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HIGH FREQUENCY SHIELDING

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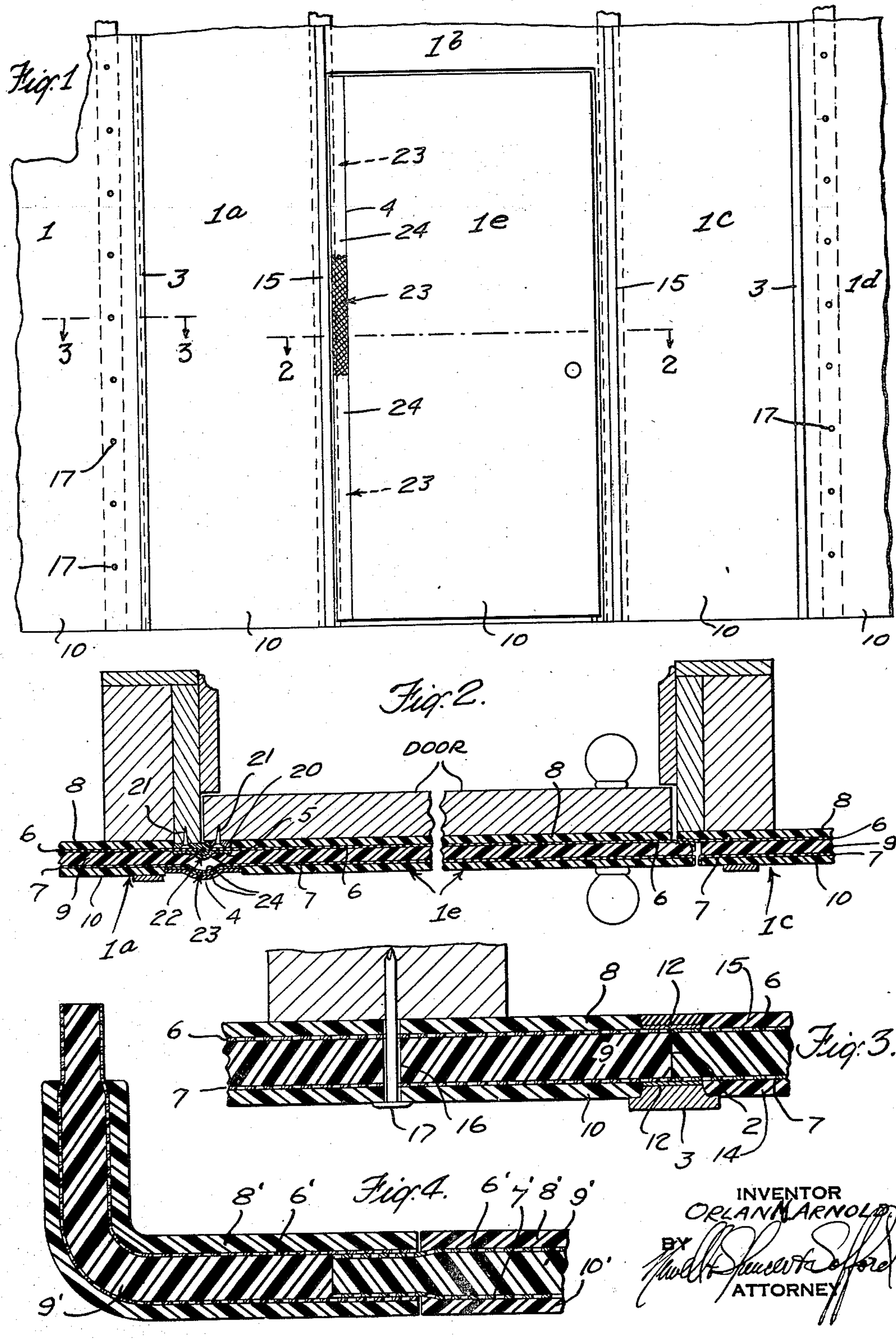

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HIGH-FREQUENCY SHIELDING

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14 Claims. (Cl. 174—35)

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This application relates to shielding against high frequency electrical effects, and more particularly to the shielding of the high frequency equipment, e. g., as used by the medical profession for treating human ailments, and in general any equipment whether scientific or commercial, which may send out high frequency electrical waves.

A great deal of trouble has arisen in the past, due to the difficulties in preventing high frequency electromagnetic waves escaping from the point of origin and causing interference in radio channels even as far as thousands of miles away. This is particularly the case in the short wave channel where "skip" distances are long and shielding problems are particularly difficult.

Attempts have been made heretofore to prevent the escape of such stray waves by shielding, and it has become accepted as a necessity for effective shielding of a room where the high frequency is used to provide a double shielding spaced by several inches. Thus, in most cases, 2'' x 4'' timbers have been used to separate the two layers of shielding. To box in a room with such 2'' x 4'' timbering and to place the shielding on both sides of this timbering has been expensive in construction and consumes valuable space in the buildings where it is used, and in some cases would so far have reduced the size of the room involved as to render such shielding totally impracticable.

It is an object of my invention to provide a shielding which can be easily placed on all four walls, the floor and ceiling of a room without substantially decreasing the cubic content of the room.

It is another object of my invention to provide a shielding which can be applied in the form of sheeting and which will not take much time to apply.

It is still another object of my invention to provide a shielding which will be more effective than the present shielding and will provide no place through which the high frequency electromagnetic rays may leak out.

It is another object of my invention to provide a shielding which will not be affected by changes in the humidity of the air but which will be as effective on wet days as on dry days.

It is another object of my invention to provide a shielding which will be effective in all frequencies.

It is another object of my invention to provide a shielding which can be easily placed over doors and other apertures and which will not affect their functioning.

It is another object of my invention to provide shielding in flexible blanket form which can be thrown over a patient and/or a high frequency apparatus when it is not possible to shield the entire room.

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Other objects of my invention will be apparent to anyone skilled in the art from the following description and the accompanying drawing, in which:

Fig. 1 is a view in elevation of a wall of a room shielded with the shielding board made in accordance with my invention.

Fig. 2 is a cross-section taken on line 2—2 of Fig. 1 through a portion of one of the shielding panels and a door;

Fig. 3 is a cross-section taken on line 3—3 of Fig. 1 showing one method of joining two pieces of shielding board in adjacent panels; and

Fig. 4 is an alternative method of joining two such pieces of board.

Referring first to Fig. 1, I have shown the side view of a wall having five separate panels 1, 1*a*, 1*b*, 1*c* and 1*d* of the shielding material and a door 1*e*, also shielded with the shielding material made in accordance with my invention. As shown, the joints 2 are covered with a strip of plastic or other material 3 whereby to give the wall a paneled appearance and to make the shielding entirely inconspicuous.

The door 1*e* is bonded electrically to the wall through the metal tapes 4 and 5 which are secured in electrical contact to the inner and outer conducting layers of the conducting material 6, 7 respectively of the door 1*e* and the panel 1*d*. The door may also be arranged so that, when it is closed, the conducting layers 6, 7 of the door shield make electrical connection by mechanically pressing against the edges of the shield of the side walls themselves or this electrical contact may be augmented by bonding along the hinged joint of the door in numerous places whereby to provide sufficient bonding. In any case, however, since the ultra-short-wave, i. e., from 30 or 40 meters down to centimeters, travel more or less in line of sight and do not readily turn corners, it is important that the shielding overlap if it is not made electrically continuous, whereby to trap the waves which may be propagated in the door before they escape from the room.

In Figs. 2 to 4, I have shown a form of sheeting made in accordance with my invention in which a plurality of sheets of a plastic material (in this case three) 8, 9 and 10 are sandwiched with a plurality of sheets 6 and 7 of a conducting material (in this case two) suitable for shielding. This shielding material may be, for example, copper, aluminum, or some similar conducting material (preferably non-magnetic), either solid sheet or open work, pierced or mesh.

I have found that wire screen is not as satisfactory for this purpose as a continuous sheet. Thus thin rolled or plated metal sheet approaching foil in thickness may be used, with or without embossing and/or piercing in order to improve its bonding to the insulating layers. Wire screens woven to a narrow mesh and plated, dipped or otherwise clad with a continuous layer of metal to electrically bond the crossing wires, behaves very much like a continuous sheet and may be suitably used for this purpose. The openings in such screen may be e. g., about 1/100 inch in width. Such a material is effective for shielding at the higher frequencies now used in medical apparatus. If these very high frequencies are not being generated larger openings may be used, since it appears that the very short waves may escape through the larger holes in the screen with sufficient energy to cause objectionable interference. Unpierced sheet metal, e. g., copper or aluminum, would be best, but it is difficult to bond the plastic material directly to such a sheet of metal and to maintain the bond with sufficient strength. I have found that the type of screen manufactured by C. O. Jelliff Manufacturing Corporation, and known commercially as "Lektromesh," provides the desired characteristics, particularly in that it has the openings formed in the metal while it is deposited in an otherwise smooth surface and is, therefore, free from projections which may occur in embossed or pierced metal. This "Lektromesh" is a continuous sheet of metal electrolytically deposited with narrow perforations. This type of screen has the advantage that, while providing a shield having very small apertures and being made as an integral piece having good conductivity throughout, it yet allows the sheets of plastic 8—9—10 to bond through the perforations and form a single integral sheet with the shielding metal permanently in place.

The insulating material must necessarily, because of the close clearances between the two metal sheets, be material having good and stable insulating properties and be a good and stable dielectric and especially should be non-hygroscopic. This insulation may be, for example, polyethylene plastic, polyphenylene-ethylene, polystyrene plastic, polybutene plastic, vistanex, or in general one of the type of stable insulating materials more fully discussed below.

In Figure 2, I have shown one manner of treating a door opening according to my invention. In this case the door is hung on a continuous strip hinge 20 of the type commonly referred to as piano hinges. This may suitably be made of metal and thus take part in the shielding, although it need not be. The screws 21 by which the hinge is secured to the door and frame are preferably of insulating material, e. g., compressed fiber, so that these will not present conducting points for propagation of high frequency waves. The shielding boards used may have their outside insulating layer 8 and 10 stopped short of the edge of the board as shown and thus the metal layer 6 may be brought into direct electrical contact with the hinge 20. The hinge alone may thus serve to connect electrically the metal layers 6 of the adjoining shielding boards, but I prefer not to rely upon this but to solder to each exposed strip of the respective layers 6 a flexible braided or woven wire tape 22. A similar connecting tape 23 is soldered to the exposed strips of the layers 7, and this may be further insulated, especially on the inside, and also on the outside if desired, by a strip 24 of flexible insulating plastic such as the hydrocarbon polymers mentioned below.

At the other edges of the door one only of the outer layers, e. g., 8, is cut back and on one only of the abutting boards. On the other abutting board one of the outer layers, e. g., 8, and the conductor 6 are extended beyond the other layers as shown. Thus the layers 6 come into contact with one another when the door is closed and overlap any gap in the layers 7.

In Fig. 3, I have suggested one way of making a joint between two adjacent sheets of the shielding. In this form of joint I have extended the two metallic layers and, advantageously, also the center layer 9 of the insulation beyond the ends of the external insulating layers 8 and 10. The exposed end of each conducting sheet 6 or 7 can advantageously be tinned so that it can be easily soldered or may be coated with a low melting solder so that it can be bonded to another similarly coated strip 12, by merely running a hot soldering iron along the strip with sufficient pressure to bring them together. Whether tinned or solder-coated it is an advantage to clean the surface of the metal or otherwise prepare it for soldering before the wall is assembled, e. g., in the manufacture of the composite shielding board, and then to coat the prepared strip with a protecting film of soldering flux. In this way a solid electrical and mechanical bond can be produced.

In the form shown in Fig. 3, a flat strip of plastic 14 or 15, e. g., of the same material as the sheets 8, 9 and 10 of the shielding board, may be inserted between the edges of the layers 8 and 10 to cover the soldered joints and complete their insulation. These strips should fit snugly and to this end may be slightly tapered, as shown, and are cemented into place, thereby making the shielding appear as a panel and completing the decorative effect of the wall. Instead of a separate strip 14—15, I may have an integral portion of the edge of the sheets 8 and/or 10 left free from the mesh 6 and/or 7 so that it can be turned back to expose the mesh and permit soldering and later pressed and cemented onto the mesh.

In Figure 4 also, I have shown an appropriate treatment of corners. Pre-molded corner strips and dihedrals are fitted into the corners of the room and assembled with adjacent sheets and other corner members in the same manner as for adjacent sheets. To facilitate assembly these strips may be supplied loosely assembled so that the outer insulation 8′ with the outer mesh 6′ may be first put in place and the mesh soldered to that of adjacent sheets; then the intermediate insulation 9′ with the inner mesh 7′ may be put in place and the latter soldered to adjacent sheets; and finally the inner insulation 10′ is pressed and/or cemented into place.

In Figure 4, I have shown an alternative form of joint in which the tongue and groove system is followed, one edge of the sheeting having a tongue formed by extending the center insulating layer 9 with the conducting sheets 6 and 7 exposed on each side thereof; and the other edge having a groove formed by stopping the inner layer 9 short of the conducting layers 6 and 7 and the outer insulating layers 8 and 10. Thus the conducting material in both cases extends out to the edge of the board whereby to make good electrical as well as mechanical contact. When the two sheets are fitted together as shown in Figure 4, they form a substantially flush joint, which may then be made perfect in form and electrical contact by use of heat and pressure. To this end a very low melting solder may be used on the exposed strips of the metal layers 6 and 7 which will bond at a temperature not substantially above the softening temperature of the insulating plastic of the layers 8, 9 and 10, in which case heat and pressure applied to the exterior over the joint may at the same time form the metal and fuse or mold the edges of the plastic; or a resistance element may be woven into or otherwise associated with the edge of the mesh 6 and 7 whereby to produce heat internally at the joint where the solder is to be fused, with or without fusing the edges of the plastic layers 8, 9 and 10 together. This construction may have the further advantage, in the event soldering is not used, that by properly and perfectly dimensioning the size of the tongue and the groove, a good contact may be obtained mechanically without soldering and this good mechanical contact may assure a sufficiently good electrical contact where soldering is not possible. If the size of the groove and the length of the tongue are equal, the two edges of the outside layers of plastic may abut one another, and the additional strip of plastic material thus may be unnecessary.

In Figure 3, I have shown a method of attaching the shielding board to the frame or walls, floor or ceiling of the room in which the shielding is to be installed. For this purpose I form small nail holes 16 in the plastic and slightly larger registering holes in the metal sheets. The holes 16 are of approximately the same size as the nails to be used. Thus nails even of metal may be used without short-circuiting the two layers of metal sheet together. It is more advantageous, however, to use nails of compressed fibre or other insulating material, and when such insulating nails are used it is not essential to provide special preformed holes in the shielding board, although it is of substantial advantage. The further advantage exists that the fibre nail need displace only that area of metal shield that it actually goes through, thus reducing to a minimum the opening in the shielding through which any high frequency wave might escape.

In the actual use of this shielding it is found that great benefits are obtained if one of the metal sheets is grounded and the other, e. g., the outer, is floating, i. e., is insulated from all other parts, or vice versa.

I have found it advantageous to use for the conducting layers 6 and 7 a smoothly polished metal which does not have any points projecting from the average surface of the sheet, for these points may form radiation points from which the high frequencies may tend to propagate new waves. The ordinary Lektromesh, mentioned above, and more especially a pierced foil or sheet metal, is ordinarily perfectly smooth on one side but the other side of it is apt to have microscopically small burrs projecting. I find it advantageous to smooth this rougher side so as to obtain a perfectly smooth effect on both the front and back and thereby to eliminate any effect of radiation of the ultra high frequency, if this is not done it is best to face the smooth side outward from the room.

While I have particularly pointed out the advantage of the use of Lektromesh, it is to be understood that my invention may be used with woven wire screen or other types of sheet metal or foil. When wire screen is used it should be of mesh sufficiently small to stop the highest frequencies concerned and of wire size sufficiently large to avoid over-heating. The limits of these dimensions as of other dimensions given herein

obviously depend upon the wattage and frequency of the apparatus concerned. For the ordinary hospital and clinical apparatus now in use I prefer to use a mesh or sheet having apertures not over 0.01 inch and wire of diameter should be at least several hundredths of an inch or metal sheet at least 0.005–0.008 inch if of copper and two or three times greater if of aluminum.

The outside sheets of the plastic material, that is those which are visible in the room, may be given any desired surface treatment for artistic appearance. Thus the physical or decorative characteristics of the surface may be improved or modified by coating with a solution of one of the di-electric plastics with or without coloring matter, etc., and the flooring may be made with an additional layer of plastic or tile, etc., to take the wear.

The thickness of the insulating layers will depend upon the particular di-electric chosen, upon the frequencies and wattage to be encountered, and upon the efficiency of shielding required. In general, it should be a material having very low dielectric constant and with low dielectric loss, particularly very low moisture sensitivity. Using polystyrene, I find 1/8″ for the center layer 9 and 1/16″ for the layers 8 and 10 to be suitable. Polystyrene plastics are preferred among those now available because of the low moisture absorption—less than 0.1% gain in weight from complete dryness to stable weight in water saturated air at room temperature. Vistanex, an isobutene polymer, and the polyethylene polymers are also suitable but have somewhat higher moisture absorption. Non-polar compounds specifically the hydrocarbon polymers which are sufficiently saturated so as not to be oxidized to polar compounds by air, are preferred as a class. Methacrylates, although usable for my invention are not recommended, as now available, because of their higher moisture absorption unless special precautions are taken to protect them against moisture or unless they are to be used only in a dry atmosphere. In general the material used for this purpose should be one with dielectric constant not over 3 and a moisture absorption, measured as above, not over 1–2%. The higher the dielectric constant and the greater its variation due to moisture absorption the thicker should be the sheets 8, 9 and 10 made of such material. The inner layer 9 is, of course, of most importance, and the outer layers could be of poorer material or even omitted, but that is not recommended. The inner layer 9 may in some cases be made in the form of a grid or perforate sheet in order to save insulation material. In this case the several layers should be assembled in a dry atmosphere, and the inner layer should be hermetically sealed by the outer layers so that no substantial changes in humidity may occur in the openings between the metal sheets 6 and 7.

Although I have above referred particularly to wall, floor and ceiling coverings, my invention may also be applied in flexible blankets which may be thrown over and around the patient and connections and/or over and around any portable or temporary apparatus where, for any reason, it is not feasible to operate in a properly shielded room. For this purpose flexible plastics may be used with flexible woven wire or flexible metal sheet combined substantially as already described above. In general, I prefer for this purpose the softer (i. e. lower) polymers of hydrocarbons of the type mentioned above, and particularly an isobutene polymer of the type sold as "Vistanex" without plasticizers or other compounding ingredients which would adversely affect the stability of its dielectric value. These may be used and combined with the metal sheets and may be joined edge to edge substantially as described above and as shown in Figs. 3 and 4, the insulating layers being more readily flexible in this case than is necessary when the shielding is to be applied to walls.

It should be understood also that, although I have referred particularly to rooms, my invention may be applied as well to the shielding of any space whether it is an entire building or a smaller case, e. g., to enclose a single apparatus.

What I claim is:

1. A high frequency shielding material which comprises spaced sheets of metal having smoothly polished surfaces protected against corrosion and mechanical injury by covering layers of insulating material and separated from one another by a layer of stable substantially non-polar insulating material, the whole being united into an integral sheet.

2. A high frequency shielding material which comprises spaced sheets of metal having smoothly polished surfaces protected against corrosion and mechanical injury by covering layers of insulating material and separated from one another by a layer of stable substantially non-polar insulating material having dielectric constant less than 3 and moisture absorption less than 2% total weight increase from complete dryness to constant weight in moisture saturated air at room temperature.

3. A high frequency shielding blanket which comprises spaced flexible sheets of metal having smoothly polished surfaces protected against corrosion and mechanical injury by covering layers of flexible substantially non-polar insulating material and separated from one another by a layer of stable insulating material, the whole being united into an integral sheet.

4. A high frequency shielding material which comprises spaced smooth perforate sheets of metal and a mass of insulating material in the space between said sheets, extending through the perforations thereof and covering the exterior surfaces thereof which comprises a stable non-polar material having a dielectric constant less than 3 and a moisture absorption less than 2% total weight increase from complete dryness to constant weight in moisture saturated air at room temperature.

5. A high frequency shielding material which comprises spaced smooth perforate sheets of metal, the perforations of which are less than 0.01 inch average width, and a mass of insulating material in the space between said sheets, extending through the perforations thereof and covering the exterior surfaces thereof which comprises a stable non-polar material having a dielectric constant less than 3 and a moisture absorption less than 2% total weight increase from complete dryness to constant weight in moisture saturated air at room temperature.

6. A high frequency shielding material which comprises spaced perforate sheets of metal free from projecting points and the perforations being less than about 0.01 inch in diameter and a mass of insulating material in the space between said sheets, extending through the perforations

thereof and covering the exterior surfaces thereof which comprises a stable non-polar hydrocarbon polymer having a dielectric constant less than 3 and a moisture absorption less than 2% total weight increase from complete dryness to constant weight in moisture saturated air at room temperature.

7. A high frequency shielding material as defined in claim 4 in which the insulating material comprises a polystyrene plastic.

8. A high frequency shielding material as defined in claim 4 in which the insulating material comprises a polybutene plastic.

9. A high frequency shielding material as defined in claim 4 in which the insulating material comprises a poly-ethylene plastic.

10. A panel for shielding a space against propagation thereto or therefrom of high frequency waves which comprises a smooth sheet of metal, an intermediate sheet of insulating material of the type having low di-electric loss and being non-hygroscopic, and a second sheet of metal, said sheets of metal being substantially free from holes large enough to allow the escape therethrough of high frequency interfering waves from said apparatus and being free from projecting points on the surfaces thereof which face one another.

11. A sectional shield for isolating in or from a space a source of radio interference, each shield section comprising spaced sheets of metal having smoothly polished surfaces protected against corrosion and mechanical injury by covering layers of insulating material and separated from one another by a layer of stable substantially non-polar insulating material, the whole being united into a laminated section, and said laminated sections being bonded together electrically and mechanically.

12. A sectional shield for isolating in or from a space a source of radio interference as defined in claim 11 in which the metal sheets extend from edge to edge of the laminated sheet, the outer protecting layers of insulating material extend from one edge to a line spaced from the opposite edge and the separating layer of insulating material extends from said opposite edge to a line spaced from the first-named edge, whereby the laminated section is formed with tongue and groove and both tongue and groove are faced with the metal sheets.

13. A sectional shield for isolating in or from a space a source of radio interference as defined in claim 11 in which said metal sheets and said separating layer of insulating material extend beyond at least one of the outer covering layers of insulation whereby a strip of said metal sheet is exposed for electrical connection to the corresponding sheet of an adjoining section.

14. A sectional shield for isolating in or from a space a source of radio interference as defined in claim 11 in which said metal sheets and said separating layer of insulating material extend beyond at least one of the outer covering layers of insulation whereby a strip of said metal sheet is exposed for electrical connection to the corresponding sheet of an adjoining section, and wherein flexible wire tapes electrically connect the exposed metal strips of adjoining sections at adjacent edges thereof.

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