

inal pressure from a large tumor or considerable fluid, the introduction of the oxygen, with the mechanical supporting effect of the gas, seemed to act as a distinct factor in the prevention of ileus.

The beneficial influence of oxygen inhalation upon the digestive system is fully recognized and its bactericidal and antiseptic properties are conceded. However, from the results already secured, it is evident that there are still unrecognized therapeutic uses for the gas and a large field for further intensive research where the clinical and surgical possibilities of oxygen are to be considered.

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(For discussion, see p. 434.)

## RHYTHMIC ELECTRIC WAVES IN GYNECOLOGY\*

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ONE of the recent advances in the use of electricity in gynecology is the development of apparatus for the rhythmic stimulation of muscular tissue, both smooth and striated, and of the neurons supplying such tissues. By the action of these machines the current used is turned on by the mechanism smoothly and painlessly to the strength desired to produce a single muscle and nerve response, and is then turned off with equal smoothness and painlessness, followed by a period sufficiently long for repose before the next wave is turned on. By the older method this alternate contraction and repose was difficult to produce by hand, and the continuous excitation of an unvaried current was rather fatiguing than helpful to muscular tissues, though still useful in action on nerves.

The waves produced by the modern apparatus may be called rhythmic if the frequency of the waves is made to correspond, or approach near to, the normal rate of contraction of the neuromuscular parts stimulated, or are not so frequent as to interfere with the normal tonal impulses. For instance: it is probable that the semivoluntary muscle bundles of the pelvis would be quickly fatigued if compelled during a prolonged treatment to contract much oftener than about 25 times per minute, while contractions at a rate from 10 to 25 per minute do not seem to fatigue the patient, are not unpleasant, and are a valuable remedy in relaxed conditions.

Confining myself to this one subject in the broad field of electricity in gynecology, I shall discuss in this brief paper the two kinds of rhythmic waves of electric power available in this work, and indicate the differing action they exert on the semivoluntary muscles of the pelvis; on uterine tissue; and on the muscular coats of the intestines. It should be understood that these waves are all of low frequency cur-

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rents, and are in no way similar to high frequency currents, and that the indications for their use are the strengthening by exercise of atrophied, torn or relaxed muscular tissue, both striated and unstriated.

The action and value of diathermy and nonrhythmic currents in gynecology is quite another and a most important subject, and is best considered separately.

There are but two rhythmic waves now available in pelvic applications: the slow galvanic sinusoidal wave and the slowly-surging alternating current wave.

The galvanic sinusoidal wave is, as seen in Fig. 1, a direct or galvanic current, or what might be called a continuous stream of elec-

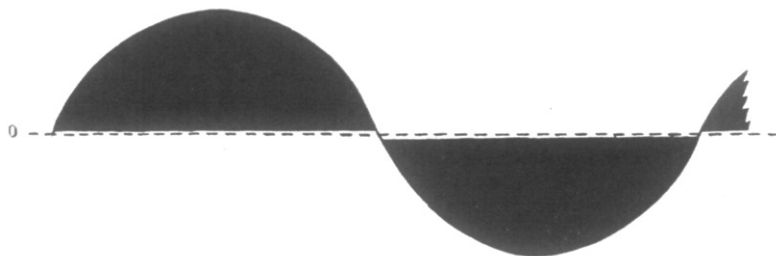


Fig. 1.—16 watt galvanic sinusoidal waves.

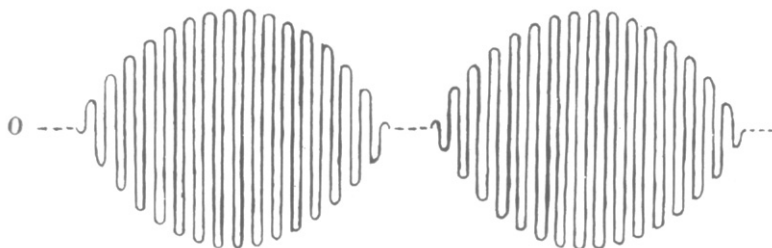


Fig. 2.—3 watt alternating current surges.

trons, that is smoothly turned on and increased by the machine as it passes through the patient to the strength selected, at which point it recedes to zero at the same rate of time and smoothness, the direction of the current being then mechanically reversed and the procedure repeated with changing polarity in each wave as long as desired.

The surging alternating current wave, (Fig. 2), is created by the surging by the machine of a current that is already alternating from 4000 to 7000 times per minute. To get the slow wave effect essential to rhythmic contractions it is mechanically surged into a rhythmic wave, which may be as slow, or even slower, than that produced by the galvanic apparatus.

Granting that we may obtain waves of the same periodicity suitable to our work from both of these machines, the question arises in what

way do they differ as articles of the *materia medica* in their gynecologic applications.

The answer is: that their chief clinical difference lies in the *duration* of the individual stimuli in the two waves. Take waves, for instance, of 30 per minute. The apex of such a wave or surge would last about a second. In the galvanic wave each wave constitutes an individual stimulus, lasting the full second.

In the alternating current surge this apex of the surge (a second in duration) contains about a thousand or more distinct stimulations, and, more important still, each stimulus exceedingly brief in its own duration, something like the one-fourhundredth of a second. To lengthen the surge would not increase the duration of any one of these brief stimuli.

Now physiologists have long since shown us most positively that the brevity of an induction impulse or wave fits it only for stimulation of normal neurons and normal striated muscular fibers, and that a much longer stimulus is required for degenerated voluntary muscles and normal involuntary muscles.

The therapeutic indications are, therefore, that in the stimulation of organs containing unstriated muscle fibers the galvanic wave is more effective in both health and disease. In organs made up of striated muscle, on the other hand, the alternating current wave is just as effective as the galvanic wave in the absence of true degeneration of the muscle. Whether pelvic muscles torn at childbirth present this degeneration depends on whether their motor neurons were also injured during parturition, causing Wallerian degeneration and the Reaction of Degeneration, in which case the galvanic wave will be most effective.

But I should not fail to mention that an important advantage of the galvanic reversal waves over the alternating current waves in weak muscles, with or without reaction of degeneration, is the fact that galvanic waves following each other in alternate reversed directions not only give sluggish muscles a long enough time to contract and relax fully, but time for each polarity to impress itself on the muscle or neuron so fully that the next polarity impressed in the same spot is doubled in efficiency by the release of stored energy—stored in the muscle by chemical change exactly as happens in a storage cell, and that the release of this stored energy occurs with the next wave, being in the same direction. This the physiologists have verified in most laborious experiments, calling it *electrotonus*, accompanied by explanations so far fetched and mentally confusing that all practical clinicians have tried to forget the whole subject. But the facts of the accentuation of response after reversal of a galvanic current have been fully verified, and only needed modern electrical conceptions to interpret them.

There are certain practical disadvantages attending the use of the machines producing galvanic waves. They are less perfect in con-

struction and more likely to give shocks by poorly acting moving parts. A motor generator is required to produce the galvanic current for their operation when the street supply is alternating. A slight electrolytic effect is produced on nickel plated vaginal or uterine electrodes but no lasting electrolysis or irritation of the tissues, and an indifferent pad with a better contact than generally used is to be advised when large currents are to be used with comfort to the patient.

The slight corrosion of the internal electrode is best met by the use of a copper ball or short cylinder (one by two inches, with an eight inch insulated stem) for the vagina that is kept amalgamated with quicksilver, and appropriate sized intrauterine copper sounds also amalgamated with quicksilver, the mercury surface readily absorbing any irritants temporarily formed during the waves and before the next wave has neutralized it. Kaolin pads form the best dispersing electrodes.

The alternating current wave generators are more fool proof, and may be turned over to an intelligent office nurse after the first treatment to a given patient. This wave is more soothing to the patient's nervous system, and seems to be fully effective in restoring tone to the voluntary muscles.

A few words should be said of the uterine muscle specifically in relation to these two waves. According to Morgan (*Electrophysiology*, New York, 1868, p. 701), T. Korner discovered through experiments on animals that the uterine muscle contracted most energetically when waves of the direct current were used. As to the proper periodicity of such stimulated contractions, it is possible that tonal impulses occur in the unimpregnated uterus at the same rate as the "pains" of childbirth.

Concerning the intestinal muscle, all physiologists agree, that these muscles contract more energetically under galvanic waves than under the briefer induction waves. If this be true when the metal electrodes are applied directly to the muscular layers of the intestine how much more must it be true of currents through the abdominal wall. Yet, on the other hand, I am sure that the large wattage of the Morse type of alternating wave generator does increase peristaltic action, the only possible explanation being the very great wattage of the waves of this generator as compared with the old faradic currents, this great wattage overcoming the effect of the slight duration of the inductions of which the waves are composed. At any rate, many patients have quickened bowel movements after strong Morse surges, applied by large pads to the back and abdomen, those with thin abdominal walls being compelled at times to go to stool shortly after the application. This is true of these patients with both forms of rhythmic waves. How

much is due in either case to the powerful contractions of the abdominal walls inducing peristalsis and how much to direct action on the intestinal muscles remains to be determined.

It is evident that we have in rhythmic waves of wattages of about 12 to 16 watts galvanic and 2 to 3 watts alternating current, a means of restoring function of the pelvic muscles after perineal tears, either with or without operative repair, if the applications are persistently given for weeks or a month or so.

In all degrees of uterine prolapse rhythmic currents are useful and at times curative, reposition preceding each application. Either wave may be employed.

In subinvolution of the uterus the galvanic wave is indicated. In both prolapse and subinvolution the vaginal electrode may be used instead of an intrauterine electrode, a distinct advantage when it is recalled that these applications must be made daily or tri-weekly for a considerable period. The dispersing pad is on the abdomen. Unlike intrauterine applications, the vaginoabdominal applications give some sense of relief at once, without the temporary discomfort attending intrauterine interference.

An hypertrophied cervix, on the other hand, needs intrauterine rhythmic applications at intervals of one week, preferably powerful galvanic waves, interspersed with more frequent vaginoabdominal applications of the Morse waves. The quick relief from discomfort and early shrinkage of the elongated cervix is most marked under these applications, and it has been my experience that greater after-comfort is experienced by patients so treated than by those in whose cases the cervix has been amputated.

Probably the most frequent indication for the vaginoabdominal application of either form of rhythmic wave is the neuromuscular impotence of multiparae who have relaxed pelvic muscles from several slight muscle tears, too slight and too multiple for effective joining of the torn ends; or who have general muscular weakness without tears. Here the effect of routine applications on the power and completeness of the contraction of all the muscles of the pelvis, at the slow rate of 10 to 25 waves per minute, can be readily judged by the grasping effect on the vaginal instrument, and the progressive increase in muscle power during the weeks or months of treatment.

In conclusion I wish to repeat that this paper is confined to the consideration of the rhythmic wave of electric power as a neuromuscular stimulant and tonic in gynecology, and does not cover the extensive surgical and medical fields of nonrhythmic currents.