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HIGH-PERFORMANCE ELECTROTHERAPEUTIC TREATMENT HEAD

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FIG. 1.

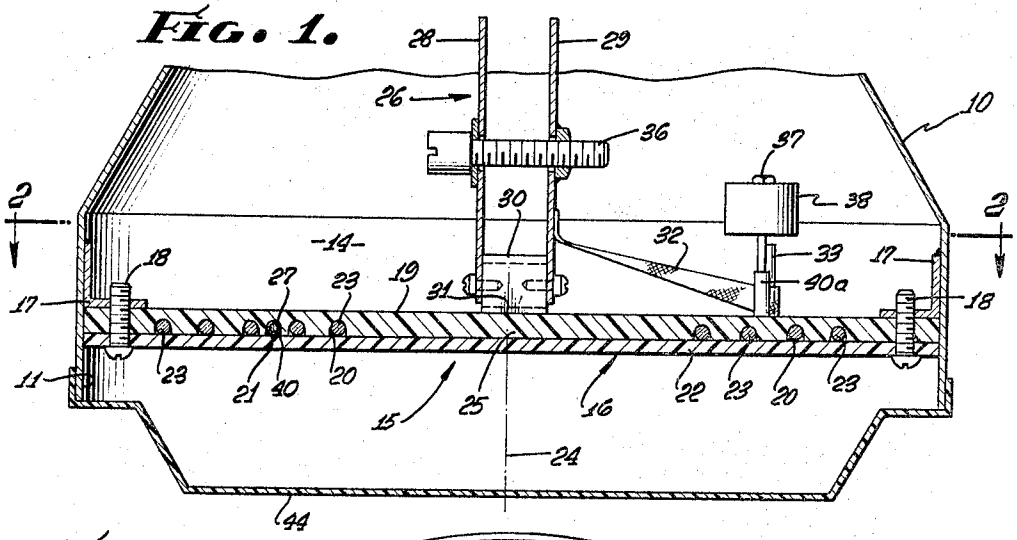

FIG. 2.

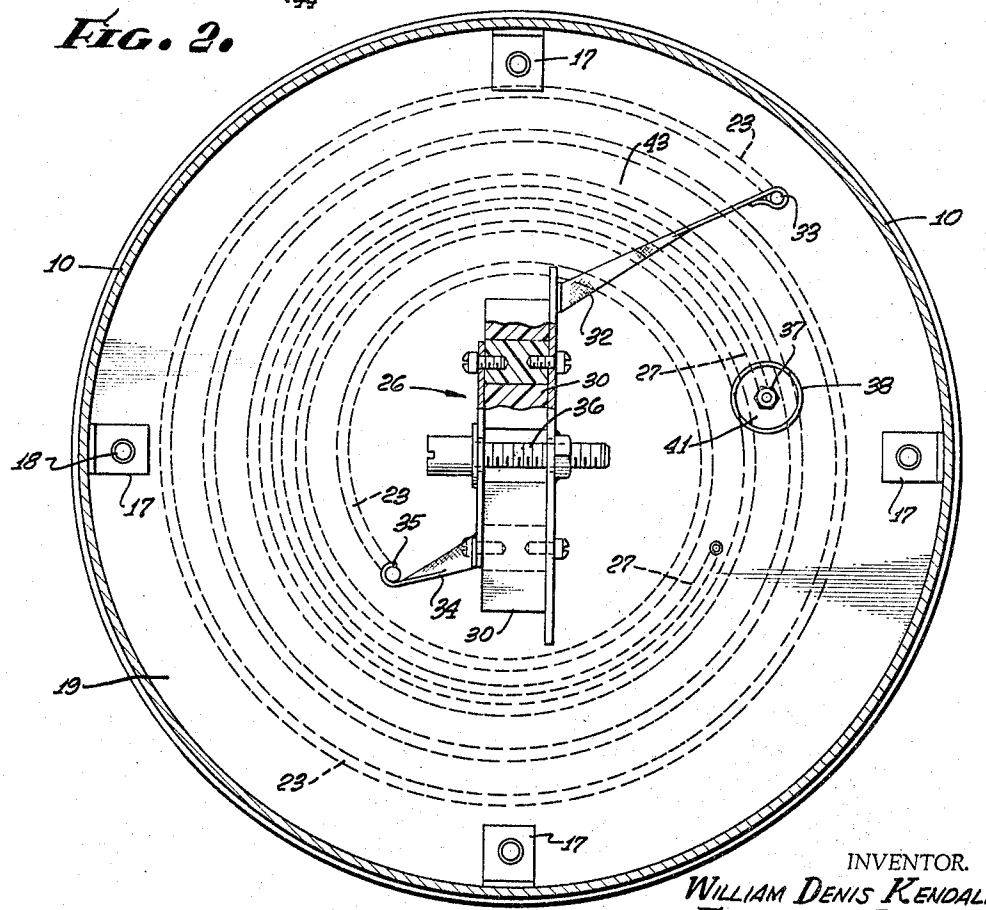

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FIG. 3.

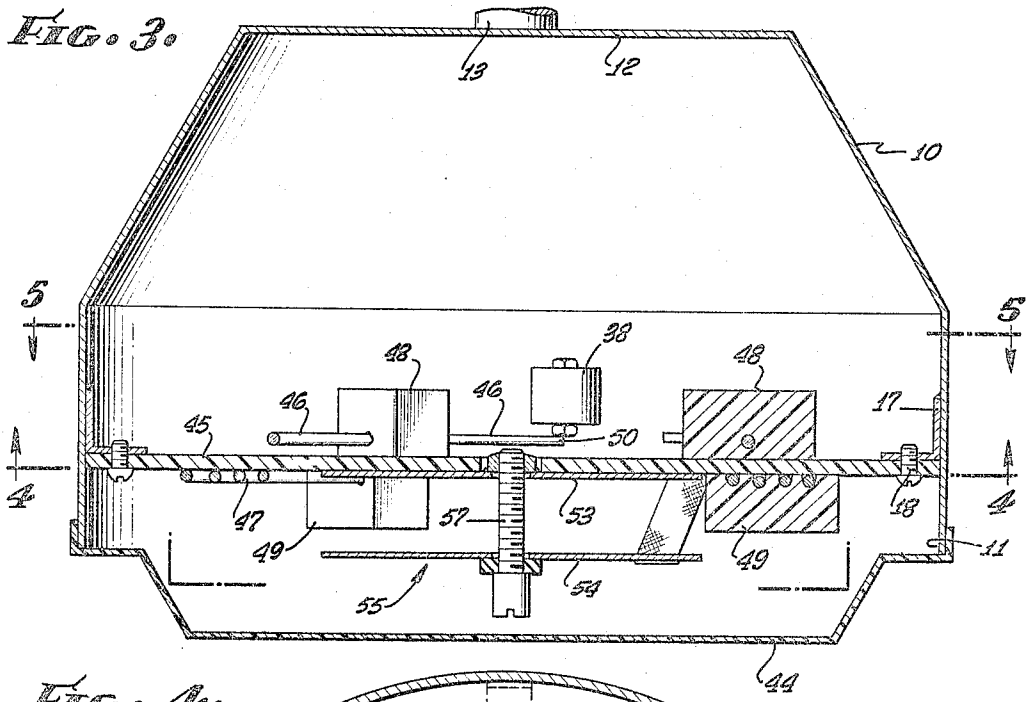

FIG. 4.

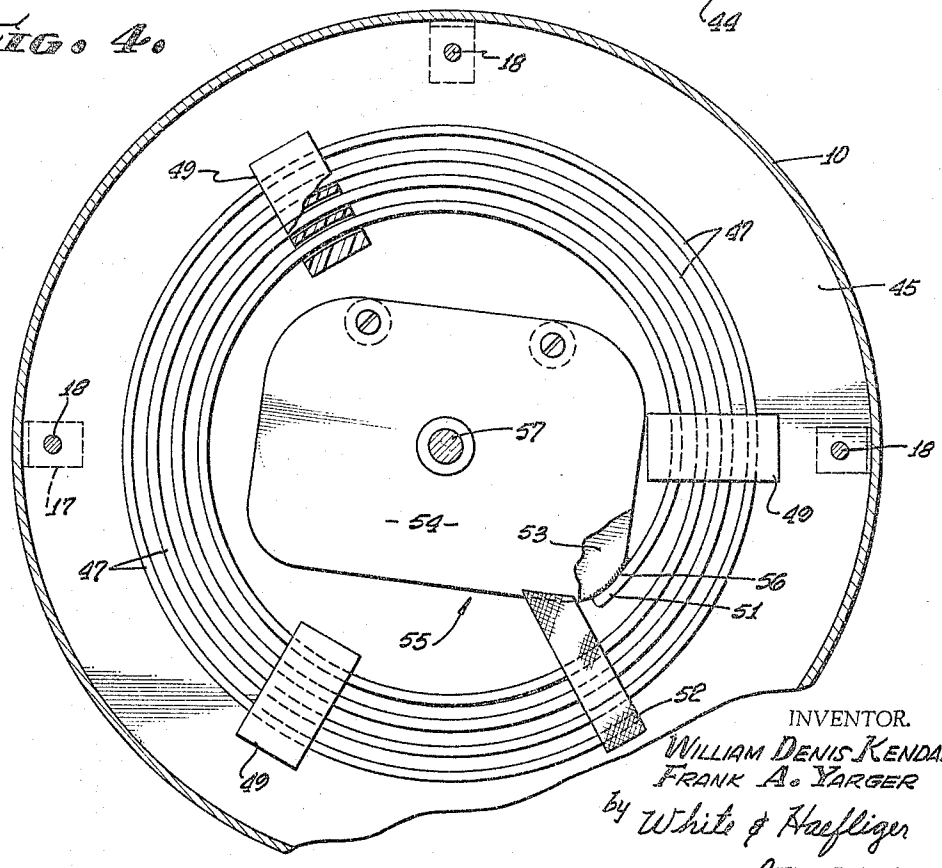

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FIG. 5.

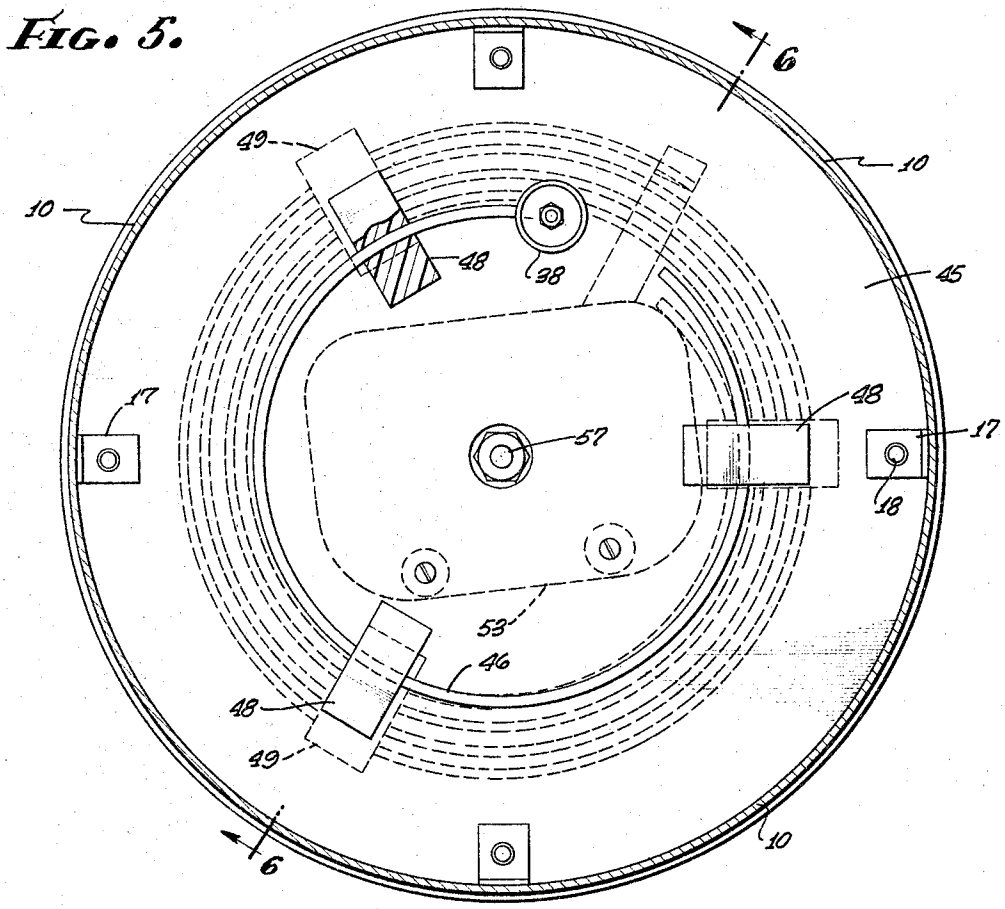


FIG. 6.

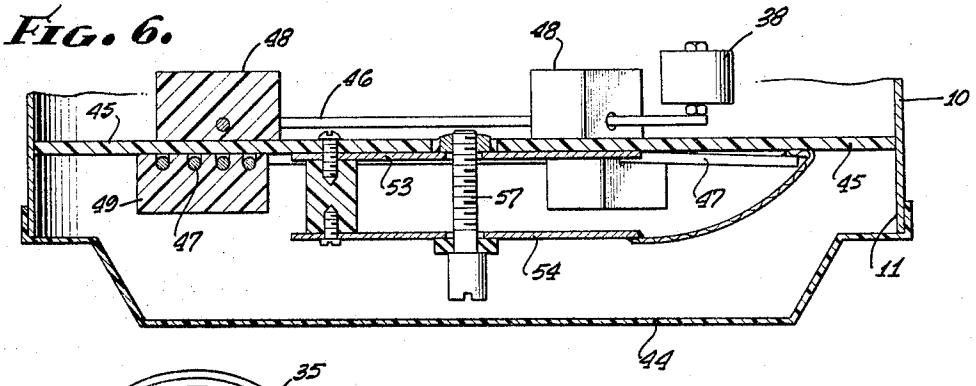
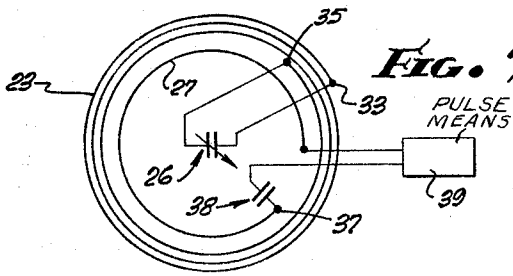


FIG. 7.



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3,270,746

HIGH-PERFORMANCE ELECTROTHERAPEUTIC TREATMENT HEAD

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1 Claim. (Cl. 128—404)

This invention relates generally to electrotherapeutic apparatus, and more particularly concerns what may be characterized as high-performance treatment heads.

In our U.S. patent application Ser. No. 294,822, filed July 15, 1963, we have described apparatus for generating, controlling and transmitting electrical pulses of high frequency for application to a patient by means of a treatment head. The latter is supplied with high voltage which is increased even further by means of high voltage primary and secondary coils. Operating voltages at the head, and power transmitting efficiency are limited by the tendency for arcing to occur between the coils, and particularly at the coil terminal connections. Decreased safety to the operator and patient, as well as less than desirably satisfactory treatment of the patient, are also involved in the design of prior treatment heads of which we are aware.

The present invention contemplates solutions to the above problems which, apart from the distinct benefits realized, are characterized by novel and unusual advances in head construction, mode of operation and results obtained in use. Broadly considered, the head comprises a metallic shell having a longitudinal axis, dielectric partition structure extending generally laterally within the shell, spaced apart primary and secondary coils carried within the shell to extend about the shell axis, and a capacitor carried within the shell and having electrically parallel connection with the secondary coil, the partition being such as to dielectrically shield the coils from each other and the exposed primary coil input connection from the secondary coil.

In one form of the invention, the coils extend within a plate-like partition containing grooving receiving the coils, the coil arrangement being such as to substantially reduce the risk of undesired high voltage arcing. As to the latter, the spacing between the primary coil high voltage connections and the nearest locus of the secondary coil is such that the maximum voltages at said connection and locus are substantially reduced below the maximum voltages developed at the secondary coil terminals. This feature permits the locating of the primary coil in the interstitial space defined by axial cylinders passing through the successive turns of the secondary coil, with the coils having approximately coincident centers, as will be seen. Accordingly, the construction of the head is simplified, and its operating efficiency is increased, higher voltages being usable for more effective treatment, all without increased risk of arcing or other danger to safety.

In another form of the invention, the coils extend at opposite sides of the partition structure in such manner that the partition dielectrically shields the coils from each other and the primary coil input connection from the secondary coil. Also, the tuning capacitor has a factory settable connection exposed toward the head cover for fine adjustment prior to closure of the shell by application of the cover, one plate of the capacitor and one high voltage terminal of the secondary coil having approximately zero length connection to reduce the risk of arcing.

These and other objects and advantages of the invention, as well as the details of an illustrative embodiment,

will be more fully understood from the following detailed description of the drawings, in which:

FIGURE 1 is an elevation taken in section through the high-performance treatment head;

FIGURE 2 is a section taken on lines 2—2 of FIGURE 1;

FIGURE 3 is a view like FIGURE 1 showing a modified head;

FIGURES 4 and 5 are sections taken on lines 4—4 and 5—5 of FIGURE 3;

FIGURE 6 is a section taken on lines 6—6 of FIGURE 5; and

FIGURE 7 is a schematic showing of the circuit associated with the FIG. 1 head.

In the drawings, the head is shown in the form of a generally cylindrical metallic shell **10** having a front opening **11** and a closed rear wall **12** supported by a rod or similar member **13**. Referring to FIGURES 1 and 2, an assembly **15** is received through the opening **11** into the shell interior **14**, the assembly including a dielectric partition **16** extending generally laterally within the shell and supported at its periphery by suitable brackets **17** and fasteners **18**. The partition illustrated includes a first dielectric plate **19** containing spiral grooving **20** and **21** opening toward and covered by a second partition plate **22**. The grooving **20** receives the turns of a secondary coil **23** spiraling about the longitudinal axis **24** and the shell. The grooving **21** receives the single turn primary coil **27** which is in the interstitial space defined by axial cylinders passing through the successive turns of the secondary coil. Further, the primary and secondary coils have approximately coincident centers at the general location **25**.

The head structure also includes a capacitor **26** carried within the shell and having electrical parallel connection with the secondary coil. For this purpose, the capacitor includes a pair of plates **28** and **29** projecting in parallel planes generally normal to the lateral extent of the partition **15**, the plates being carried by a dielectric block **30** which is suitably attached to the partition at **31**, as by bonding thereto. In this regard, the partition and block may comprise a suitable plastic dielectric material, such as Lucite. The plate **29** is shown as electrically connected at **32** to the outer terminal **33** of the secondary coil, while the plate **28** is connected at **34** to the inner terminal **35** of the secondary coil. Finally, the spacing of the plates may be factory set by adjustment of a threaded fastener **36** interconnecting the plates, the fastener being non-conductive.

The primary coil has a high voltage input connection **37** to which a series of high voltage pulses are transmitted through an input capacitor **38**, the means for transmitting the pulses being generally indicated at **39** in FIGURE 7. Such means is of the type described in our pending application refered to above. In this regard, it will be seen that the partition structure **15**, and in particular the plate **19**, dielectrically shields the coils **23** and **27** from each other and from the shell, and that the plate **19** also shields the exposed primary coil input connection **37** from the secondary coil. Additional dielectric shielding is offered by the tubular plastic sheathing **40** about the primary coil turn, and also about the extent of the primary coil connection seen at **40***a* in FIGURE 1.

It is an important feature of the invention that the spacing between the connection **37** and the nearest locus, say locus **41**, of the secondary coil is such that the maximum voltages at said locus and connection are substantially reduced below the maximum voltages developed at the secondary coil terminals **35** and **33**. In this regard,

the length of the secondary coil is such that maximum voltages exist at the terminals **35** and **33** thereof, whereas an approximately null voltage point exists substantially midway between opposite terminals of the secondary coil as measured along the coil length. Said null voltage point may, for example, be in the region **43**, FIGURE 2. Thus, said nearest locus **41** of the secondary coil is spaced closer to the null voltage region **43** than to the terminals **35** and **33**, as measured along the secondary coil length. As brought out above, this condition substantially reduces the risk of unwanted arcing.

Referring now to FIGURES 3–6, the shell **10** is generally the same as the shell shown in FIGURE 1, a front non-metallic cover **44** for the shell also being generally the same. The dielectric partition **45** in this form of the invention extends generally laterally within the shell between the primary coil **46** at the rear of the partition and the secondary coil **47** at the front of the partition. The coils are carried by dielectric blocks **48** and **49**, as illustrated, with suitable grooves or openings being formed in the blocks to receive the coil turns. Blocks **48** and **49** may be formed of the same dielectric material as the partition **45** to which they are bonded, the material typically comprising Lucite. Accordingly, the partition structure dielectrically shields the coils from each other, and it is also seen that the partition shields the primary coil input connection **50** from the secondary coil. The latter has high voltage terminals **51** and **52** respectively connected to the plates **53** and **54** of the capacitor **55**, said plates extending in planes generally parallel to the partition **45** and at the front thereof. Terminal **51** is seen to have zero length connection at **56** to plate **53**, to minimize unwanted electrical effects at high frequency. The plates of the capacitor may be adjusted to flex toward or away from each other at the factory by means of a fastener **57** the head of which is exposed toward the cover **44**.

It will be seen that the connections of the secondary coil to the capacitor in both forms of the invention are quite short, thereby minimizing the undesirable effects

of cross polarization. Also the adjustment of the capacitor can be carried out with minimum risk of arcing, in view of the capacitor positions.

Reference to FIGURE 7 shows the electrical schematic of the circuit incorporated in the head. Pulses transmitted by the means **39** are typically characterized as having frequencies of 27.12 megacycles, the pulse interval being, for example, .001 to .025 second.

We claim:

In electrotherapeutic treatment head structure, a metallic shell having a longitudinal axis, spaced apart primary and secondary coils, the primary coil having a high voltage input connection, insulative tubular sheathing about the primary coil, dielectric means carried by said shell and supporting both coils to extend about said axis, and a capacitor carried by said dielectric means generally rearwardly of said coils within the shell and electrically connected across the secondary coil, the capacitor having two generally parallel plates with edge portions attached to said dielectric means to prevent their relative displacement, major portions of the plates extending freely away from said edge portions to flex toward and away from each other, and a non-conductive fastener carried by said major portions of the plates in spaced relation to said plate edge portions to hold said major portions of the plates at adjusted separation, said fastener extending between the plates for attachment thereto, the secondary coil having more turns than the primary coil and both primary and secondary coils comprising circular cross section wire.

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