material, second, sifting the dampened material into the empty casing so as to produce therein a uniformly impressionable mass containing a considerable amount of air, introducing into said mass a previously formed resistance element, and afterward subjecting the mass to pressure whereby the air is expelled and the embedding material compacted into close contact with the casing and element.

6. The process of making an electric heating element which contains the steps of forming a resistance wire into a predetermined shape characterized by the possession of spaced, naked, turns, submerging such formed wire in a slightly moistened embedding material which has been rendered uniformly impressionable by grating through a sieve, and afterward subjecting the mass to a uniform pressure whereby the embedding material is compacted between and around said turns.

7. In the process of making an electric heating unit, the steps which consists of mixing the pulverized material uniformly with water and air to produce a light, non-fluid mass, introducing into the mass a resistor consisting of a plurality of turns of spaced wire, and compacting the mass so as

to expel the air and introduce the solid portions thereof uniformly between and around said wires.

8. The process of making an electric heating element which contains the steps of first producing an intimate uniform mixture of pulverized electrical insulating, heat conducting refractory material, binding material, water, and air, introducing therein a strand of metallic resistor, compacting said mass so as to expel the air and cause it to embrace closely said resistor, drying said element at a low temperature until the water is expelled, and finally raising the temperature sufficiently to mature and stabilize the binding material.

9. The hereindescribed process which comprises the steps of preparing a non-fluid mixture of a liquid and a granular material insoluble therein, disintegrating said mixture, embedding an element therein, and subsequently integrating the mixture by compressing it.

In testimony whereof I hereunto affix my signature.

EDWIN L. WIEGAND.