Diathermy Generator

Any experienced radio constructor can build a serviceable diathermy machine

By H. L. BUMBAUGH

Front-panel photo shows the control markings.

THE diathermy equipment shown on these pages has been in use several years. It has proven powerful enough and free from "bugs." No repairs or adjustments have ever been necessary, mostly due to the fact that all components operate with large safety factors.

The application of high-frequency alternating currents to body tissues has long been considered of great therapeutic value. The equipment, however, is relatively costly. With this fact in mind the author set out to design and build a modern diathermy oscillator and to present information about it in such form that any amateur, serviceman, or other technically qualified person might easily duplicate the device.

A word of caution should be given. All apparatus of this nature comes under the regulations of the Federal Communications Commission and must be constructed and operated strictly in accordance with those regulations. The equipment described here does comply.

Medical men consulted expressed the opinion that a raw a.c. wave places considerably more strain on the body tissues and nerves than the relatively smoother wave from a rectifier with a small amount of filtering and that the rectified waveform gives greater heating effect for any given power output.

Since a rectified output means lengthened tube life, a reduction in interference, and generally better all-around conditions a rectified setup using 866 tubes was decided on.

Considering the nature of the requirements and the probability of operation by technically unskilled persons, it was deemed advisable to provide for at least 200 watts of power.

The oscillator chosen was a push-pull type using 838 tubes. Other tubes of equivalent power rating may, of course, be substituted. The circuit diagram appears on the next page.

The oscillator must operate at one of the frequencies designated for diathermy by the FCC; in our case the 13,560-kc band was chosen. The oscillator should not deviate from this center frequency by more than 6.78 kc, which is a reasonable stability requirement.

As will be seen from Fig. 1, the circuit for the applicator pads consists of a pickup coil L2 mounted co-axially with the plate coil and a series variable tuning capacitor. With increasing capacitance this capacitor causes the pad circuit to approach but never attain resonance with the plate circuit. This permits loading the oscillator adequately but cannot make it unstable due to reduced excitation resulting from a too heavily loaded plate circuit.

The degree of heat furnished is controlled by the grid-bias setting of the 4-position bias switch and of the pad-circuit variable capacitor.

Many of the parts required for the oscillator will be found in the junk-box. The pads or other applicators will probably have to be purchased from a manufacturer of physical therapy apparatus.

Tubes equivalent in power rating to 838's may also be used if proper grid bias is applied and other operating requirements are met. Gammatron 54's have been used with considerable success, and the initial cost is quite low.

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The equipment is mounted on two decks inside the cabinet. R.f. section is on top.

In Fig. 1 it will be noted that two switches are required to put the device in operation. The ON position of these switches is indicated by a red and a green bullseye behind which small night light assemblies have been placed. The TREATMENT switch cannot connect the primary of the power transformer to the line unless the WARM UP switch has connected the filament transformers. This is to prevent application of plate voltage with no filament voltage; the filaments should be heated for a short time before applying high voltage. Operators should be thoroughly instructed in this routine.

To apply the output of the equipment to a patient, plug the machine into a convenient 117-volt a.c. outlet. Insert the banana plugs on the ends of the pad leads into the large jacks on the lower-right-hand corner of the control panel (see photo). Turn on the WARM UP switch which applies filament voltage and turns on the green pilot light. After a couple of minutes—having arranged the pads on the patient as explained later — close the TREATMENT switch which applies power, lights the red pilot light, and begins the treatment.

Coarse adjustment of the treatment intensity is obtained by adjusting the POWER switch in the lower-left-hand corner of the control panel. Fine gradations are obtained by varying the setting of the pad-circuit variable capacitor (the wheel in the lower center section of the control panel). In the majority of cases a maximum meter reading will occur at or near full scale on the capacitor dial. While the milliammeter will not show as great changes in readings with rotation of the variable pad-circuit capacitor as it will between successive points on the POWER switch, a neon bulb held near one of the pads will show a considerable variation in r.f. energy output through the range of the capacitor.

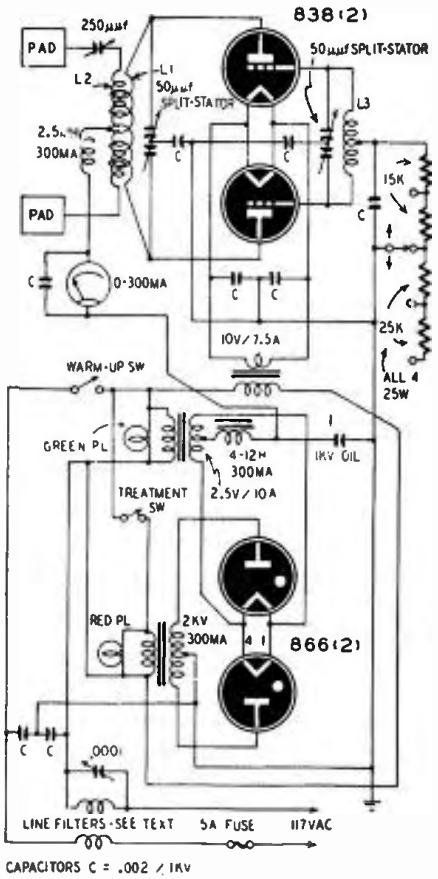

Fig. 1—Schematic of the diathermy generator.

The cabinet for the equipment may either be purchased or made by the constructor. We were unable to find a ready-made cabinet which met our requirements, so we built one, 21 inches high, 18 inches wide, and 15 inches deep out of 3-ply veneer. The sloping panel on which all the controls are mounted was made of tempered Presdwood and after several coats of shellac was finished off with three coats of black enamel, dressed down with steel wool, and a final coat of wax applied. The cabinet proper was given three coats of an orchid gray enamel.

Four large-wheel casters and a metal handle on each side of the cabinet make it easy to move the equipment from place to place.

Figure 2 shows how the pad circuit terminates on the control panel in two large jacks which accommodate large banana plugs on the end of the pad leads.

The high-voltage transformer is an old instrument transformer obtained from the local power company's salvage shop. It furnishes 1,000 volts each side of the center tap. Such transformers are ideally suited for this use as they are very small and yet have adequate power capacity. Any local power company should be able to furnish an obsolete one at a very reasonable price. Of course, any other transformer giving 1,000 volts each side of center and having a power capacity of 200 or 300 watts may be used equally well.

Any value between 4 and 12 henries will do for the filter choke. It should have a current-carrying capacity of about 300 ma.

The line filter chokes shown in the 117-volt supply line are air-wound 1¼ inches in diameter to a length of 2⅜ inches with 14 turns of No. 18 enameled wire. There are two windings, interwound with each other. One winding is shunted with a 100-µµf variable capacitor which can be tuned to give greatest trap effect. Because of the unity coupling between the two windings, the one capacitor serves to tune both windings.

The 838 plate coil L1 is 17 turns of No. 8 enameled wire air-wound 2½ inches in diameter to a length of 4 inches. L2, the pad pickup coil, is 22 turns of No. 10 enameled wound to a diameter of 1½ inches in two sections of 10 turns each, spaced the diameter of the wire, the two sections being spaced 2 inches apart by partially straightening out two of the center turns. L3 is 25 turns of No. 10 enameled, 1½ inches in daimeter, air-wound, 3 inches long.

The builder has the option of using either pads or a coil for applying r.f. to the patient. Either form may be obtained from the larger supply houses.

Each pad is a flat grid of small-mesh wire cemented or molded between two layers of rubber, with a stranded conductor soldered to the wire mesh, the conductor being housed in rubber tubing. In use, the pads are placed on each side of the body or the member to be treated.

When the coil is used, it is wound around the member or coiled upon it. Distributed capacitance completes the "patient circuit."

A word of caution is in order here concerning any metal objects in the field of either the pads or the coil. Any piece of metal—no matter what size—will have induced in it currents which may heat the metal to a very high temperature and may cause painful burns or perhaps ruin clothing. Always make sure no metal objects of any kind are in the field of the applicator.

Diathermy can be extremely dangerous. Treatments must be administered only by a qualified physician who is familiar with diathermy techniques.

When constructon is finished, the oscillator should be set on the operating frequency of 13,560 kc by means of an r.f. oscillator, a calibrated communications receiver, or other available means. Once set it will require no further attention. As a final precaution a check should be made to see that the operation of the device in no way interferes with any established service, such as radio or television. Should any such interference show up, the usual amateur remedies may be applied.

(Interference from diathermy equipment has troubled many users of radio equipment for a number of years. The FCC, after considerable study, assigned three bands of frequencies for diathermy equipment. These bands were allocated in portions of the radio-frequency spectrum where they are least likely to interfere with broadcast or vital communication services. The center frequencies of the bands are 13,560, 27,120, and 40,680 kilocycles. The frequency tolerances of these bands are 6.78, 162.0, and 20.0 kilocycles respectively. There is no limit to the radiation of the fundamental so long as it is within the prescribed bands. The harmonic radiation shall not exceed 25 µv per meter at a distance of 1,000 feet.

If such equipment interferes with operation of nearby broadcast or television receivers, wave traps and tuned stubs may effect a cure. If your equipment does interfere with the neighbors radio, it is advisable to have a radio service technician take the necessary remedial steps.—*Editor*)

MATERIALS FOR DIATHERMY GENERATOR

Resistors: 2—15,000, 2—25,000 ohms, 25 watts.
Capacitors: 6—.002-µf, 1-kv, mica; 1—1-µf, 1-kv, oil-filled; 2—50-µµf, split-stator, 1—250µµf, variable, ¼-inch plate spacing.
Tubes: 2—838, 2—866/866A.
Switches: 2—s.p.s.t. toggle, 1—single-circuit, 4-position rotary.
Transformers and choke: 1—2.5-volt, 10-ampere, 1—10-volt, 7.5-ampere filament transformers; 1—2,000-volt, 300-ma, center-tapped high-voltage transformer; 1—12-henry, 300-ma filter choke.
Miscellaneous: 1—2.5-mh, 300-ma r.f. choke; 1—0-300-ma d.c. meter; sockets for 838's and 866's; 2—117-volt pilot-lamp assemblies, one with green, one with red jewel; 1—5-ampere fuse and holder; 2—diathermy application pads; cabinet; necessary hardware.