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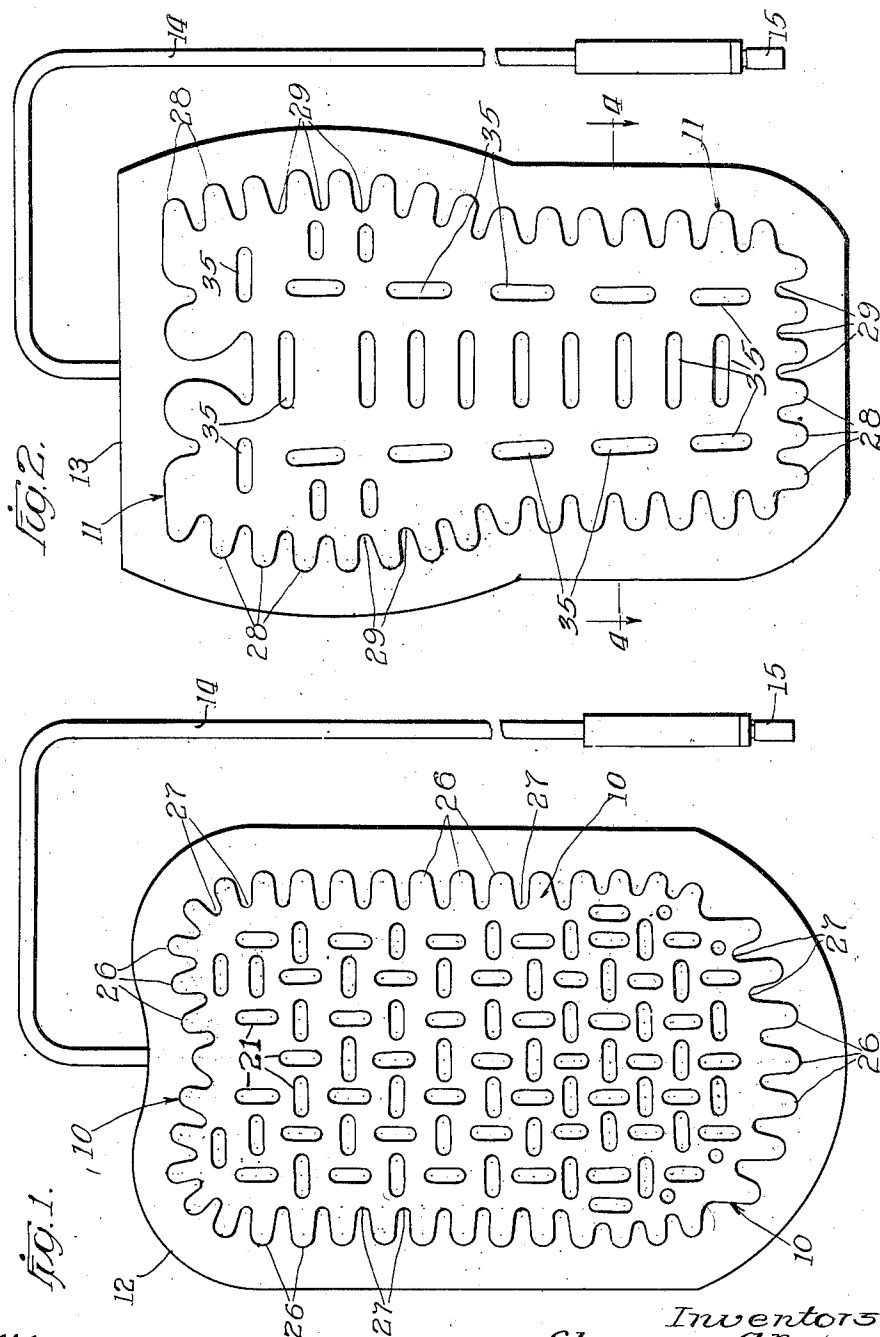
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APPARATUS FOR USE IN GIVING DIATHERMIC TREATMENTS AND THE LIKE

Filed June 13, 1932

2 Sheets-Sheet 1



Witnesses:

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By Arthur T. Sprinkle.
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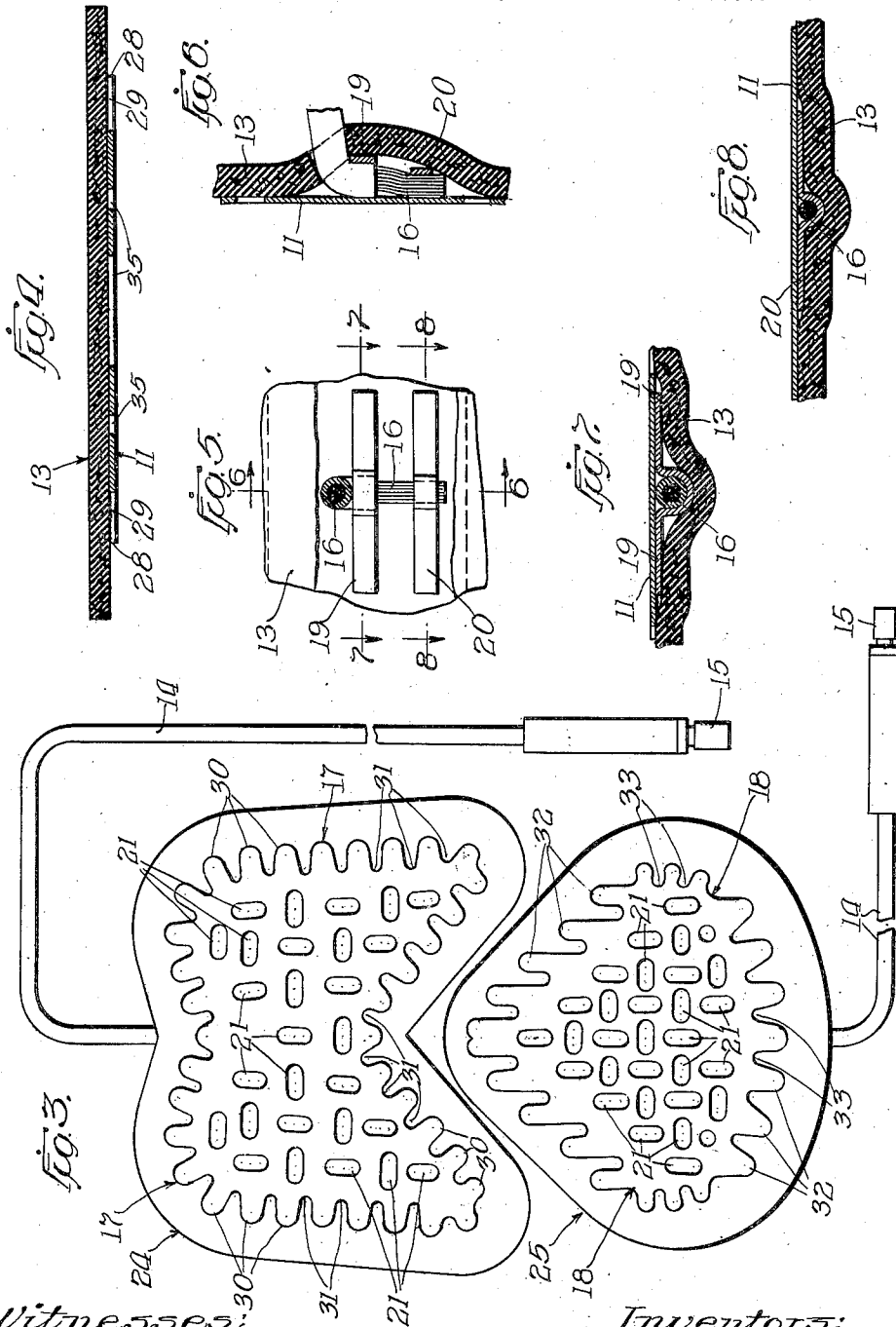
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UNITED STATES PATENT OFFICE

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APPARATUS FOR USE IN GIVING DIATHERMIC TREATMENTS AND THE LIKE

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3 Claims. (Cl. 174—89)

Our invention relates to improved apparatus for use in the production of an artificial fever by means of high frequency currents as a therapeutic procedure in the treatment of various diseases which is a form of treatment probably having its inception in the disclosures of Wagner von Jauregg about 1918 for the treatment of dementia paralytica by inoculation with malaria to produce hyper-pyrexia which is referred to along with other prior and subsequent analogous bibliography in our published article appearing in the Journal of the American Medical Association, January 3rd, 1931, vol. 96, p. 7-11, entitled "The treatment of dementia paralytica by hyper-pyrexia produced by diathermy".

The production of an artificial fever by means of high frequency currents instead of by the introduction of a foreign protein or infection seemed to us to be an ideal method, if possible of attainment, as stated in the published reports of our experiments in attempting to develop a method of application that might be demonstrated to be safe and reasonably feasible.

Our greatest difficulty has been in discovering and perfecting suitable electrodes to be used in the proper application and distribution of the current and the invention is accordingly directed to the improved construction of electrodes by which these difficulties were finally overcome.

The prime requisites for the production of artificial fever by diathermy as demonstrated by us are a well constructed high frequency machine capable of delivering not less than four thousand mill amperes under load, together with properly constructed electrodes adapted for surface application to the body of the patient and thorough heat insulation of the patient.

In our later experiments we have used apparatus of greater capacity comprising a new high frequency machine capable of delivering under load not less than seventy-five hundred milliamperes, thirty-five to one hundred volts, and having a frequency of five hundred to fifteen hundred kilocycles, such machine being capable of giving more than double the power of the usual high frequency machine and more than can be safely applied to a patient under treatment. The use of the more powerful machine has been found desirable in reducing the length of the treatment period to the minimum, but the application of the greater amounts of current from the improved machines of higher power has further added to the problem of the production of suitable electrodes and their connections with the machine for decreasing the possibility of burns

in the application of current and increasing the comfort of the patient while insuring more even current distribution and at the same time providing improved means to prevent cords breaking contact accidentally or by the excited patient deliberately tearing them off during the course of treatment, and to produce improved apparatus conforming to these stated requirements is, therefore, the primary object of our invention.

It is a further object of our invention to provide certain improvements in the construction of electrode apparatus by which the total current passing through the body of the patient in giving treatments in diathermy may be divided so that approximately two-thirds of the current delivered to the apparatus by the high frequency machine may be passed through the chest of the patient and one-third through the abdomen, thus allowing for the demonstrated difference in resistance of the chest and abdominal structures of the body.

It is a further object of our invention to provide improved construction of apparatus in the form of extended surface electrodes for use in diathermy having the before described characteristics and which at the same time may be applied to extended areas of the skin surface of the patient with a minimum degree of discomfort with respect to physical contact pressures of the apparatus in relation to the patient's body and at the same time securing the maximum desired degree of body contact.

Other objects of the invention will appear from the following description of the preferred embodiment thereof as depicted in the drawings forming a part of this specification, the features of novelty being set forth in the appended claims.

In the said drawings:

Fig. 1 is a plan or elevation view of the body contacting surface of an electrode embodying our invention, with a flexible cord shown attached, with part thereof broken away, by which the electrode is connected to the required machine for delivering current, the particular electrode of Fig. 1 being designed for use or application over the front or chest and abdominal regions of the patient's body and in conjunction with high frequency machines capable of delivering under load relatively moderate amounts of current or usually not to exceed four thousand milliamperes.

Fig. 2 is a view similar to Fig. 1 illustrating the preferred form of electrode adapted for use in covering substantially the entire back of the patient.

Fig. 3 is a view similar to Figs. 1 and 2 but show-

ing the preferred construction of the split or divided form of the front electrode for use with any permissible amount of current including current above four thousand milliamperes.

5 Fig. 4 is a detailed sectional view through the electrode of Fig. 2 looking in the direction indicated by the arrows.

Fig. 5 is a back view of a fragmentary portion of any one of the electrodes of Figs. 1 to 3 inclusive illustrating the manner in which the insulated connector cords or wires are attached to the electrode, the attaching cord in this view being shown in section.

10 Figs. 6, 7 and 8 are enlarged detailed sectional views illustrative of the cord attaching structure, the respective views being taken on the lines 6—6 to 8—8 inclusive of Fig. 5 and looking in the directions indicated by the arrows.

The preferred form of the invention on account of its greater adaptability and use is to be found in the provision of the companion back electrode shown in Fig. 2 and the split or divided front electrode of Fig. 3, although under conditions or with machines not exceeding a maximum current capacity of four thousand milliamperes, a front electrode of the type illustrated in Fig. 1 may be used in conjunction with the back electrode of Fig. 2 and for the purposes of description, the front electrode of Fig. 1 and the back electrode of Fig. 2 may be taken as typical of our invention, the same being shown as quite similar in form or contour, both with respect to the flexible metallic or conducting portion thereof as well as the flexible, non-conducting portions, the difference in construction of both metallic and insulating portions being worked out to accommodate the respective electrodes to varying resistances depending largely on variations in body thickness or character of underlying body structure.

40 Our typical electrodes are preferably made of a pliable metal, backed by a half inch thickness of sponge rubber. In Figs. 1 and 2, the conducting electrodes are designated by reference characters 10 and 11 respectively while the reference characters 12 and 13 designate the respective attached flexible backs of sponge rubber or other relatively soft, flexible insulating material. For the preferred backing portions, ordinary vulcanized sponge rubber, preferably of substantially uniform thickness, is found to be admirably adapted, the same to be ordinarily cured or vulcanized between plates so that the spongy rubber sheets will have well defined skin-like surfaces to which the pliable metallic electrode portions may be suitably attached with their flat surfaces in contact as illustrated, such attachment being secured in any desired manner, but where a rubber sponge or spongy rubber material is used for the backing sections 12, 13, the pliable metallic electrode sheets 10 and 11 may be attached thereto by the use of a suitable adhesive, or cement preferably containing a solution of rubber or analogous gum so that a comparatively firm union between the metallic electrode plates and the sponge rubber backing may be secured.

From the sectional view, Fig. 4, taken through the back electrode, the relative thickness of the sponge rubber backing 13 and the metallic electrode plate 11 will be apparent, and when it is understood that the metallic electrodes 10 and 11 are preferably made of lead or a composition of metals as lead, tin and the like in which lead largely predominates, the pliability of the material will be apparent which, taken in connection with the well-known flexibility and pliability of

rubber, gives the composite electrode, the characteristics of pliability or flexibility, enabling the exposed surfaces of the electrode plates 10 and 11 to conform to body surfaces without discomfort to the patient.

The flexible and insulated cords or electrical connectors, designated by the reference character 14 throughout the several views, will terminate in the usual switch or socket plug 15 and an electrical union with the metallic conducting element of the cord as designated by the reference character 16, Figs. 5 to 8 inclusive, will be accomplished by passing the conductor element 16 through a slit in the body of the sponge rubber backing 13 or the equivalent part in the several forms of apparatus, the terminal of the element 16 being electrically connected to the several electrode plates 10, 11, 17, 18 in any desired manner but preferably by the metallic bands 19, 20 which may be soldered to the metallic electrode plates in a well known manner whereby current passing through the conductor cords 14 will be delivered to the respective electrode plates 10, 11, 17 and 18.

Obviously any other desirable means for electrically connecting the wires 16 to the metallic electrode plates may be employed, it being desirable that a firm connection be secured because this apparatus is commonly used over extended periods with a class of patients that may require some physical restraint due to discomfort frequently produced from the treatment and it is important that the electric cord connections be of a firm and permanent character with respect to the metallic electrode plates.

The metallic electrode plates 10 and 11 are both fenestrated in substantially the manner illustrated in Figs. 1 and 2 and the general contours or outer peripheries of these metallic plates are formed to coincide substantially with the front and back body surfaces of the patient, it being one of the prime requisites of the pliable metallic electrode plates that we have discovered that to prevent burning while the current is on, it is necessary that there shall be no outlying portions of the plates that shall be formed with acute points or projections which in an electrode of this character tends to lower the discharge resistance of the plate at such points and by accentuating the discharge at such points, serious burns may result. The fenestrated or interior openings of the plate 10 are designated by the reference character 21 and such fenestrations are somewhat elongated in form as illustrated in Fig. 1 and being suitably alternated and spaced apart and always formed without acute angles.

The larger number of fenestrations arranged over the abdominal portion of the electrode plate of Fig. 1 has a tendency to decrease the amount of current discharge over the abdominal portion of the plate 10 with a corresponding proportional increase of the discharge over the chest or upper portion of the plate thus making some allowance for the difference in resistance of the chest and abdominal structures. However, this is a feature that we prefer to be taken care of especially where currents above four thousand milliamperes are used by the universal construction of split or divided form of the front electrodes appearing in Fig. 3 which consists of the two electrodes having the pliable metallic chest electrode plate 17 and the corresponding abdominal plate 18 to which is attached the usual conductor cords 14. The split or divided front electrode of Fig. 3 will

have the usual sponge rubber backing sheets 24, 25 and as in the case of the front and back electrodes of Figs. 1 and 2, each of these split or divided electrode portions will have the backing members formed so that there will be protruding marginal edges around the entire periphery of the pliable metallic electrode plates. From the drawings, Figs. 1 and 3, it will be seen that in dividing the front electrode plate, the design of the chest portion will not be materially altered except to sinuate the peripheral or outer edges of the divided plates with well defined curves that partake of no sharp angles or angular serrations in either projecting or receding portions of the outer marginal edges of the metallic electrode plates, the same thing being true of the abdominal divided plate 18 of the front electrode of Fig. 3, the fenestrated portion of which corresponds substantially with the fenestrations 21 over the abdominal portions of the electrode plate 10 of Fig. 1. The split or divided form of the front electrode of Fig. 3 has been developed by us after much experimentation and found to be safe and satisfactory under all permissible conditions of usage even with machines of the highest electrical capacity, a rheostat being placed in the patient's circuit when the split or divided form of front electrode is used, in a well known manner, for the purpose of dividing the total current so that approximately two-thirds of the current is passed through the chest and one-third through the abdomen by which arrangement it is possible to pass sixty-five hundred milliamperes through the body for many hours with safety, the current used obviously being varied somewhat with different types of patients, but we have ascertained by extensive experiment that if the amount of current be kept below this maximum and other technical directions followed with the use of the split front electrode of Fig. 3 in conjunction with the back electrode of Fig. 2, no burns will occur. This is due to the special construction of each of the metallic electrodes illustrated in that they are all provided with the peripheral sinuous curved portions decreasing the so-called "edge-effect" which results in greater comfort for the patient as well as very greatly decreasing the possibility of burns for the reasons set forth.

It will be noted in the procedure followed in the construction of the metal plates 10, 11, 17 and 18 of the electrodes that the before described principles of construction are adhered to with respect to the production of sinuous curves throughout the peripheral or boundary edges of the metallic plates thereby avoiding all sharp curves; and the same sinuous or curve-like effect, it will be seen, is employed in the fenestrated interior portions of the plates where sinuous edges are likewise provided to avoid all sharp angular recesses or projections. In the case of the front metallic electrode plate of Fig. 1, the characteristic peripheral projections and marginal recesses of a sinuous character are designated respectively at 26, 27 while similar marginal portions are designated by reference characters 28, 29 on the typical back electrode plate of Fig. 2 and by the reference characters 30, 31 of the divided chest plate of Fig. 3 while on the divided abdominal plate 18 of Fig. 3, corresponding parts that have a like function in the marginal edges of the plate are designated at 32, 33 and while in the peripheries of the split or divided plates of the preferred form of front electrode shown in Fig. 3, there are some variations in

the construction of the marginal edges, the general principle of avoiding all sharp angled recesses or projections is carefully avoided to decrease "edge-effect" which results in lowered discharge resistance and burning at such points.

The reference character 35 designates the same typical form of fenestration or interior openings shown at 21 Fig. 1 in the typical back electrode plate 11 of Fig. 2, other similar fenestrations being shown in this plate and arranged preferably in the manner illustrated with reference to the differential resistance desired at various points to correspond with body structure.

In the interior fenestrations of the split or divided electrodes of Fig. 3, the reference character 21 is also applied to these openings in both chest and abdominal sections as being typical whether the unitary or divided type of front section of the invention be employed.

In giving a diathermic treatment with our improved apparatus as described when the same is connected with the usual high frequency machine of the described character, the skin of the patient where the applications of the front and back electrodes are to be made may be thoroughly anointed with conductive jelly and then the chest and back electrodes applied with the exposed metallic surfaces of the sinuously bounded and fenestrated plates in contact with the bare skin, the electrodes being held in place by suitable means as a properly fitting canvas jacket which may be successfully employed for this purpose, especially if made so that when used as a binding covering for the electrodes it may be adjustably secured in position by lacing, the same, however, not being shown in the drawings since the same forms no part of the invention and obviously any suitable means may be used for binding the electrodes firmly to the front and back body surfaces of the patient in order to render displacement of the electrodes unlikely even with vigorous movements of the patient undergoing treatment.

In the use of the apparatus, the patient's bed may be prepared by spreading a rubber sheet over the mattress and this covered by one or more blankets upon which the patient will lie while being treated and being covered with a blanket and another rubber sheet, and all the patient's clothing removed, over which more blankets may be applied to prevent the possible loss of heat during the treatment thus securing thorough heat insulation of the patient. With the apparatus thus applied to the body of the patient, the current may be then turned on to about three thousand (3,000) milliamperes and in about fifteen to thirty minutes the patient will ordinarily begin to perspire profusely when the skin resistance will then be lowered and in consequence the current strength can be gradually increased until the maximum is reached in accordance with the desired methods of procedure as set forth in our aforesaid article appearing in the Journal of the American Medical Association as well as in our published article entitled "A new method of producing fever" published in Physiotherapy Review, March-April, 1931, and in a published article in the British Journal of Physical Medicine, vol. 6, No. 7, October, 1931, by one of the joint applicants, Clarence A. Neymann, to which respective publications reference may be had for information with respect to the therapeutic value and uses of our improved diathermic apparatus, further reference to the details being omitted from this specification since

the same obviously forms no part of the present invention.

Our described improved electrode apparatus for producing hyperpyrexia or artificial fever by diathermy in man has been found to have many advantages over any apparatus known to us since it permits of easily controlled dosage both in time and quantity elements when used in conjunction with the well known high frequency machines of the character heretofore mentioned and at the same time reducing the liability to dangers from burning and the like which can be entirely overcome by proper care and attention.

In order that the invention might be understood, we have shown and described the preferred embodiments as known to us with particularity, but it will be apparent that persons skilled in the art may resort to various modifications without departing from the purpose and spirit of our invention as defined by the scope of the appended claims.

We claim:

1. Apparatus for use in giving diathermic treatments and the like comprising front and back electrode plate devices, the said back plate comprising a unitary metallic sheet of pliable electrically conductive material, interiorly fenestrated and provided with substantially sinuous boundary portions, and the said front portion of the apparatus comprising a pair of separated metallic electrode plates of pliable electrically conductive material adapted to be used in spaced-apart relation to substantially cover the thoracic and abdominal cavities of a patient, the outer peripheries of the said spaced-apart front electrode plates be-

ing also sinuously formed to avoid the production of peripheral re-entrant angles or projections.

2. Apparatus for use in giving diathermic treatments and the like comprising an electrode plate of pliable electrically conductive material secured to an extended sheet of pliable heat insulating and electrically non-conductive material, the material of the said plate being fenestrated and provided with an outer sinuously formed periphery whereby to avoid the production of angular re-entrant or projecting portions in the fenestrated and peripheral boundary portions of the plate, and an insulated conductor cord electrically connected with the said plate through an opening in the said backing material.

3. Apparatus for use in giving diathermic treatments and the like comprising an electrode plate of pliable electrically conductive material secured to an extended sheet of pliable heat insulating and electrically non-conductive backing material, the material of the said plate being fenestrated and provided with an outer sinuously formed periphery whereby to avoid the production of angular re-entrant or projecting portions in the fenestrated and peripheral boundary portions of the plate, and an insulated conductor cord electrically connected with the said plate through an opening in the said backing material, and the body of the sheet of the said backing material being peripherally extended to form a covering over the outer sinuously formed portion of the said electrode plate.

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