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Localized Heat Production in Living Tissue at a Distance.*

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The observations here reported were designed to test a method for injuring or destroying specific, localized areas of living tissue at a distance. The underlying principle of the method was the known heating effect upon metal of an electromagnetic field. The method consisted of implanting in the target areas of cats and rats small pieces of metal and then placing the whole animal in an electromagnetic field.

Source of the Electromagnetic Field. The source used for developing the electromagnetic field consisted of a quenched gap high frequency generator designed to operate from a 60 cycle power supply, requiring several kilowatts when operating at maximum output.

The field on the high frequency or secondary side of the generator was built up by means of a water cooled inductance, wound on a tube of bakelite of a size sufficient to accommodate the experimental animal and to prevent direct contact with any part of the winding during treatment.

In those experiments reported here, the frequency of the field was fixed at 400,000 cycles per second, relatively low compared with the frequencies used in diathermy. The secondary current, or that creating the field, reached values as high as 122 amperes.

Tests With Various Metals. After some preliminary experiments had demonstrated the feasibility of the method, tests of 3 metals were carried out in order to discover their relative suitabilities for this purpose. It was found that magnetic iron was better than cold rolled steel and that both were very much more useful than silver.

The difference between metallic iron and cold rolled steel is illustrated by their relative speeds in melting paraffin under the conditions of the experiment. Plates of metal, 3 x 3 mm were imbedded in paraffin with a melting point of 55°C, so as to be surrounded by about 3 mm of paraffin on all sides. The blocks of metal-containing paraffin were placed in a coil with an internal diameter of 4 inches. Sixty amperes of current were delivered to the coil. The relative lengths of time required to melt the paraffin are shown in Table I.

TABLE I.

Metal		Melting time, sec
Magnetic iron	.001 thickness	28
	.002 "	22
Cold rolled steel	.001 "	45
	.002 "	30

With the cold rolled steel plates, a temperature level of 113°F was reached in 30 seconds. The temperatures were measured with a specially made alcohol (not mercury) thermometer.

Tests With Animals. For experiments on the brains of rats, a coil 2.5 inches in internal diameter was employed. The rats were anesthetized with nembutal. The skull was opened, and a piece of magnetic iron wire 5 mm in length and 1 mm in diameter was inserted into the hemisphere at right angles to the surface and so that no wire was visible at the surface. The skull and soft tissues were then closed. In one experiment 90 amperes and in another 100 amperes were delivered for

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20 minutes. In both cases, a core of tissue 4 mm in diameter was destroyed (Fig. 1).

Extremely high or moderately high temperatures could be reached with varying speeds, depending upon the size of the coil, the amount of current delivered to it and the size and type of the metal. One cc of a water suspension of granulated iron, inserted by rectum into the colon of an ether-anesthetized rat with a syringe, for example, burned and destroyed the colon and adjacent tissues in 1 minute.

Temperatures were measured in a sampling manner only.

These observations are reported in order to exemplify a method which could have a

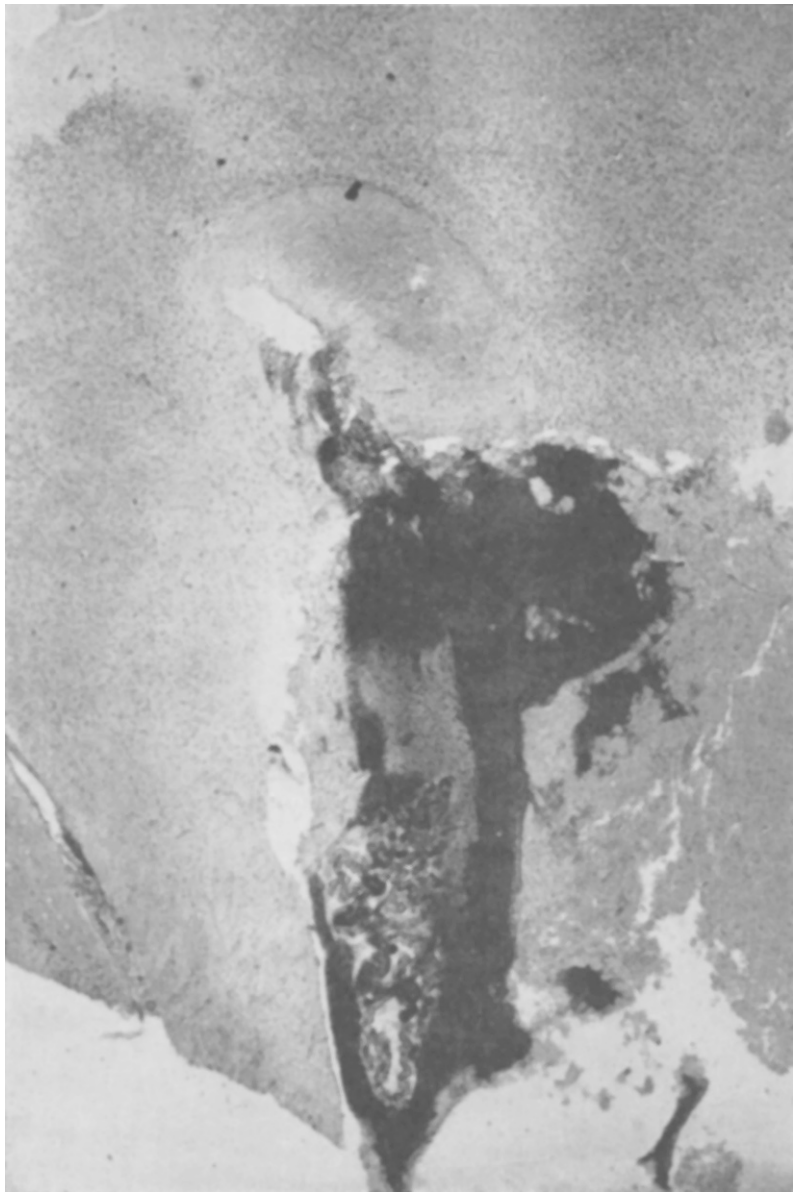

FIG. 1.
The burned area, bounded by a zone of less severely injured tissue. H. and E. stain.

variety of possible uses in experimental surgery, and perhaps even in clinical surgery. It might be especially applicable to areas difficult to approach, but which can be reached by a needle of wide calibre, through which wire, or granulated or perhaps powdered metal could be introduced.

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Influence of Spinal and Regional Anesthesia upon Vasoconstriction and Vasodilatation of Small Peripheral Blood Vessels.*

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In the current studies of the development of shock during surgical procedures, alterations in the rhythmical variations in the caliber of the small peripheral blood vessels of the fingers and toes have been noticed after spinal anesthesia and anesthetization of the stellate ganglion.

It is well known that spinal anesthesia may occasion a fall in blood pressure especially in the presence of moderate hemorrhage or trauma.[1,2,3,4] It is also known that peripheral blood vessels dilate when denervated of their sympathetic supply.[5] These two phenomena, fall in pressure and dilatation of the vessels, are related. What is still unknown is how those other small peripheral blood vessels with their sympathetic supply still intact participate in this result. If the blood pressure and the pulse rate were to remain constant, then, on the assumption that the cardiac output also remains constant, it may be assumed that, as one large set of vessels dilates, another contracts.

Method. The pneumoplethysmograph of Turner,[6] as modified by Neumann[7] was used to record the variations in volume of fingers and toes simultaneously. Normally, waves are inscribed representing constantly occurring changes in volume. These include the *pulse waves,* synchronous with the cardiac beat, and *alpha waves*[8] which occur 5 to 7 times per minute and vary in size up to 10 times that of the pulse waves.

Twelve patients free from hypertension and from peripheral vascular diseases, ranging in age from 24 to 54 years were studied. In 9, records were made during and after intrathecal injection of procaine hydrochloride or monocaine formate (150 mg). Sensory anesthesia as determined by testing sensory dermatomes reached the level of the umbilicus (T 12). In 3 patients, records were obtained before, during and after the injection into one stellate ganglion of 10 to 15 cc of 1½% solution of procaine hydrochloride. The clinical

* This is the 12th paper reporting the results of studies of the small blood vessels and related subjects.

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