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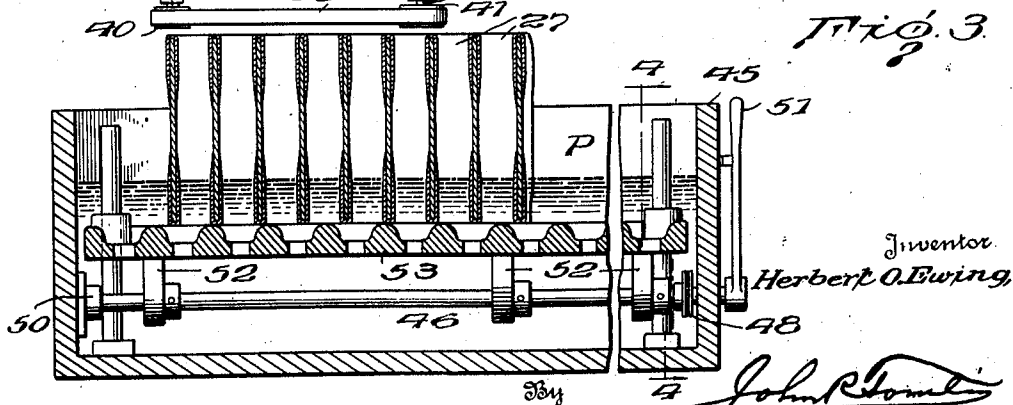
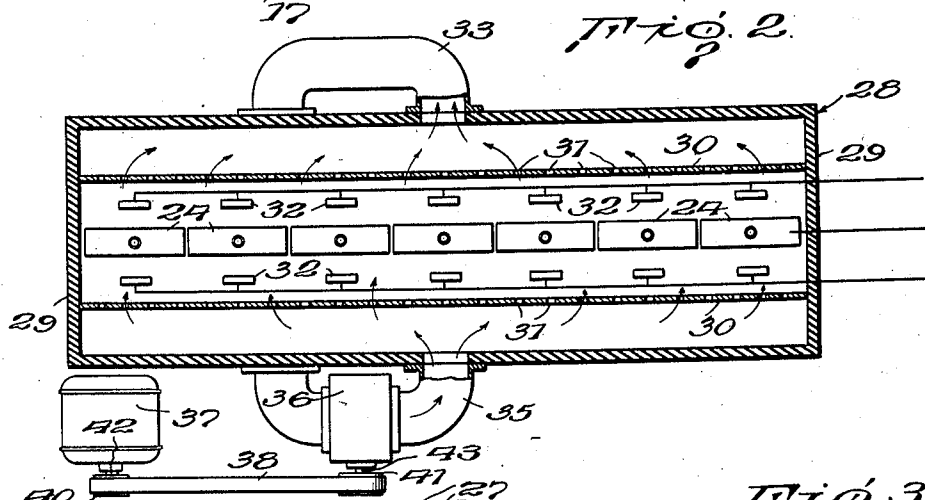
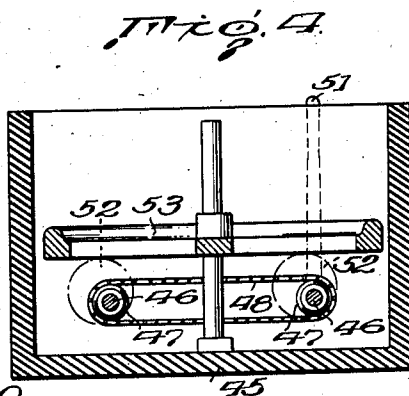
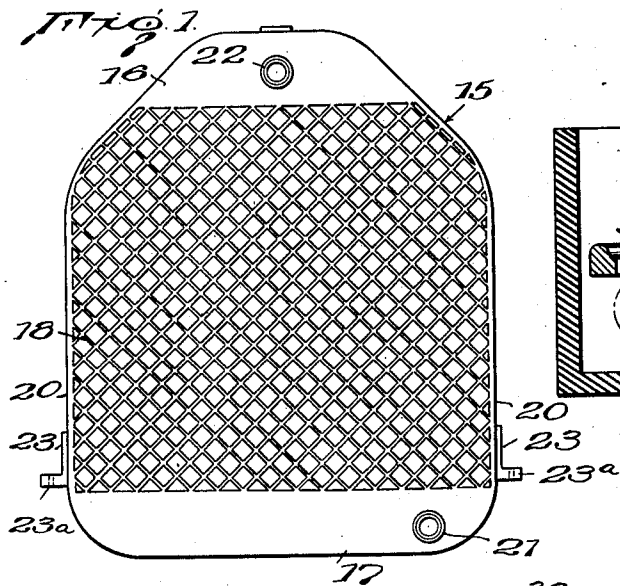
H. O. EWING

2,260,893

ELECTROFORMING METHOD FOR PRODUCING RADIATORS

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2 Sheets-Sheet 1



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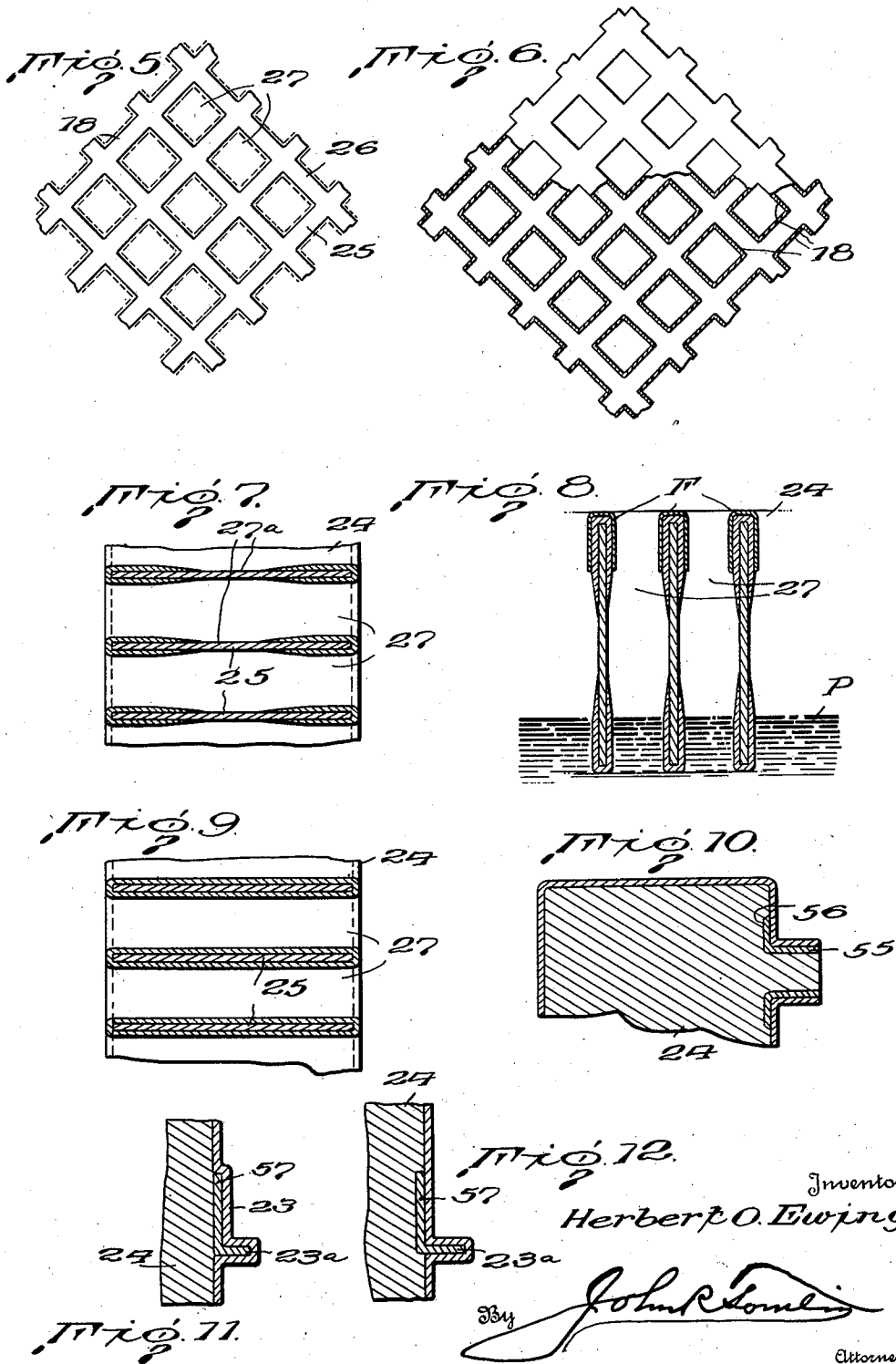
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UNITED STATES PATENT OFFICE

2,260,893

ELECTROFORMING METHOD FOR PRODUCING RADIATORS

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3 Claims. (Cl. 204—9)

This invention relates to improvement in the art of making radiators and similar hollow tubular or honey-comb structures, and the primary object of the invention is to provide a novel process whereby radiators and analogous structures may be inexpensively produced, and the hollow tubular body thereof formed as an integral seamless one-piece structure of great strength, the expense and other objections incident to soldering, brazing or other modes of joining component parts as usually practiced in the building of structure of this character being avoided, the seamless construction rendering the radiators free from leakage even though they may be subjected to vibration and other stresses.

The invention involves an improved process for the manufacture of hollow cellular heat-exchange bodies, such as automobile radiators and the like, by electrolytic deposition of copper or other metal of requisite strength on a fusible metal matrix or core, which matrix is subsequently removed from the electrolytically deposited metal by melting it from the formed body.

A specific object of the invention is the provision of a novel process for producing one-piece seamless radiators or other cellular heat-exchange bodies, by, first, producing a fusible matrix or core of the desired configuration, and, then, electrolytically depositing suitable metal thereon, and the provision of steps in the process for controlling the thickness of the electrolytically deposited metal at any point or area in the article to be produced.

A more specific object of this invention is the provision of an approved process for producing radiators or other hollow heat-exchange bodies, by, first, forming a matrix of fusible metal having a configuration to produce the required article, electrolytically depositing a coating of metal on the core or matrix, positioning the matrix or core with the electrolytically deposited metal thereon in a bath of paraffin or other suitable material to which the electrolytically deposited metal will not adhere during the electrolysis, again positioning the core or matrix with the electrolytically deposited metal thereon in an electrolytic bath or electrolyte to electrolytically deposit additional metal on the parts which have not been masked or coated by the paraffin, and repeating this process until the desired quantity of metal is deposited on all parts of the matrix core to insure a strong body, and then melting the fusible core from the electrolytically deposited metal so that the electrolytically deposited metal forms a strong one-piece seamless cellular heat-exchange body or shell.

Another object of this invention is the provision of a process for electrolytically producing strong one-piece seamless cellular bodies, such as radiators and the like, by providing a matrix

or core to which suitable reinforcing members or components are secured, and then electrolytically depositing suitable metal, having a higher fusing point than the relatively soft fusible core or matrix, on the core or matrix and also on the reinforcing members until a sufficient quantity of the metal is electrolytically deposited on the matrix and the reinforcing components, and then melting the fusible matrix from the electrolytically deposited metal and the reinforcing members leaving the reinforcing members secured to the electrolytically deposited metal to form reinforcements at the point of union between the reinforcing members and the electrolytically deposited metal.

A further object of this invention is the provision of a novel method for forming hollow or cellular bodies by electrolytically depositing suitable metal on prepared cores or matrices and circulating the electrolyte so that equal quantities of metal will be deposited at opposed sides of the matrices.

With the foregoing and other objects in view, which will appear as the description proceeds, the invention resides in the combination and arrangement of parts, and in the details of construction hereinafter described and claimed, it being understood that various changes in form, proportion, or details of construction may be made within the scope of the claims without departing from the spirit or sacrificing any advantages of the invention.

For a complete disclosure of the invention, a detailed description of the improved electrolytic process and mechanism will now be given in connection with the accompanying drawings forming a part of this specification, wherein:

Figure 1 is an elevational view of a conventional automobile radiator formed by my improved process,

Figure 2 is a horizontal sectional view, parts appearing in elevation, of the vat or tank in which the electrolyte, anodes and the matrices or cores are positioned during the electrolytic process,

Figure 3 is a vertical sectional view taken through the mechanism for coating the matrix or core and the electrolytically deposited metal with a suitable coating of paraffin or other fluid to which the electrolytically deposited metal will not adhere during the electrolysis process,

Figure 4 is a vertical sectional view taken on the line 4—4 of Figure 3,

Figure 5 is an enlarged fragmental elevational view depicting a portion of the tube or cell forming component of the radiator core or matrix,

Figure 6 is an enlarged fragmental elevational view depicting the tubular portion of the formed radiator, parts appearing in section,

Figure 7 is an enlarged detailed sectional view

taken through the core or matrix with a quantity of electrolytically deposited metal thereon and disclosing the condition of the radiator or cellular body during a phase of its formation.

Figure 8 is a similar view but depicting a portion of the matrix or core submerged to a predetermined depth in a paraffin or other suitable masking bath, and showing other portions of the matrix or core coated with the paraffin or masking material.

Figure 9 is a view similar to Figure 7 but depicting the condition of the body after additional metal has been electrolytically deposited thereon.

Figure 10 is a detailed sectional view taken through the matrix, and depicting the method of securing reinforcements to the electrolytically deposited metal, and

Figures 11 and 12 are similar views but depicting the method of securing reinforcements of different configurations to the electrolytically deposited metal.

Referring to the drawings in which similar reference characters designate corresponding parts, there is depicted in Figure 1 a radiator 15 formed by my improved process or method. Although radiators or other hollow heat-exchange members of various types may be formed with my process, the radiator here depicted is typical of the type to be employed in connection with internal combustion engines in which water is circulated around the combustion chambers and through a radiator to cool the engine. The radiator depicted includes a hollow crown tank or receptacle 16 formed at its upper portion and a hollow settling tank or pan 17 located at its lower portion. Cellular members or tubes 18 are formed in the body of the radiator between the tanks 16 and 17 and the sides 20 of the radiator. The ventilating or radiating tubes may be of any shape or form but the rectangular or diamond shape tubes 18, best depicted in Figures 1, 5 and 6, presents a preferred configuration. An inlet nipple or tube 21 is positioned in the lower portion of the radiator to communicate with the settling tank 17, and a similar nipple 22 communicates with the upper tank 16. There are various ways for securing the radiator 15 to its supporting structure, such as the chassis of an automobile, and to this end flanged securing ears 23 are formed adjacent the lower terminal of the radiator. Bolts or other suitable securing devices pass through the outwardly extending flanges 23a of the securing ears 23 to rigidly secure the radiator to its supporting structure, but inasmuch as such securing means are well understood by those skilled in the art and form no part of this invention they have not been illustrated in this application.

The radiator here disclosed is of conventional form and is illustrative of one of the many types of radiators or hollow tubular heat-exchange members that may be produced with my improved process. Preparatory to forming the radiator, a matrix or core of suitable configuration is cast or otherwise formed of blocked tin or other suitable material having relatively low fusing point. The matrix is cast in solid form, and in order to form the cellular or tubular radiating portion of the radiator, angularly disposed ribs 25 and 26, best shown in Figure 5, are provided, and these ribs intersect to form diamond shape or rectangular tubes 27 which extend entirely through the matrix or radiator core, as best shown in Figures 5, 7 and 8.

Any preferred number of suitably formed matrices or radiator cores 24 are positioned preferably in the central portion of an elongated rectangular tank or vat 28, shown in Figure 2, and this tank is formed of suitable material for the reception of the usual electrolyte. At each side of the row of matrices or cores 24 there is provided a perforated vertically-disposed partition 30, and the perforations 31 of these partitions are arranged to aid in uniformly distributing and circulating the electrolyte in the vat or tank 28 so that each core or matrix 24 is subjected to a sufficient quantity of electrolyte, as will be hereinafter more fully disclosed. To this end the apertures or perforations 31 of the partitions 30 are positioned progressively closer together as the end terminals 29 of the vat or tank 28 are approached. Although any preferred material capable of electrodeposition may be employed to form the radiators about the cores or matrices, copper is a preferred material, and, to this end, a plurality of copper anodes 32 are positioned in the tank or vat preferably at each side of the row of matrices and inside the perforated partitions 30. A conduit 33 communicates with the vat or tank 28 at one side of the row of radiator cores or matrices, and a similar conduit 35 communicates with the vat at the opposed side of the radiator cores. The conduits 33 and 35 communicate with a reversible circulating pump 36 of conventional construction which may be driven from any suitable source of power. A preferred means for driving the reversible circulating pump 36 includes a reversible electric motor 37 of conventional construction which is operably connected to the reversible pump 36 through a chain or belt 38 and pulleys or sprockets 40 and 41, the sprocket or pulley 40 being carried by the shaft 42 of the electric motor 37, and the sprocket or pulley 41 carried by the shaft 43 of the circulating pump 36.

After the cores or matrices 24 have been positioned in the vat or tank 28, the reversible electric motor 37 is actuated to drive the circulating pump 36. During the operation of the pump 36, it is driven in one direction for a given period and then reversed and driven in the opposed direction for a like period, thereby circulating the electrolyte, first, in one direction and, then, in the opposed direction through the perforated partitions 30, so that copper from the anodes 32 are deposited on the fusible matrices or radiator cores which are electrically connected in the circuit to serve as cathodes. The conduits 33 and 35 communicate with the tank or vat 28 near its central portion and at each side of the matrices, and by positioning the apertures or perforations 31 of the partitions 30 progressively closer together as the ends 29 of the vat are approached, the electrolyte is uniformly circulated so that a like quantity of electrolyte and electrolytic metal reaches each radiator core. This process is continued until the requisite quantity of metal is electrolytically deposited on the open and exposed surfaces of the fusible radiator core or matrix.

It is well known, however, to those skilled in the art, that in the action of an electrolytic process a greater quantity of metal is deposited on open exposed surfaces than on the more remote congested surfaces. In forming a radiator having a plurality of small elongated cells or tubes, a greater quantity of metal is deposited on the front and rear walls of the radiator matrix and on the exposed peripheral surfaces of the matrix tubes than on the central portion of the matrix tubes 27. In the form of radiator here

depicted, the cells or tubes 27 are of relatively small cross section and of relatively great length, consequently the intermediate portion of each tube 27 receives practically none, or, at best, a small quantity of electrolytically deposited metal. In Figure 7 there is depicted the condition of the radiator matrix after it has been subjected to the action of the electrolyte bath. The front and rear walls of the matrix 24 are supplied with ample electrolytically deposited metal but the intermediate portion 27a of each tube 27 has, at best, a thin coating of electrolytically deposited metal. This, of course, produces a faulty radiator structure, because the thin intermediate portion of each tube would break down in commercial use. If the electrolytic process were continued long enough to deposit the requisite quantity of metal on the intermediate portion of each cell or tube, then an excess quantity would be deposited on the open or exposed surfaces of the radiator core.

In order to overcome this difficulty and to produce a radiator having walls of controlled thickness throughout, applicant provides a tank or receptacle 45, shown in Figures 3 and 4, having spaced shafts 46 extending longitudinally there-through, and each shaft is provided with a sprocket or pulley 47 about which a chain or belt 48 is trained in order to rotate the shafts in unison. The shafts 46 are rotatably mounted in suitable bearings 50, and one of the shafts extends through the wall of the receptacle and has a manipulating lever 51 secured thereto. Cams 52 are secured at spaced intervals along each shaft 46, and these cams engage the lower surface of a grating or platform 53 which is mounted for vertical sliding movement in the tank or receptacle 45.

After the radiator cores or matrices have been subjected to the electrolytic bath for a period of time, in which the requisite quantity of metal is electrolytically deposited on the exposed portion of each matrix or core, the cores are then removed from the electrolyte and washed preparatory to their removal to the dipping or masking tank 45, shown in Figures 3 and 4. After the matrices or cores 24 have been removed from the electrolytic bath and cleaned, any convenient number of them are then placed on the platform 53 with their tubular cells 27 positioned upright. The manipulating lever 51 is then rotated, thereby rotating the cams 52 to lower the horizontal platform 53 until the lower terminals of the tubular cells 27 have been projected sufficiently far into the hot paraffin bath to coat the portion of the matrix which has sufficient metal deposited thereon. After the terminals of the cellular tubes 27 have been coated at the lower side of the submerged radiator cores 24 the cores are reversed on the platform 53, and the operation is repeated so that the portion of each radiator at its opposed side which has sufficient metal deposited thereon receives a coating or film of paraffin, which deposit or film is best indicated at F in Figure 8. In this figure the upper portions of the tubes have received their paraffin bath, and their lower portions are being dipped in the bath a sufficient depth to mask the portion of each tube which has had sufficient metal deposited thereon. After the radiator cores have been dipped in the hot paraffin to receive a masking or film coating on their portions which have insufficient metal thereon, these cores are again positioned in the electrolytic bath and the electrolytic process repeated. During this process the outer surface

of the radiator cores and the terminal portions of the tubular cells which have had sufficient metal deposited thereon in the previous electrolytic operation are masked out by the paraffin coating, so that no additional metal is deposited on the paraffin coating, but additional metal is deposited on the intermediate portions of the tubes, and this process is continued until the requisite quantity has been deposited on the intermediate portions of the tubes and all remote portions of the radiator cores. While two electrolytic operations are sufficient in most instances, it is, of course, to be understood that this operation may be repeated until the requisite quantity of material has been deposited on all portions of the radiator cores or matrices. Any suitable means may be employed for heating the paraffin in the tank 45, and, inasmuch as such heating means is common and well understood by those skilled in the art, it has not been illustrated in the application. Figure 9 depicts the condition of the radiator core or matrix after the requisite quantity of material has been electrolytically deposited thereon. If, for any reason, it should be desirable to have a greater quantity of material deposited at the intermediate portion of each tube, this could be readily done by repeating the electrolytic process after the superficial or exposed portions of the matrix has been properly masked by dipping it in the paraffin bath or other suitable masking fluid. Inasmuch as the cams 52 raise and lower the grating or platform 53 any predetermined distance and maintains it in horizontal position, it is manifest that each radiator matrix 24 may be dipped into the bath P a predetermined distance to accurately cover or mask the portion of the radiator which has received the requisite quantity of metal, thus leaving the remaining portion on which only a scanty supply of metal has been deposited free for subsequent electrolytic deposition.

After the requisite quantity of metal has been uniformly electrolytically deposited on each matrix or core, the metal covered matrix is then placed in an oven or otherwise heated until the temperature is raised above the fusing point of the fusible matrix or core, thereby melting the core but leaving the electrolytically deposited seamless shell intact. The molten matrix metal is drained from the shell, thus leaving a structure of the desired configuration with a hollow tank formed at its upper portion and a similar tank at its lower portion and a radiating portion formed by spaced cells or tubes with narrow water passages therebetween as, best shown in Figures 1 and 6.

The nipples or tubes 21 and 22 and the reinforcing or supporting members 23 may be formed by masking out the remaining portion of the radiator core so that a relatively heavy deposit of metal may be made at these points, and inasmuch as the quantity of metal deposited on any portion of the radiator can be controlled by the masking processes, it is manifest that any degree of strength may be secured according to the quantity or thickness of metal deposited. It is preferred, however, that these portions of the radiator be supplied with reinforcing members, and, to this end, a short nipple or tube 55, as shown in Figure 10, is cast or otherwise secured to the matrix, and this nipple is provided with an annular flange 56 which is preferably embedded in the matrix, although it is to be understood that the flange may be secured to the outer

portion of the matrix if preferred. The matrix is then subjected to the hereinbefore described electrolytic process until a sufficient quantity of metal is deposited on the matrix and also on the nipple 55 and its flange 56. After the matrix has been melted and removed from the electrolytically deposited metal, the nipple, 55 which is formed of copper, steel or other metal of high fusing point, remains as an integral part of the radiator shell and serves as a reinforcement for this portion.

The same method may be also employed to secure any reinforcing plate, securing pad or securing member to the radiator shell, and, in Figure 11, there is depicted a method in which the reinforcing ear 23 is formed by casting or otherwise securing an angular plate 57 of relatively high fusing point to the matrix 24, and then electrolytically depositing the requisite quantity of metal thereover. After the fusible matrix has been removed from the electrolytically deposited radiator shell, the angular plate 57 remains as an integral part of the shell to serve as a reinforcement therefor. The body of the angular plate 57, in the form of the invention depicted in Figure 11, is secured to the outer surface of the formed radiator matrix or core 24 so that the electrolytically deposited metal forms an offset portion. However, if preferred, the body of the angular plate 57 may be let into the matrix so that its outer face is flush with the outer surface of the matrix 24, as depicted in Figure 12. While the plate 57 in the present instance has been shown as of angular formation, it is, of course, to be understood that a reinforcing plate of any configuration may be secured to any selected portion of the radiator shell and formed integrally therewith by simply electrolytically depositing the requisite quantity of metal thereon. By this arrangement, securing or reinforcing pads or members may be placed at any desired portion of the radiator shell without affecting the process of electrolytically depositing the metal on the matrix.

From the foregoing it is seen that this process enables the operator to control the quantity of metal electrolytically deposited on any portion of the radiator. The remote or inaccessible portions of the radiator, which heretofore received only an insufficient quantity of metal, may be built up to any required thickness, and, if necessary or desired, the remote or inaccessible portion of the radiator may be built up to a thickness in excess of the remaining portions thereof. Furthermore, the joints between the sides of the radiator and the terminals of the tubes or cells may have thickness somewhat in excess of the thickness of the remaining portions of the tubes by simply depositing a heavy deposit of metal on these portions, and then arranging the masking process so that a smaller quantity of metal will be deposited on the remaining portions of the tube so that the junctures between the tube terminals and the radiator front and back may present relatively great strength.

What I claim as new and useful is:

1. The method of producing hollow radiator bodies having a plurality of tubes, which consists in forming a fusible core having tubular apertures extending therethrough, electrolytically deposit-

ing metal of higher fusing point than the core on the core, immersing opposed sides of the core to a predetermined depth in a bath of liquid masking material which liquefies at a temperature lower than the melting point of the fusible core so that the masking material adheres to and covers the portions of the core and its tubular apertures on which sufficient metal has been deposited, leaving the remote or intermediate portions of the tubular apertures on which an insufficient quantity of metal has been deposited free of the masking material, electrolytically depositing additional metal on the unmasked portions of the radiator core until sufficient metal has been deposited on these portions, and raising the temperature of the core, masking material and deposited metal higher than the melting point of the fusible core to thereby melt the core and masking material from the deposited metal.

2. The method of producing hollow radiator bodies having a plurality of tubes, which consists in forming a fusible core having tubular apertures extending therethrough, electrolytically depositing metal of higher fusing point than the core on the core, immersing opposed sides of the core to a predetermined depth in a bath of liquid masking material which liquefies at a temperature lower than the melting point of the fusible core so that the masking material adheres to and covers the portions of the core and its tubular apertures on which sufficient metal has been deposited, leaving the remote or intermediate portions of the tubular apertures on which an insufficient quantity of metal has been deposited free of the masking material, electrolytically depositing additional metal on the unmasked portions of the radiator core until sufficient metal has been electrolytically deposited on these portions, repeating these operations until predetermined quantities of metal have been electrolytically deposited on selected portions of the radiator, and raising the temperature of the core, masking material and deposited metal higher than the melting point of the fusible core to thereby melt the core and masking material from the deposited metal.

3. The method of producing hollow radiator bodies having a plurality of tubes, which consists in forming a fusible core having tubular apertures extending therethrough, electrolytically depositing metal of higher fusing point than the core on the core, supporting the radiator core on a support which is movable vertically in a bath of liquid masking material which liquefies at a temperature lower than the melting point of the fusible core to thereby lower the core into the liquid masking material to a depth sufficient to cover the portions of the core and its tubular apertures on which sufficient metal has been electrolytically deposited, leaving the remote or intermediate portions of the tubular apertures on which an insufficient quantity of metal has been deposited free of the masking fluid, and raising the temperature of the core, masking material and deposited metal higher than the melting point of the fusible core to thereby melt the core and masking material from the deposited metal.

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