ECT Time Machine

What yesterday's device teach about tomorrow's therapy

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Experimental Therapeutics & Pathophysiology Branch
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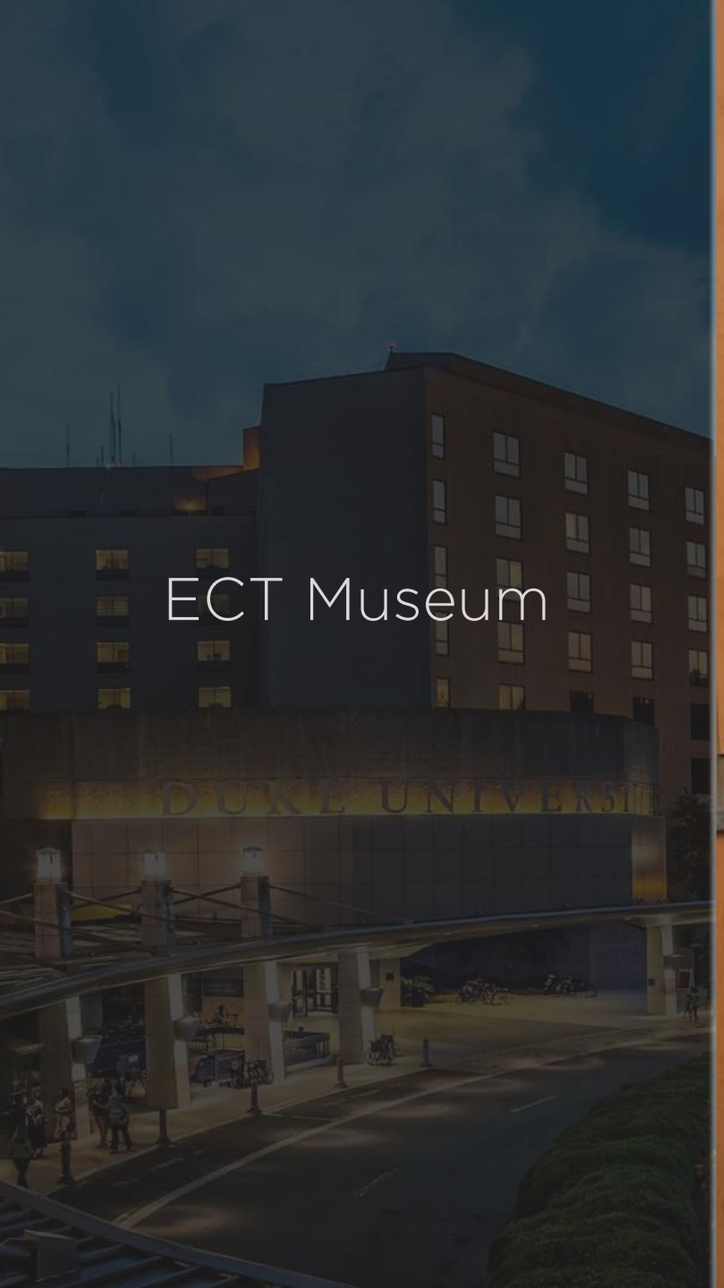
ECT Museum



THE

ELECTROPATHIC GUIDE:

PREPARED WITH

PARTICULAR REFERENCE TO

HOME PRACTICE;

CONTAINING

HINTS ON THE CARE OF THE SICK, THE TREATMENT OF DISEASE AND THE USE OF ELECTRICITY:

WITH

Full Directions for Treating over 100 Diseases.

CONTENTS.

CONTENTS.

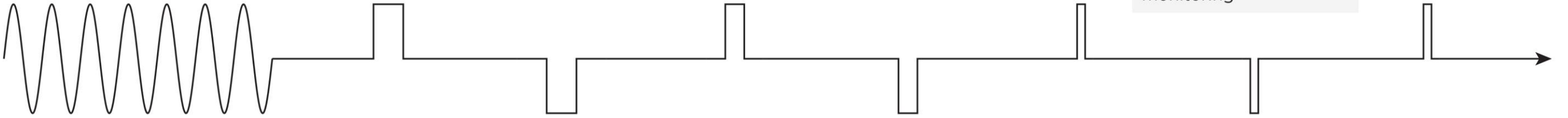
1938
Cerletti & Bini treated first patient with bitemporal sine-wave ECT

1973
MECTA's first ECT device was designed at OHSU

1984
Somatics Thymatron System IV cleared for marketing by FDA

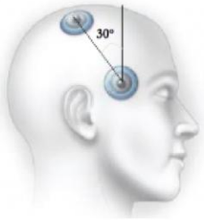
2003
MECTA introduced spECTrum 5000Q featuring ultrabrief pulse and physiological monitoring

2019
MECTA introduced Σigma



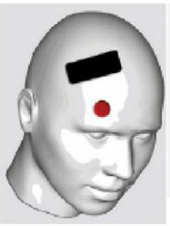
1948
Liberson introduced "Brief Stimulus Therapy", which laid the groundwork for modern brief pulse ECT. In his work, he already described electrode placements resembling today's right unilateral (vertex–temporal) and bifrontal configurations.

W. T. Liberson
1904–1994



1974
d'Elia standardized modern right unilateral ECT

1980s–1990s
Studies have demonstrated that brief pulse ECT results in less memory impairment than sine-wave ECT. Similarly, right unilateral ECT is associated with fewer cognitive side effects compared to bitemporal ECT.



2013
Nahas completed feasibility study of focal electrically administered seizure therapy (FEAST)

ORIGINAL STUDY

Controlling Stimulation Strength and Focality in Electroconvulsive Therapy via Current Amplitude and Electrode Size and Spacing

Comparison With Magnetic Seizure Therapy

Zhi-De Deng, PhD,† Sarah H. Lisanby, MD,*‡ and Angel V. Peterchev, PhD*§||*

Objectives: Understanding the relationship between the stimulus parameters of electroconvulsive therapy (ECT) and the electric field characteristics could guide studies on improving risk/benefit ratio. We aimed to determine the effect of current amplitude and electrode size and spacing on the ECT electric field characteristics, compare ECT focality with magnetic seizure therapy (MST), and evaluate stimulus individualization by current amplitude adjustment.

Methods: Electroconvulsive therapy and double-cone-coil MST electric field was simulated in a 5-shell spherical human head model. A range of ECT electrode diameters (2–5 cm), spacing (1–25 cm), and current amplitudes (0–900 mA) was explored. The head model parameters were varied to examine the stimulus current adjustment required to compensate for interindividual anatomical differences.

Results: By reducing the electrode size, spacing, and current, the ECT electric field can be more focal and superficial without increasing scalp current density. By appropriately adjusting the electrode configuration and current, the ECT electric field characteristics can be made to approximate those of MST within 15%. Most electric field characteristics in ECT are more sensitive to head anatomy variation than in MST, especially for close electrode spacing. Nevertheless, ECT current amplitude adjustment of less than 70% can compensate for interindividual anatomical variability.

Conclusions: The strength and focality of ECT can be varied over a wide range by adjusting the electrode size, spacing, and current. If desirable, ECT can be made as focal as MST while using simpler stimulation equipment. Current amplitude individualization can compensate for interindividual anatomical variability.

Key Words: electroconvulsive therapy, magnetic seizure therapy, electric field, focality, model

(*J ECT* 2013;29: 325–335)

Electroconvulsive therapy (ECT) is the most effective treatment for severe depression due to its powerful and rapid therapeutic action in patients who are otherwise treatment resistant.[1] However, ECT can cause amnesia and other adverse effects, which impedes its broader application.[2,3] Various alterations of ECT technique have been introduced to achieve more focal stimulation, based on the theory that increased focality of the electrical stimulus and the resultant seizure may be a means of reducing adverse effects.[4]

Among the approaches that make ECT more focal, electrode placement has been the subject of most intensive investigation. The shift from bilateral (BL) to right unilateral (RUL) electrode placement is representative of the move toward more focal electrical stimulus delivery, based on the assumption that by reducing the spacing between the electrodes and placing them over the right hemisphere, the direct stimulation and seizure intensity in the left hemisphere can be reduced, thereby sparing verbal and memory functions. Indeed, with appropriately dosed electrical stimulus,

(12) **United States Patent**
Sackeim

(10) **Patent No.: US 10,583,288 B2**
(45) **Date of Patent: *Mar. 10, 2020**

(54) **THERAPY DEVICE WITH CURRENT ADJUSTMENT**

(71) Applicant: **Mecta Corporation**, Tualatin, OR (US)

(72) Inventor: **Harold A. Sackeim**, Fleetwood, PA (US)

(73) Assignee: **MECTA CORPORATION**, Tualatin, OR (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/696,872**

(22) Filed: **Sep. 6, 2017**

(65) **Prior Publication Data**

US 2018/0056064 A1 Mar. 1, 2018

Related U.S. Application Data

(60) Continuation of application No. 14/262,234, filed on Apr. 25, 2014, now Pat. No. 9,789,310, which is a division of application No. 12/464,545, filed on May 12, 2009, now Pat. No. 8,712,532.

(51) **Int. Cl.**
A61N 1/36 (2006.01)
A61N 1/38 (2006.01)
A61N 1/372 (2006.01)

(52) **U.S. Cl.**
CPC ***A61N 1/36014*** (2013.01); ***A61N 1/36025*** (2013.01); ***A61N 1/3727*** (2013.01); ***A61N 1/38*** (2013.01)

(58) **Field of Classification Search**
CPC A61N 1/36014; A61N 1/36025; A61N 1/3727; A61N 1/38
See application file for complete search history.

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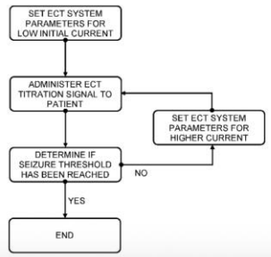
(Continued)

Primary Examiner — Allen Porter
Assistant Examiner — Natasha Patel
(74) *Attorney, Agent, or Firm* — Miller Nash Graham & Dunn LLP

(57) **ABSTRACT**

An ECT system capable of focusing the electrical signals on a specific portion of the patient's brain is provided. The ECT system includes a means of applying unidirectional electrical signals and asymmetric electrodes for focusing the signals on the patient. A method of titrating an electroconvulsive therapy (ECT) system and a method of operating an ECT system are also provided. The method includes setting an initial current value, administering an ECT signal to the patient, determining if the seizure threshold has been achieved, and repeating as necessary until the seizure threshold is achieved.

8 Claims, 7 Drawing Sheets



Individualized Low-Amplitude Seizure Therapy: Minimizing Current for Electroconvulsive Therapy and Magnetic Seizure Therapy

Angel V Peterchev*[,1,2,3], Andrew D Krystal[1], Moacyr A Rosa[4] and Sarah H Lisanby[1,5]

[1]Department of Psychiatry and Behavioral Sciences, Duke University, Durham, NC, USA; [2]Department of Biomedical Engineering, Duke University, Durham, NC, USA; [3]Department of Electrical and Computer Engineering, Duke University, Durham, NC, USA; [4]Institute for Advanced Research in Neurostimulation, São Paulo , Brazil; [5]Department of Psychology and Neuroscience, Duke University, Durham, NC, USA

Electroconvulsive therapy (ECT) at conventional current amplitudes (800–900 mA) is highly effective but carries the risk of cognitive side effects. Lowering and individualizing the current amplitude may reduce side effects by virtue of a less intense and more focal electric field exposure in the brain, but this aspect of ECT dosing is largely unexplored. Magnetic seizure therapy (MST) induces a weaker and more focal electric field than ECT; however, the pulse amplitude is not individualized and the minimum amplitude required to induce a seizure is unknown. We titrated the amplitude of long stimulus trains (500 pulses) as a means of determining the minimum current amplitude required to induce a seizure with ECT (bilateral, right unilateral, bifrontal, and frontomedial electrode placements) and MST (round coil on vertex) in nonhuman primates. Furthermore, we investigated a novel method of predicting this amplitude-titrated seizure threshold (ST) by a non-convulsive measurement of motor threshold (MT) using single pulses delivered through the ECT electrodes or MST coil. Average STs were substantially lower than conventional pulse amplitudes (112–174 mA for ECT and 37.4% of maximum device amplitude for MST). ST was more variable in ECT than in MST. MT explained 63% of the ST variance and is hence the strongest known predictor of ST. These results indicate that seizures can be induced with less intense electric fields than conventional ECT that may be safer; efficacy and side effects should be evaluated in clinical studies. MT measurement could be a faster and safer alternative to empirical ST titration for ECT and MST.

Neuropsychopharmacology (2015) **40,** 2076–2084; doi:10.1038/npp.2015.122; published online 20 May 2015

ARTICLE **OPEN**

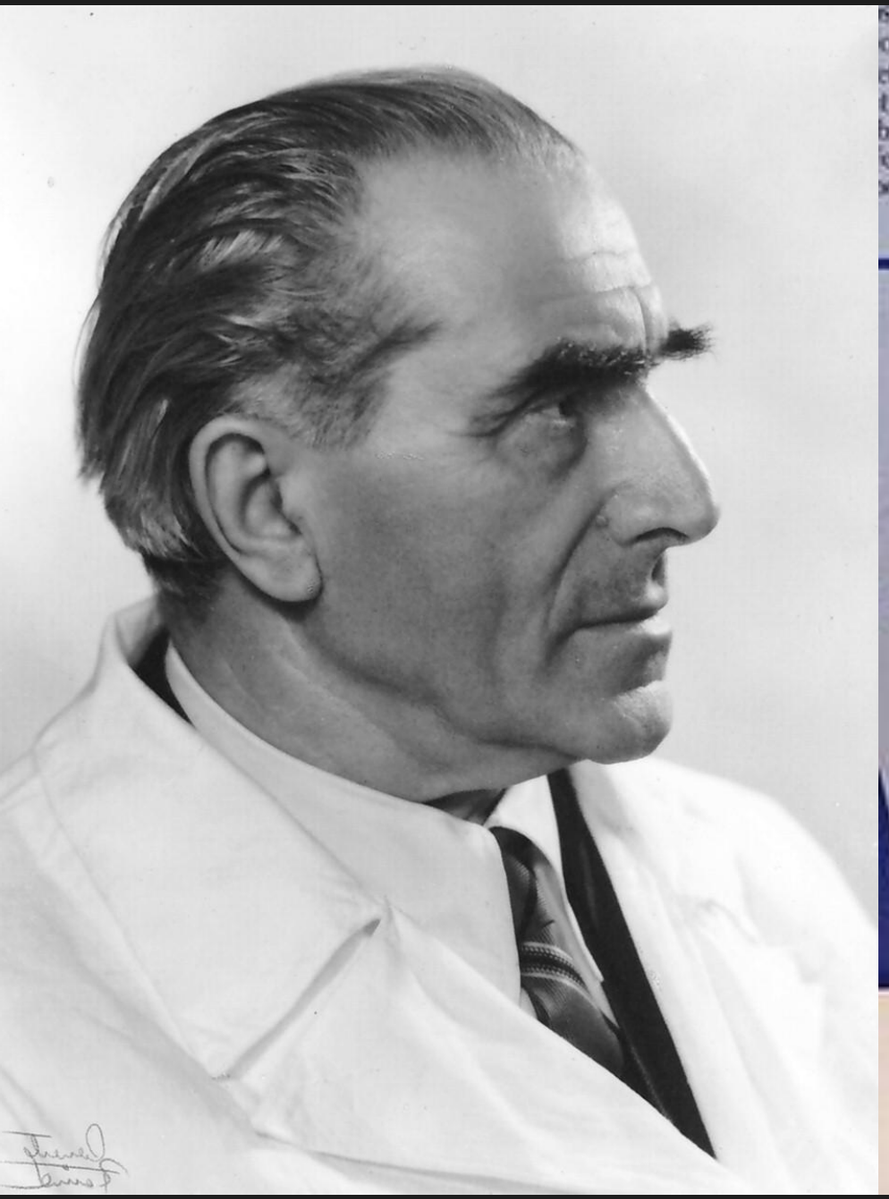
Check for updates

Amplitude-determined seizure-threshold, electric field modeling, and electroconvulsive therapy antidepressant and cognitive outcomes

Christopher C. Abbott[1✉], Jeremy Miller[1], Danielle Farrar[1], Miklos Argyelan[2,3], Megan Lloyd[1], Taylor Squillaci[1], Brian Kimbrell[1], Sephira Ryman[4,5], Thomas R. Jones[1], Joel Upston[1], Davin K. Quinn[1], Angel V. Peterchev[6,7,8,9], Erik Erhardt[10], Abhishek Datta[11], Shawn M. McClintock[6,12] and Zhi-De Deng[6,13]

Electroconvulsive therapy (ECT) pulse amplitude, which dictates the induced electric field (E-field) magnitude in the brain, is presently fixed at 800 or 900 milliamperes (mA) without clinical or scientific rationale. We have previously demonstrated that increased E-field strength improves ECT's antidepressant effect but worsens cognitive outcomes. Amplitude-determined seizure titration may reduce the E-field variability relative to fixed amplitude ECT. In this investigation, we assessed the relationships among amplitude-determined seizure-threshold (ST_a), E-field magnitude, and clinical outcomes in older adults (age range 50 to 80 years) with depression. Subjects received brain imaging, depression assessment, and neuropsychological assessment pre-, mid-, and post-ECT. ST_a was determined during the first treatment with a Soterix Medical 4×1 High Definition ECT Multi-channel Stimulation Interface (Investigation Device Exemption: G200123). Subsequent treatments were completed with right unilateral electrode placement (RUL) and 800 mA. We calculated E_{brain} defined as the 90th percentile of E-field magnitude in the whole brain for RUL electrode placement. Twenty-nine subjects were included in the final analyses. E_{brain} per unit electrode current, E_{brain}/I, was associated with ST_a. ST_a was associated with antidepressant outcomes at the mid-ECT assessment and bitemporal electrode placement switch. E_{brain}/I was associated with changes in category fluency with a large effect size. The relationship between ST_a and E_{brain}/I extends work from preclinical models and provides a validation step for ECT E-field modeling. ECT with individualized amplitude based on E-field modeling or ST_a has the potential to enhance neuroscience-based ECT parameter selection and improve clinical outcomes.

Neuropsychopharmacology (2024) 49:640–648; https://doi.org/10.1038/s41386-023-01780-4




ey and experimental epilepsy.
ong series of experiments on animals,
etti (1877–1963) tries out ECT in 1938 on a patient
t to his department in an apparent confusional state.
bsequent use of ECT in clinics demonstrates
ectiveness of Cerletti's technique in the treatment
pression and manic-depressive disorders.

Convulsive Therapy
4(1):40–49 © 1988 Raven Press, Ltd., New York

An Eyewitness Account of the Discovery of Electroshock

Ferdinando Accornero

Department of Nervous and Mental Diseases, University of Rome, Rome, Italy

Summary: The author was one of the pupils of U. Cerletti and his assistant for almost 20 years. He worked with his master in the discovery of electroshock and in its first application in man in 1938. The author has thought it useful to publish his own testimony for the purpose of making the truth about the events known—the same truth that has often been questioned.

The first application of electroshock in human beings occurred in April 1938, in a room of the Clinic for Mental and Nervous Diseases in Rome, then under the direction of Professor Ugo Cerletti. Vittorio Challiol, an assistant in the clinic; Mario Felici; and I, and the aide Spartaco Mazzanti, are the only eyewitnesses still alive. Ugo Cerletti, Lucio Bini, and the nurse Ezio Capelletti are no longer with us.

"

I heard Bini say, "We gave 80 volts for 1/10 of a second. The patient had an absence."

"We need to increase the current," said Prof. Cerletti, "let's try another setting."

Bini set the device: "90 volts, 1/10 of a second."

"O.K. Go!"

Accornero, *Convul Ther*, 1988

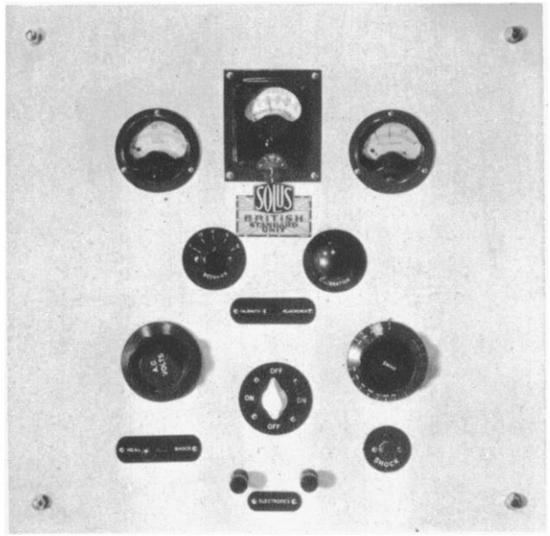


FIG. 1.—Instrument panel.

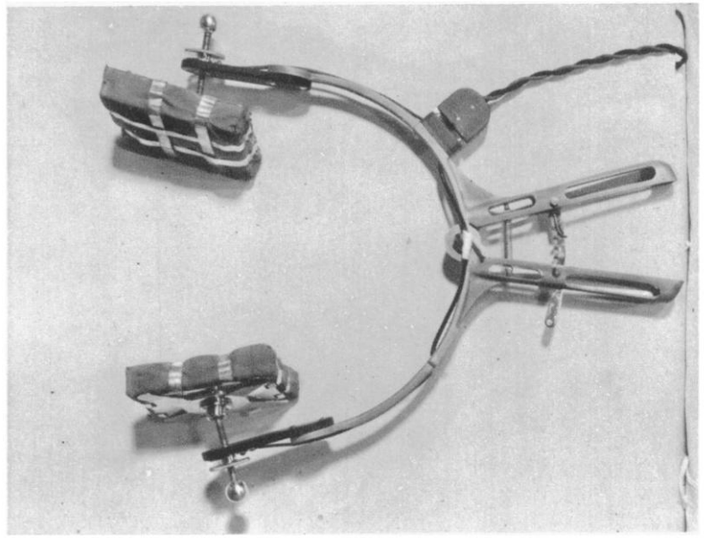


FIG. 2.—Electrodes.

- Modification of the Bini patent designed by “Solus” Electrical Co.
- Voltage can be varied by means of a tapped auto-transformer between 50 and 150 V.
- Time of the stimulation is limited by means of an electrical time switch adjustable between 0.1 and 0.5 s.

Shepley & McGregor, *Br Med J*, 1939

Friedman-Wilcox-Reiter (FWR) technique

- The rheostat adjusted so that 15–20 mA of current was delivered.
- If a convulsion was not induced, the patient would be allowed to rest for several minutes until respirations were again regular.
- The series would then be repeated with an additional 5–10 mA.

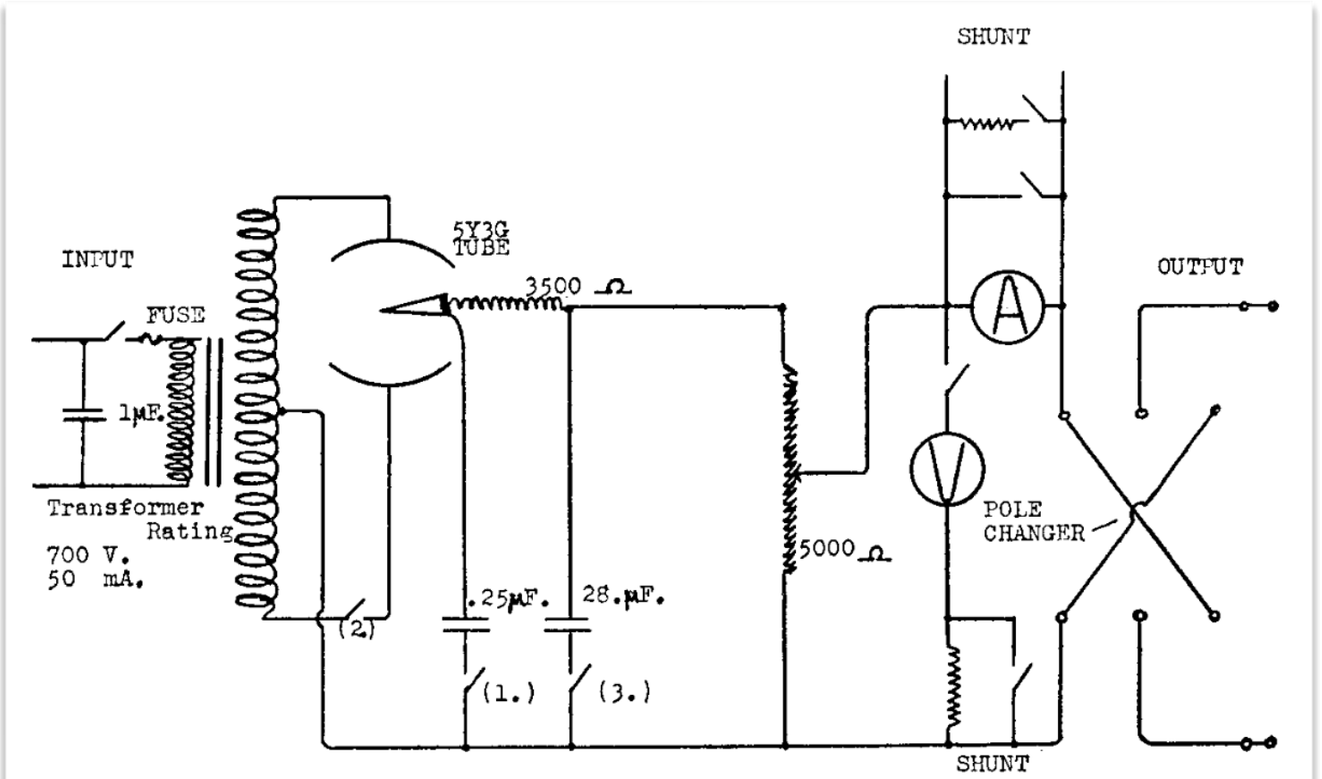


FIGURE 1.—Diagram of electrostimulation apparatus for delivering a variety of unidirectional currents including, practically, a galvanic type. Half-sine wave (our Type 1A) current is delivered when switches (1) (2) and (3) are all 'off'; galvanic (our pseudogalvanic) current is delivered when these switches are all 'on'. By appropriate shunting of the 3500 Ω resistance a much larger quantity of current is available.

Friedman & Wilcox, *J Nerv Ment Dis*, 1942

In the beginning, ECT had current amplitude control.
We lost it.

Pulse Waveform

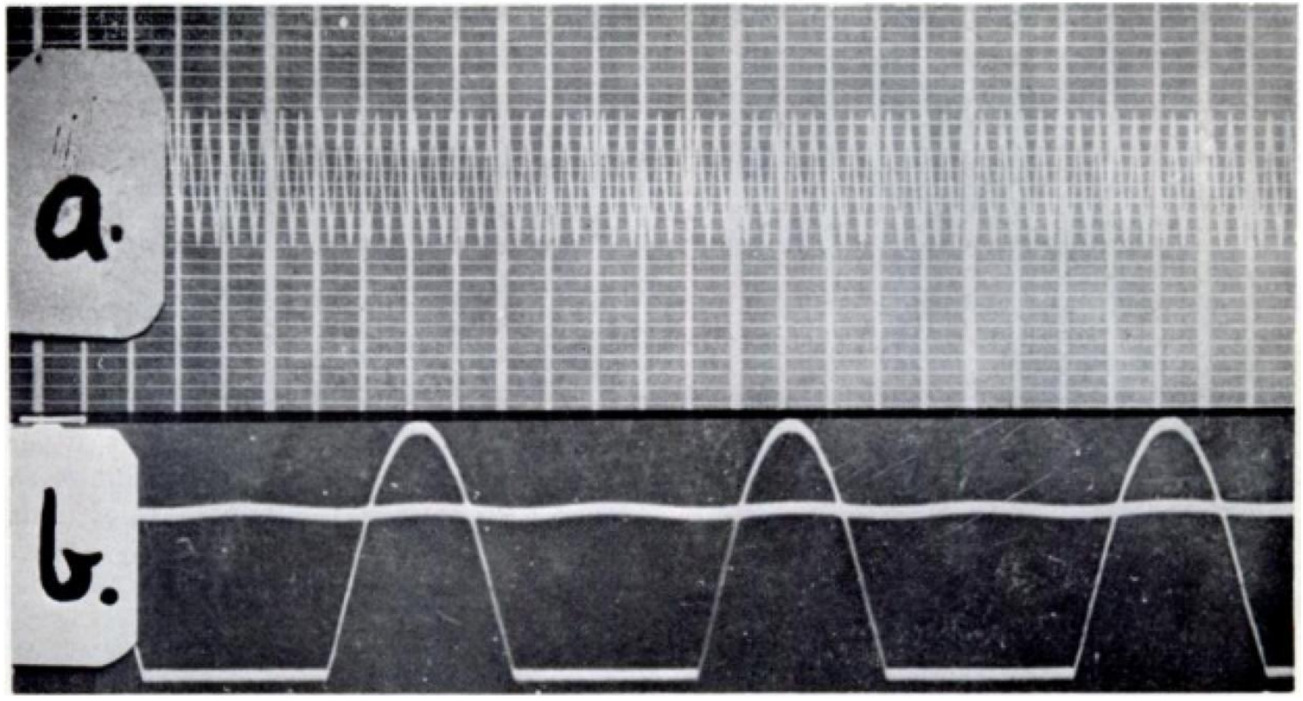


FIG. 1.

(a) Modified galvanoscope tracing of type A. 1. wave form. Standard Ekg. and time marking paper were used for this and the other galvanoscope tracings in this work.

(b) Oscillographic photograph illustrating the wave form characteristics. It is noted that these are essentially half-sine waves at 60/sec. with time intervals of 1/120 sec. and free intervals of 1/120 sec. at the base line.

In 154 trials, 68% gave convulsive thresholds at 50 mA or less.

Friedman, *Am J Psychiatr*, 1942

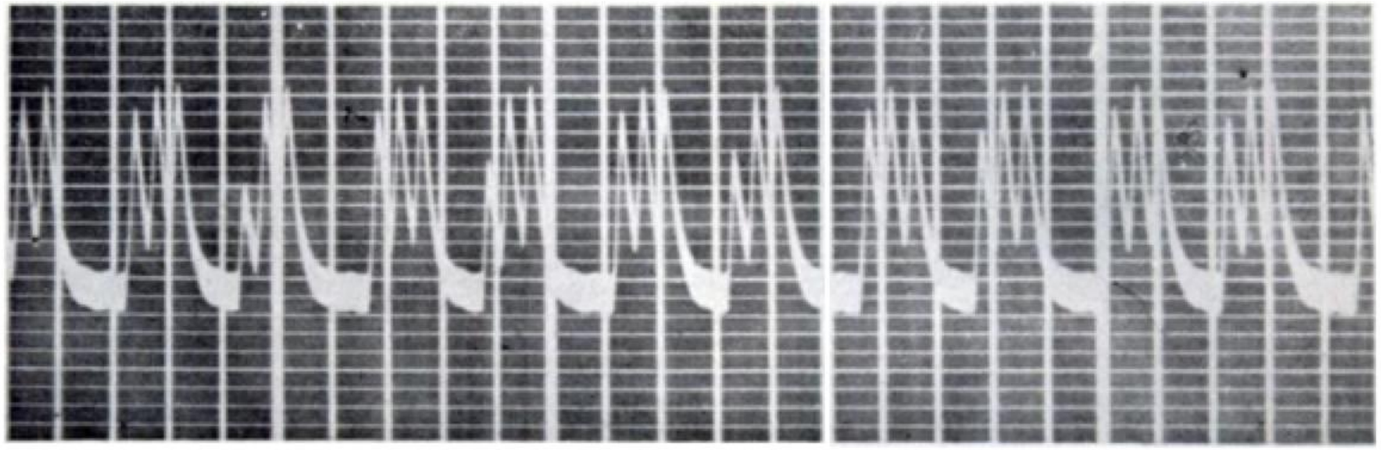


FIG. 2.

Type A. 2. wave form. Tracing made by modified galvanoscope shows bursts of 1/20 sec. intervals of 1/20 sec. and the grouping of the original 60/sec. waves into 3 wave impulses. This grouping occurs when a make commutator interrupts the type A. 1. waves at 10/sec.

In 1735 trials, 83% achieved seizure threshold with 50 mA or less.

Friedman, *Am J Psychiatr*, 1942

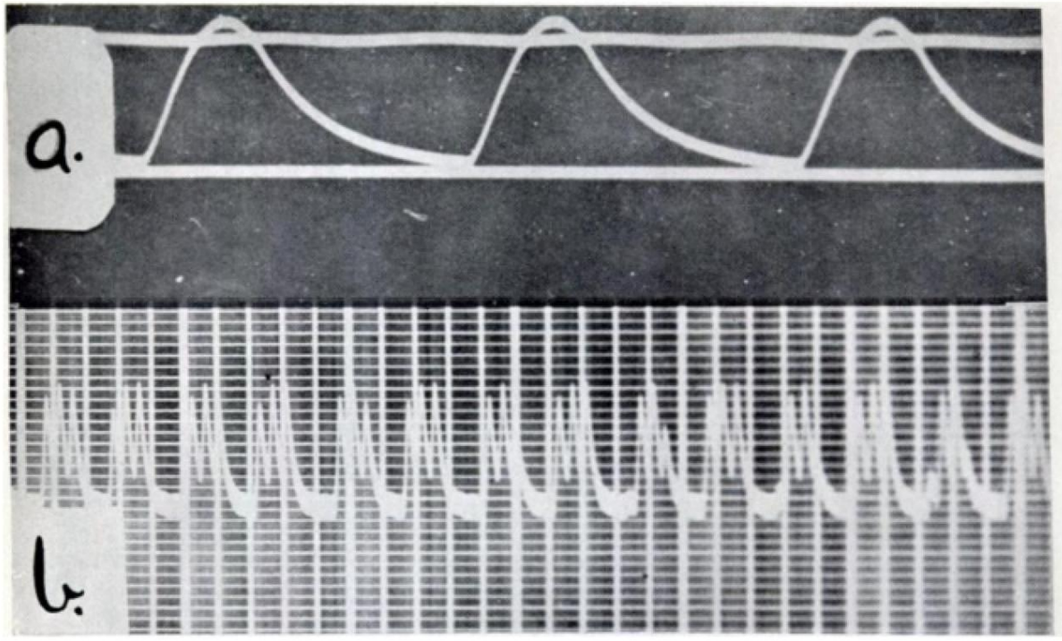


FIG. 3.

(a) Oscillographic photograph of type C. 1. wave form. Time interval is 1/60 sec. at the base line. This wave form may be described as a slightly smoothed, rectified wave. The wave decadency is slowed so that the current barely reaches zero before the next wave begins.

(b) Modified galvanoscope tracing of type C. 2. wave form. Impulse bursts lasting 1/20 sec. with free intervals of 1/20 sec. are apparent. Although the primary type C. 1. wave form measures 1/60 sec. on the base line as compared to 1/120 sec. of type A. 1., no difference in pattern is noted in the grouping of these waves into impulses lasting 1/20 sec.

Of 270 convulsive doses by type C.2. stimulation, 66% occurred at 50 mA or less. Subjectively, patients displayed practically the same reaction with type A.1, A.2, and C.2.

Friedman, *Am J Psychiatr*, 1942

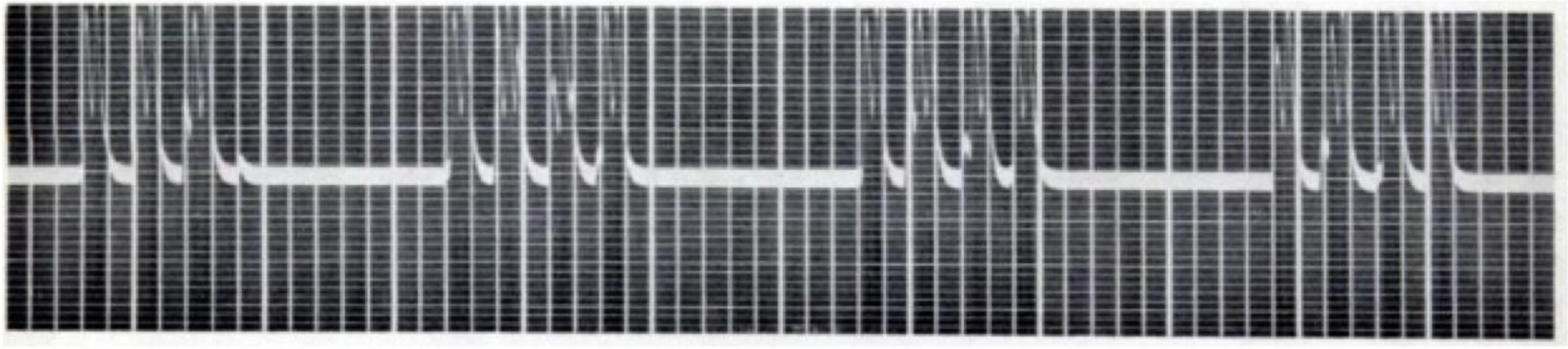


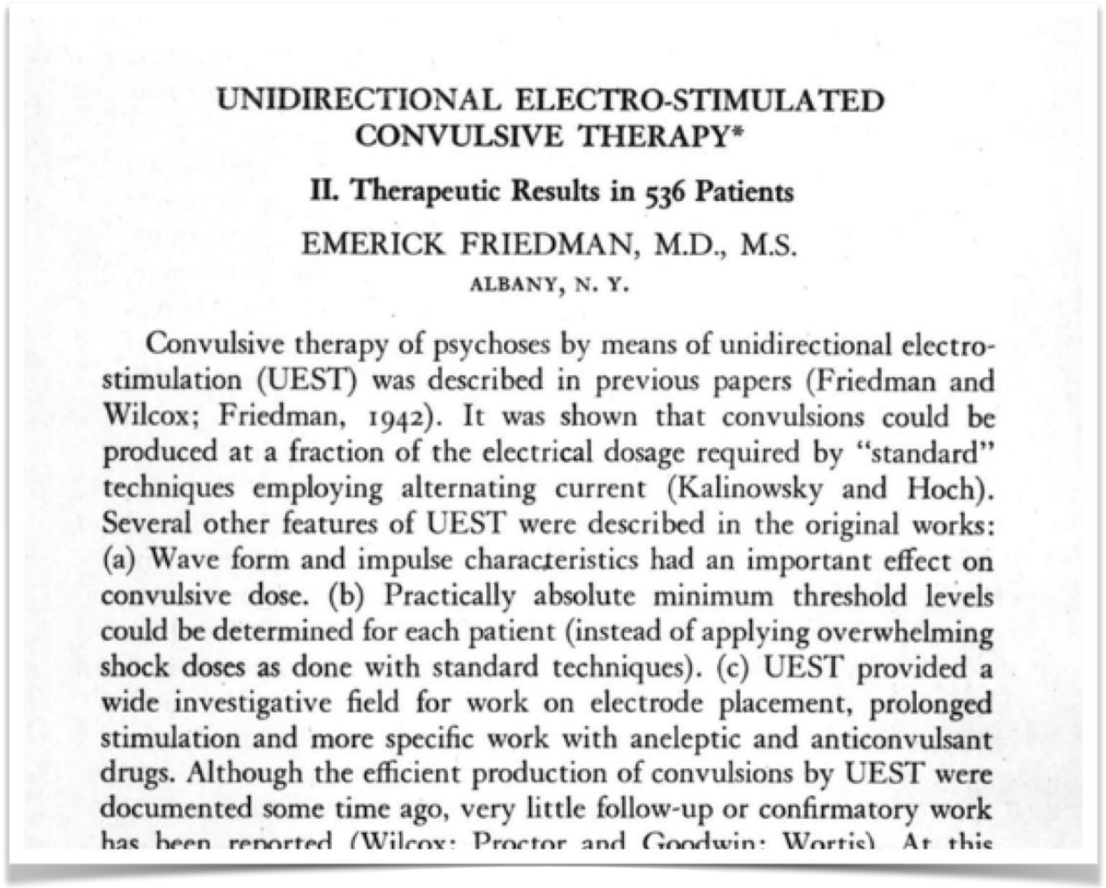
FIG. 4.

Galvanoscope tracing of type C. 3. stimulation. This type consists of the type C. 2. pattern further interrupted by manipulation of the hand switch. Note that at times the switch may be turned on or off before a 10/sec. commutator impulse has begun or has subsided.

In 587 convulsions, practically all occurred at 50 mA or less, 80% at 1–25 mA. From the experiential data offered by patients who had both type C.3 and some of the other types, the preference was unanimous for type C.3.

Friedman, *Am J Psychiatr*, 1942

Temporal pattern of pulses > shape of pulses



UNIDIRECTIONAL ELECTRO-STIMULATED CONVULSIVE THERAPY*

II. Therapeutic Results in 536 Patients

EMERICK FRIEDMAN, M.D., M.S.

ALBANY, N. Y.

Convulsive therapy of psychoses by means of unidirectional electro-stimulation (UEST) was described in previous papers (Friedman and Wilcox; Friedman, 1942). It was shown that convulsions could be produced at a fraction of the electrical dosage required by "standard" techniques employing alternating current (Kalinowsky and Hoch). Several other features of UEST were described in the original works: (a) Wave form and impulse characteristics had an important effect on convulsive dose. (b) Practically absolute minimum threshold levels could be determined for each patient (instead of applying overwhelming shock doses as done with standard techniques). (c) UEST provided a wide investigative field for work on electrode placement, prolonged stimulation and more specific work with aneleptic and anticonvulsant drugs. Although the efficient production of convulsions by UEST were documented some time ago, very little follow-up or confirmatory work has been reported (Wilcox; Proctor and Goodwin; Wortis). At this

- N=536 (21,154 convulsive reactions), hospitalized schizophrenic and affective psychoses
- Average dose ranged from 30–50 mA, for 0.4–0.6 s, with convulsions obtained at as low as 15–20 mA for 0.5–1.5 s
- Confusion, disorientation and memory defects were not found in this series. This was believed to be a direct result of low electrical dosage

Friedman, J *Nerv Ment Dis*, 1949

Alternating Current VS. Unidirectional Current for Electroconvulsive Therapy – Comparative Studies *

By Joseph EPSTEIN and Louis WENDER

ECT as originally introduced, utilized the alternating current (AC) as the stimulating agent. This was originated by *Bini* and *Cerletti*. It consists of a sudden application of the current over a period of a fraction of a second. With the treatment, a violent, uncontrollable convulsion ensues instantly, and complications, such as fractures, may occur within the first second or two of treatment, and there is nothing that can be done in a mechanical manner to prevent this. Various drugs can be given to soften the convulsion, but these carry along inherent dangers to the respiratory mechanism. The violent convulsive reaction resulting from AC method of treatment most likely is an expression of excessive and therapeutically unnecessary overstimulation, and it may be due to the latter that other dangers and complications are encountered. In the latter category we meet the respiratory and cardiac difficulties, and also disturbing psychological states, particularly confusion and forgetfulness.

- N = 806
- 436 received sine-wave ECT (Offner/Medcraft)
- 370 treated with Reiter apparatus
- Recovery rates for various psychoses were roughly the same with the two methods
- FWR method may require 1 or 2 more treatments than SW ECT
- Complications very greatly reduced with the FWR method (fractures, confusion, memory defects)

Epstein and Wender, *Confin Neurol*, 1956

BRIEF STIMULUS THERAPY

Physiological and Clinical Observations [1]

W. T. LIBERSON, M. D.

Institute of Living, Hartford, Connecticut

Introduction

Electric convulsive therapy remains a treatment of choice or of trial for a considerable number of patients with so-called functional mental disorders. The possibility of brain damage produced by such treatment is still a debatable question (Alpers and Hughes(1, 2); Ebaugh *et al*(4); Globus *et al*(8); Neubuerger *et al*(24)).

The understanding of the fundamental mechanisms involved in this therapy is still lacking. The following events should be considered.

Direct and immediate action of the current resulting in a profound change in the circulation, oxidation, and excitability of the brain; the setting up of a self-sustaining and self-propagating "excitatory state" (Rosenblueth and Cannon(28)) associated with electrical discharges in wide areas of

treatments as a vivid reactivation of fear of death; organic-like prolonged confusional states (Kalinowsky and Hoch(13)), etc.

The major problem in research in convulsive therapy is to determine which one of these events has a therapeutic value. An appropriate modification of the stimulative technique will then permit the therapist to reenforce its effect.

It has been shown that mere anoxic episodes do not have any definite effect on the mental disease (Reitman and Frazer(26); Sillman and Terrence(30)). Neither does minor loss of consciousness with subconvulsive stimulation seem to have a full therapeutic action (Gottesfeld *et al*(10)). This leads to the suggestion that convulsions expressing a hidden dramatic increase of the excitatory state in the brain cells have major therapeutic significance. Some authors

Liberson, *Yale J Biol Med*, 1945; Liberson, *Am J Psychiatry*, 1948

WLADIMIR THEODORE LIBERSON, MD, PhD

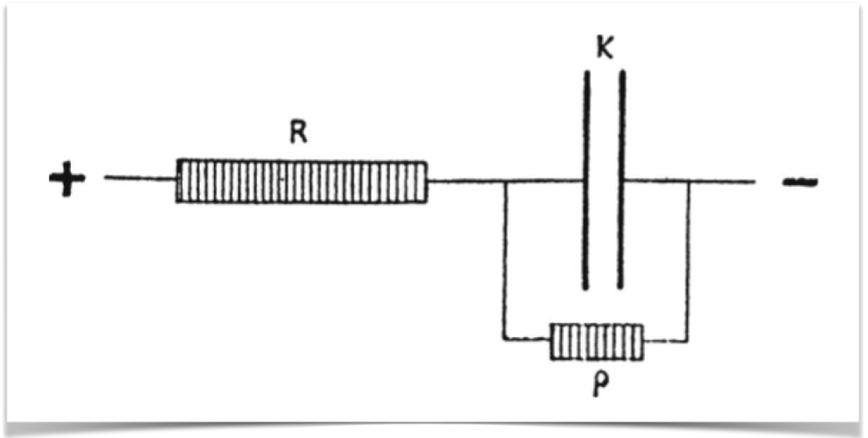
ROBERT E. LOVELACE, MD, FRCP

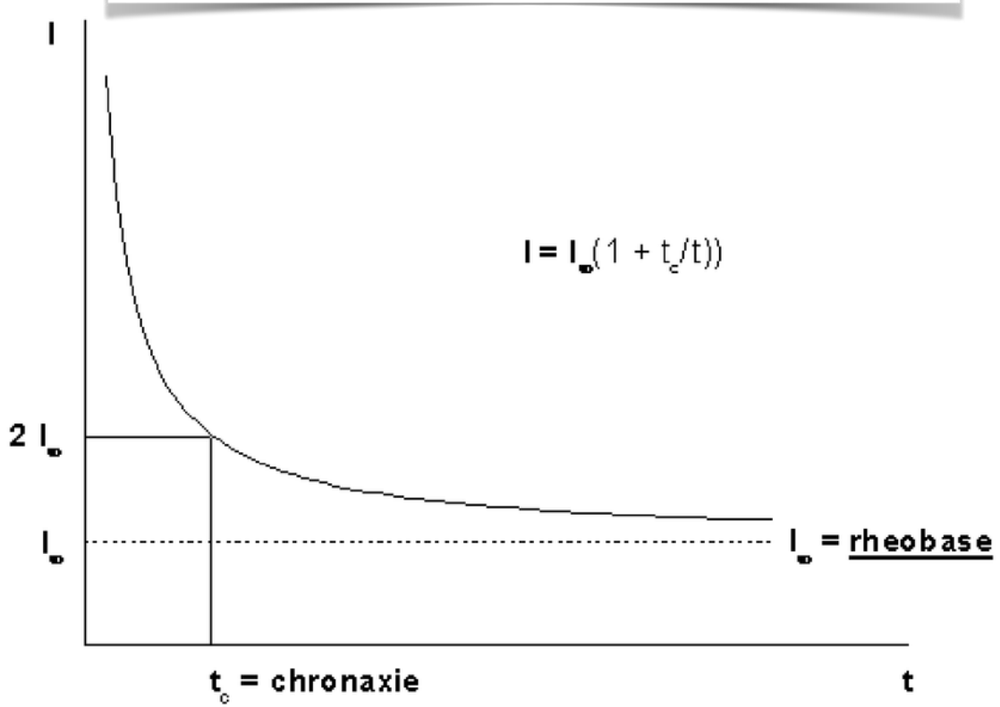
Dr. Wladimir Theodore Liberson, clinician, researcher, and educator, died September 3, 1994. In his long and varied career Dr. Liberson made major contributions to psychopharmacology, physical medicine and rehabilitation, and clinical neurophysiology, including electroencephalography, electromyography, and nerve conduction and evoked potential testing.

Dr. Liberson was born in Kiev, Russia, on August 2, 1904, and studied in Moscow and Leningrad. In Leningrad (recently renamed St. Petersburg) he worked in the laboratories of the famous physicist Herman von Helmholtz who described the string galvanometer used in early electrophysiology. He received his medical degree in Paris in 1936 and trained under Professors Louis Lapicque and Henri Laugier at the Sorbonne, and Georges Bourguignon at the Salpêtrière. He earned his doctorate in physiology at the University of Montréal in 1951.

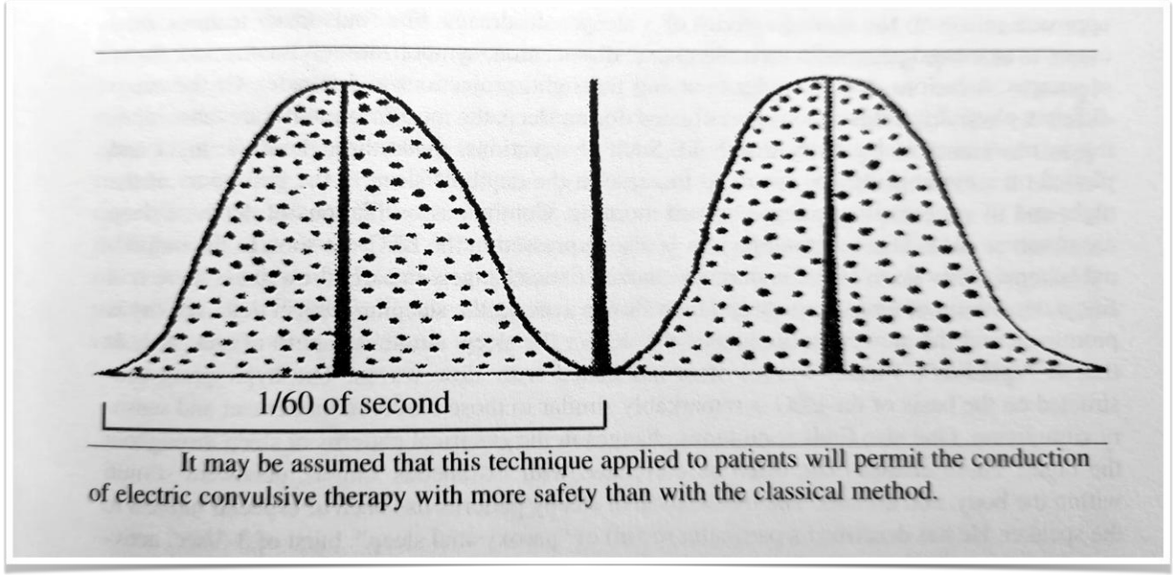
raphy and Electrodiagnosis (AAEE) (1963–1964) (now the American Association of Electrodiagnostic Medicine), the American Electroencephalographic Society (1958–1959), and also the American Society for Clinical Evoked Potentials (1992–1993). He was very active in establishing the American Electroencephalographic Society and is considered one of the "founding fathers" of the American Society for Clinical Evoked Potentials. He was coeditor of the international journal, Electromyography and Clinical Neurophysiology, and editor of the North American issue from its inception until his death. He also served as editor of the AAEE's newsletter *Bulletin* (1960–1970). Dr. Liberson prepared a special issue of the EMG Bulletin commemorating 100 years of research in neuromyography with seminal papers reprinted. In the words of Dr. Golseth, the first president of the AAEE, "It was a monumental effort and I only wish that every AAEE member could have a copy

Lovelace, *Muscle Nerve*, 1995





Lapicque, *J Physiol Pathol Générale*, 1907



It may be assumed that this technique applied to patients will permit the conduction of electric convulsive therapy with more safety than with the classical method.

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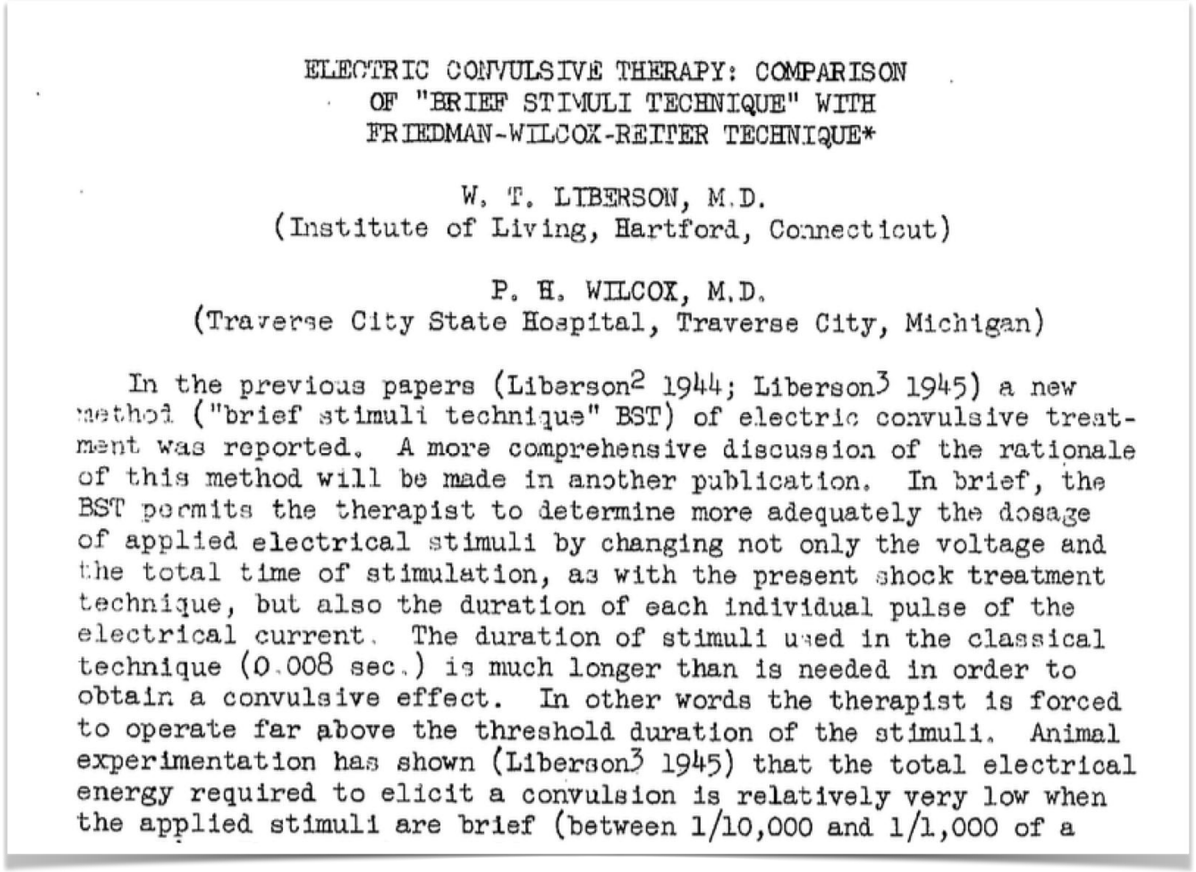
As might be reasonably assumed, the excitabilities involved in electrically induced convulsions are the rapid ones, characterized by a chronaxie below 1 ms.

Liberson, *Dig Neur Psychiat*, 1944



ELECTRIC CONVULSIVE THERAPY: COMPARISON
OF "BRIEF STIMULI TECHNIQUE" WITH
FRIEDMAN-WILCOX-REITER TECHNIQUE*

W. T. LIBERSON, M.D.
(Institute of Living, Hartford, Connecticut)

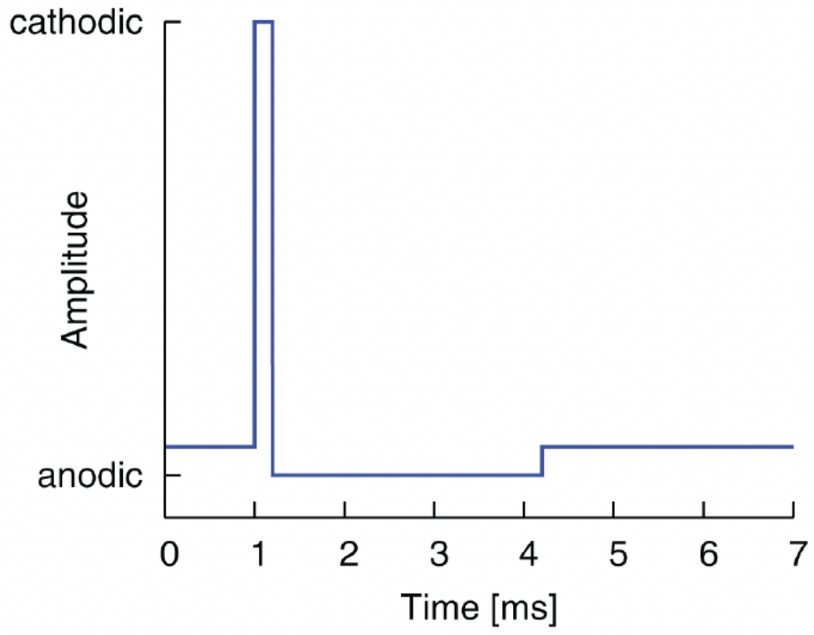
P. H. WILCOX, M.D.
(Traverse City State Hospital, Traverse City, Michigan)

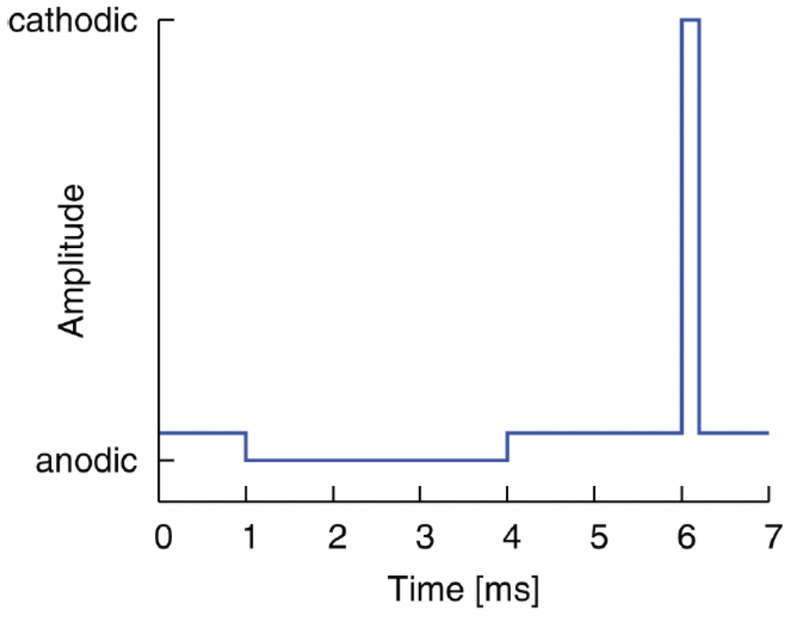
In the previous papers (Liberson[2] 1944; Liberson[3] 1945) a new method ("brief stimuli technique" BST) of electric convulsive treatment was reported. A more comprehensive discussion of the rationale of this method will be made in another publication. In brief, the BST permits the therapist to determine more adequately the dosage of applied electrical stimuli by changing not only the voltage and the total time of stimulation, as with the present shock treatment technique, but also the duration of each individual pulse of the electrical current. The duration of stimuli used in the classical technique (0.008 sec.) is much longer than is needed in order to obtain a convulsive effect. In other words the therapist is forced to operate far above the threshold duration of the stimuli. Animal experimentation has shown (Liberson[3] 1945) that the total electrical energy required to elicit a convulsion is relatively very low when the applied stimuli are brief (between 1/10,000 and 1/1,000 of a

“

The threshold energy required was distinctly less, and memory scores were significantly higher with the BST than with the FWRT.

Liberson & Wilcox, *Dig Neur Psychiat*, 1945





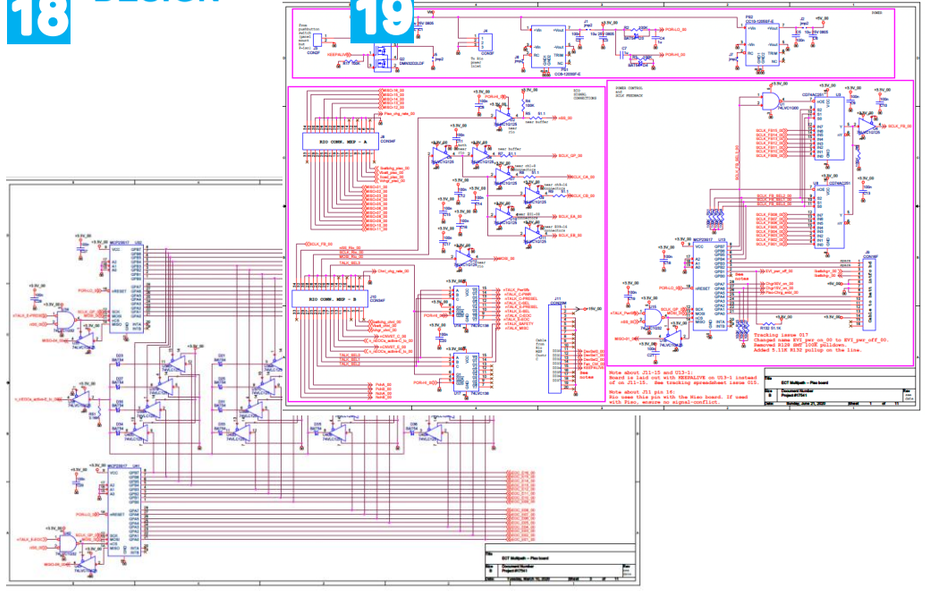
The modification of the pulse shapes resulted in an improvement of up to 50% for both the activation of resting neurons and the entrainment of bursting neurons.

Hofmann et al., *Front Neuroeng*, 2011

2018

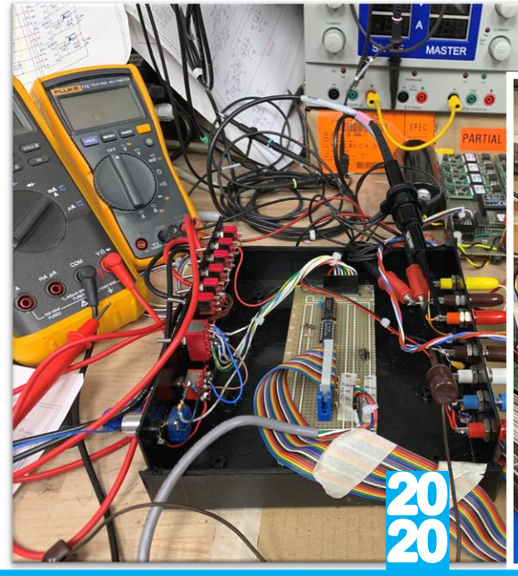
DESIGN

2019



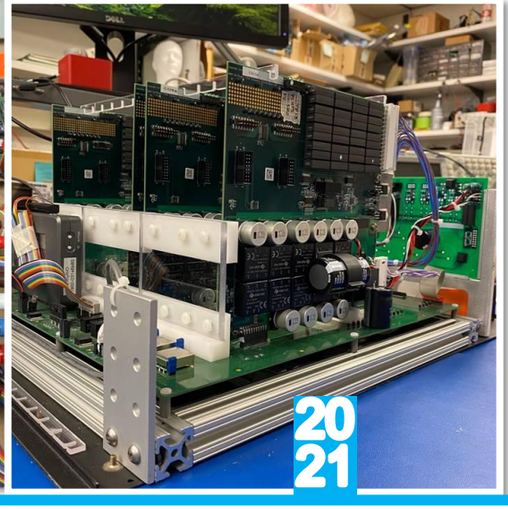
2020

PROTOTYPING



2021

ASSEMBLY

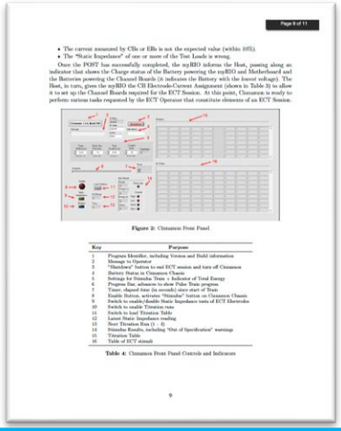


2022

BOXING/ TESTING

2023

USER INTERFACE PROGRAMMING/ DOCUMENTATION

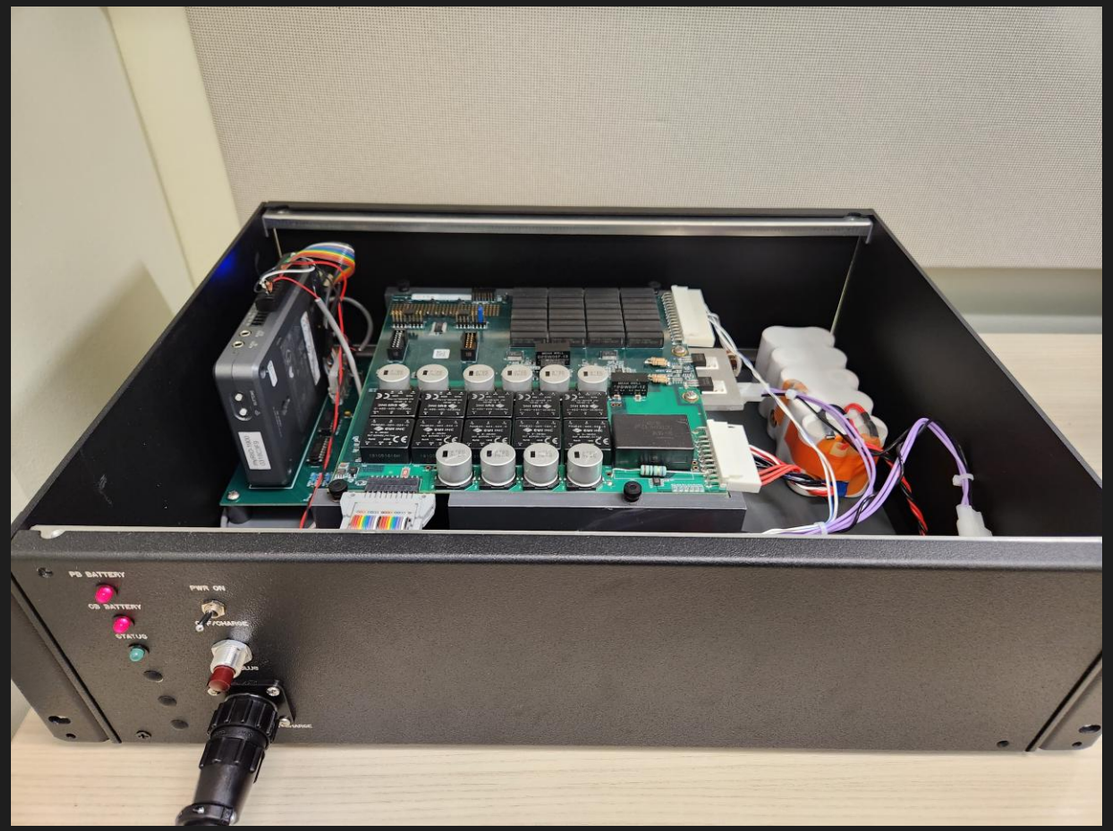


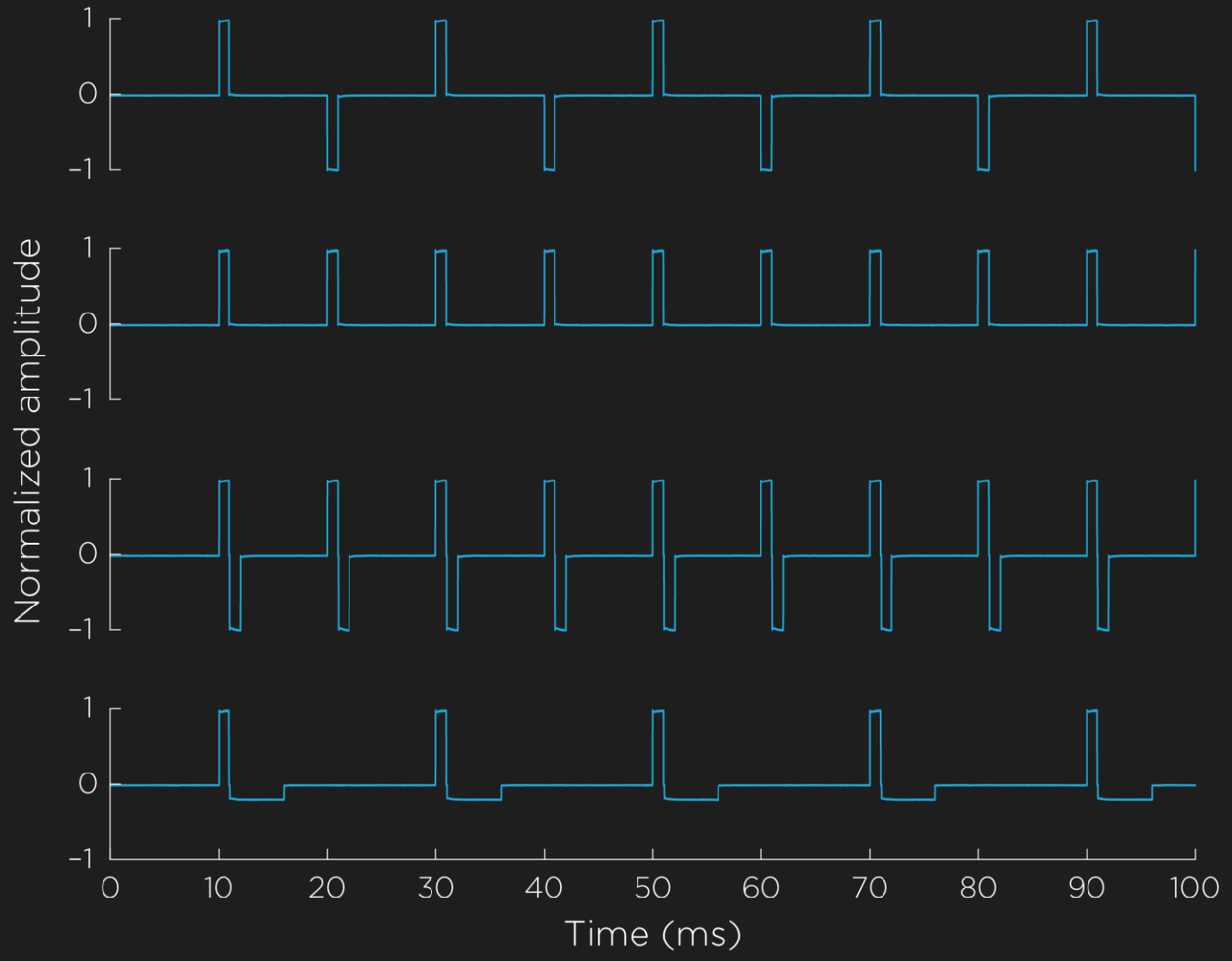
INVENTION DISCLOSURE, IP FILING

2024

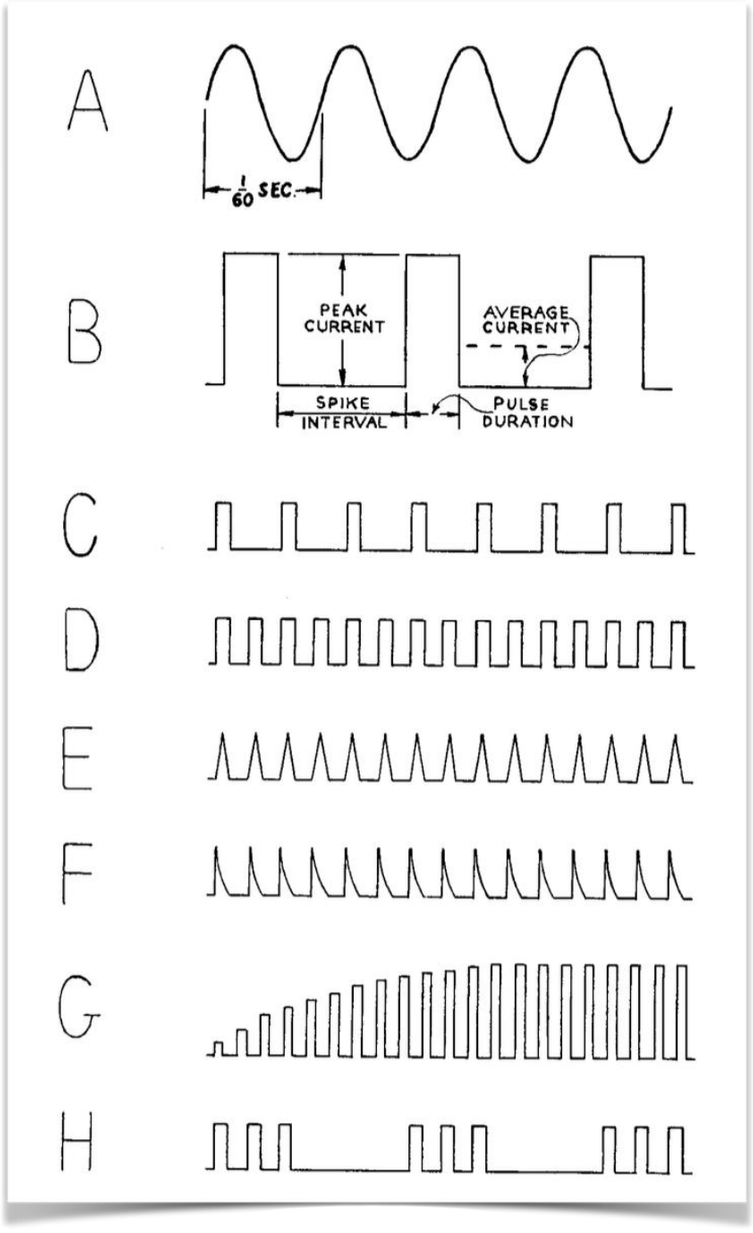
PRECLINICAL TESTING

PROTECT (PRecision Optimally Targeted ECT)
Feature 1: novel waveforms





Pulse Pattern



Liberson, *Res Publ Assoc Res Nerv Ment Dis*, 1953

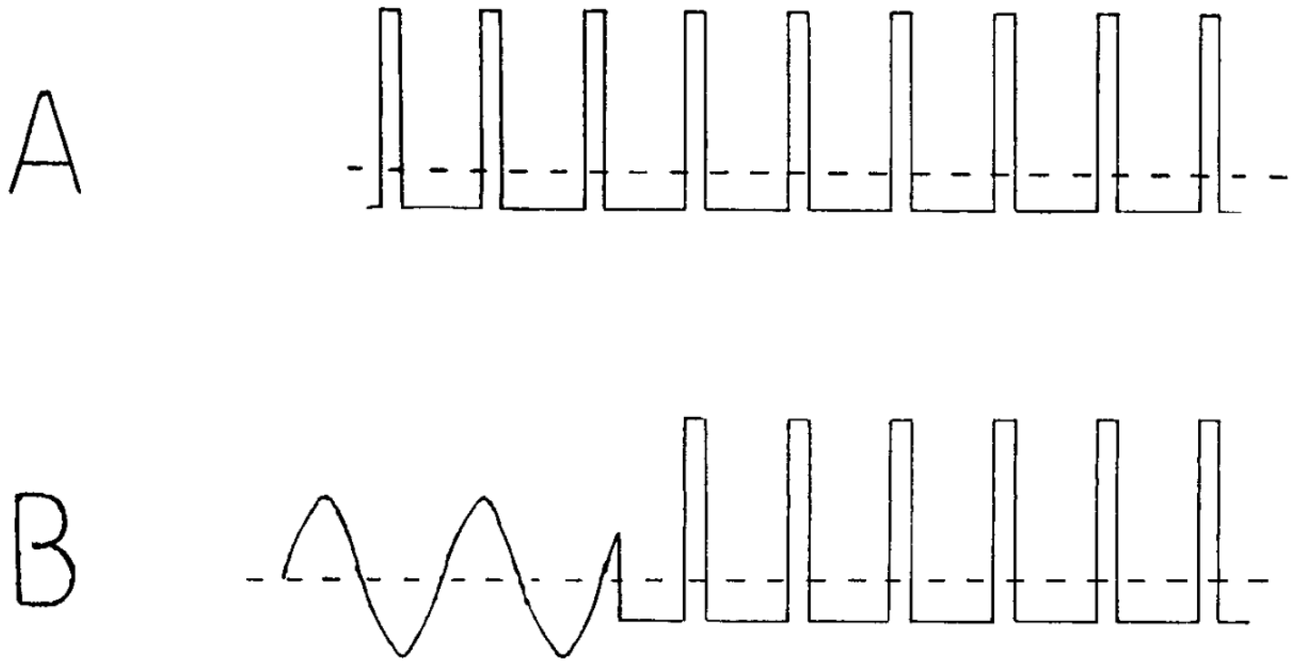
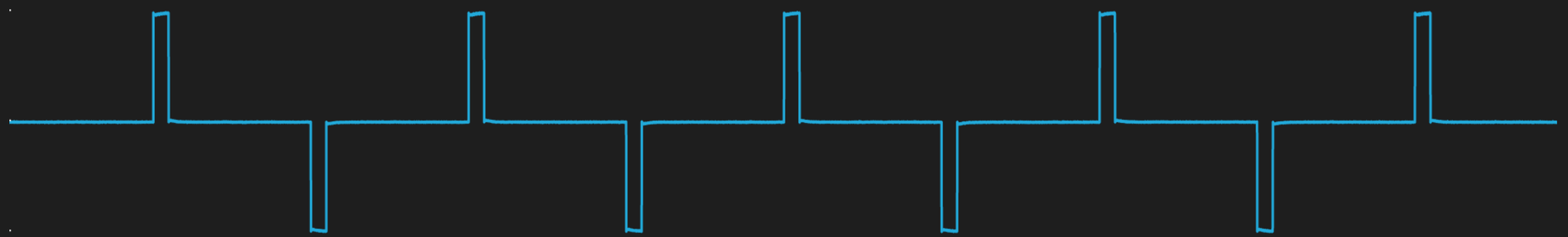


Fig. 16. A: The "courant chevauchant" used in Brief Stimulus Therapy. In this case the zero potential is above the line corresponding to the origin of the "spike". B: The "wave-and-spikes" current, the waves producing a "petit mal" and the spikes a convulsion.

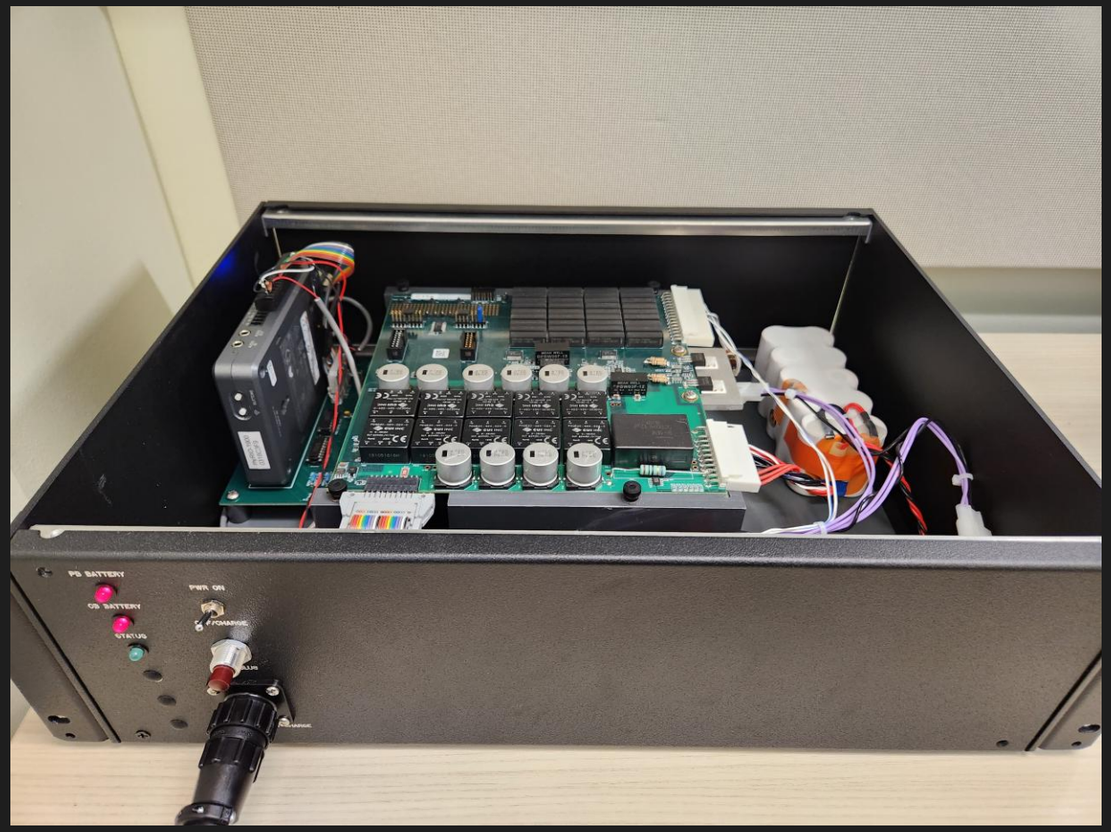
Liberson, *Res Publ Assoc Res Nerv Ment Dis*, 1953

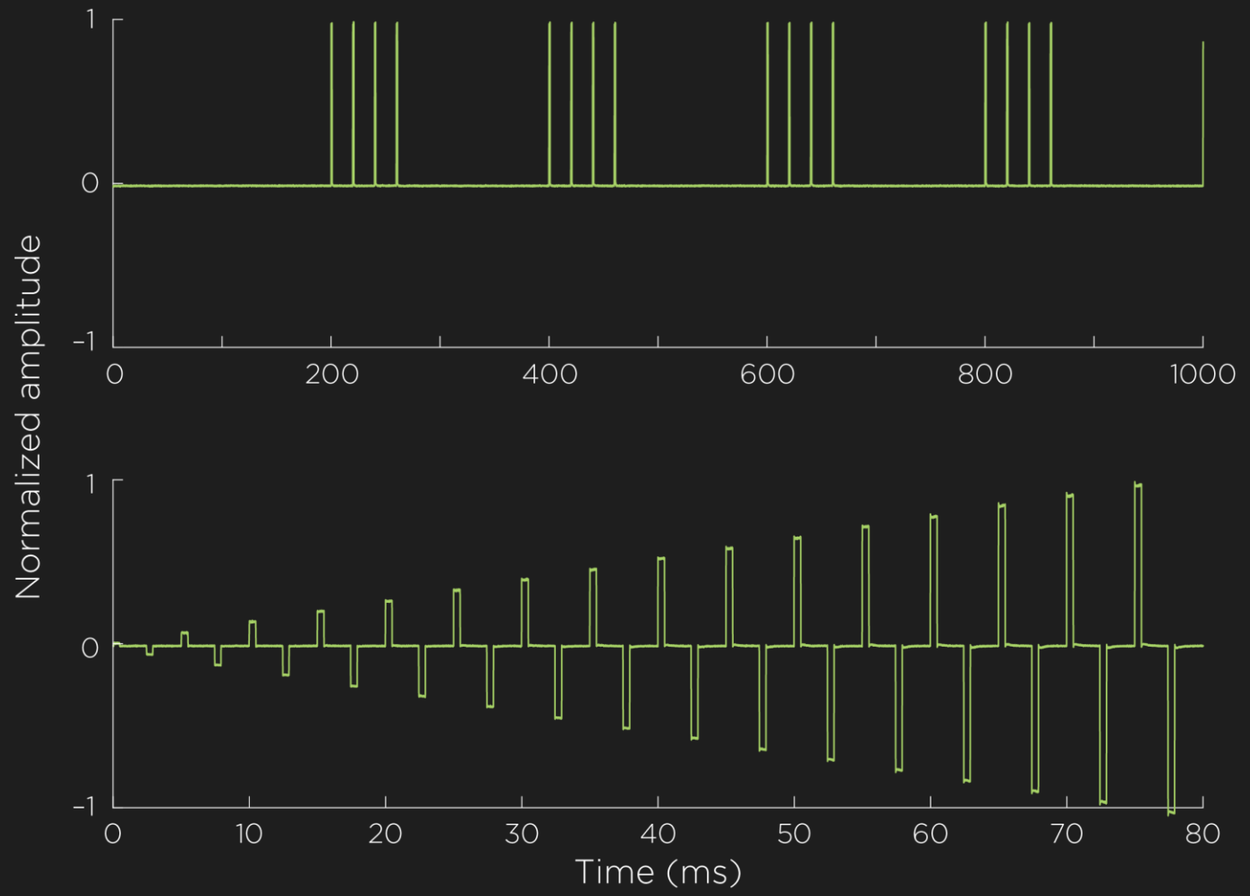
Where does this



come from?

PROTECT (PRecision Optimally Targeted ECT)
Feature 2: programmable waveforms





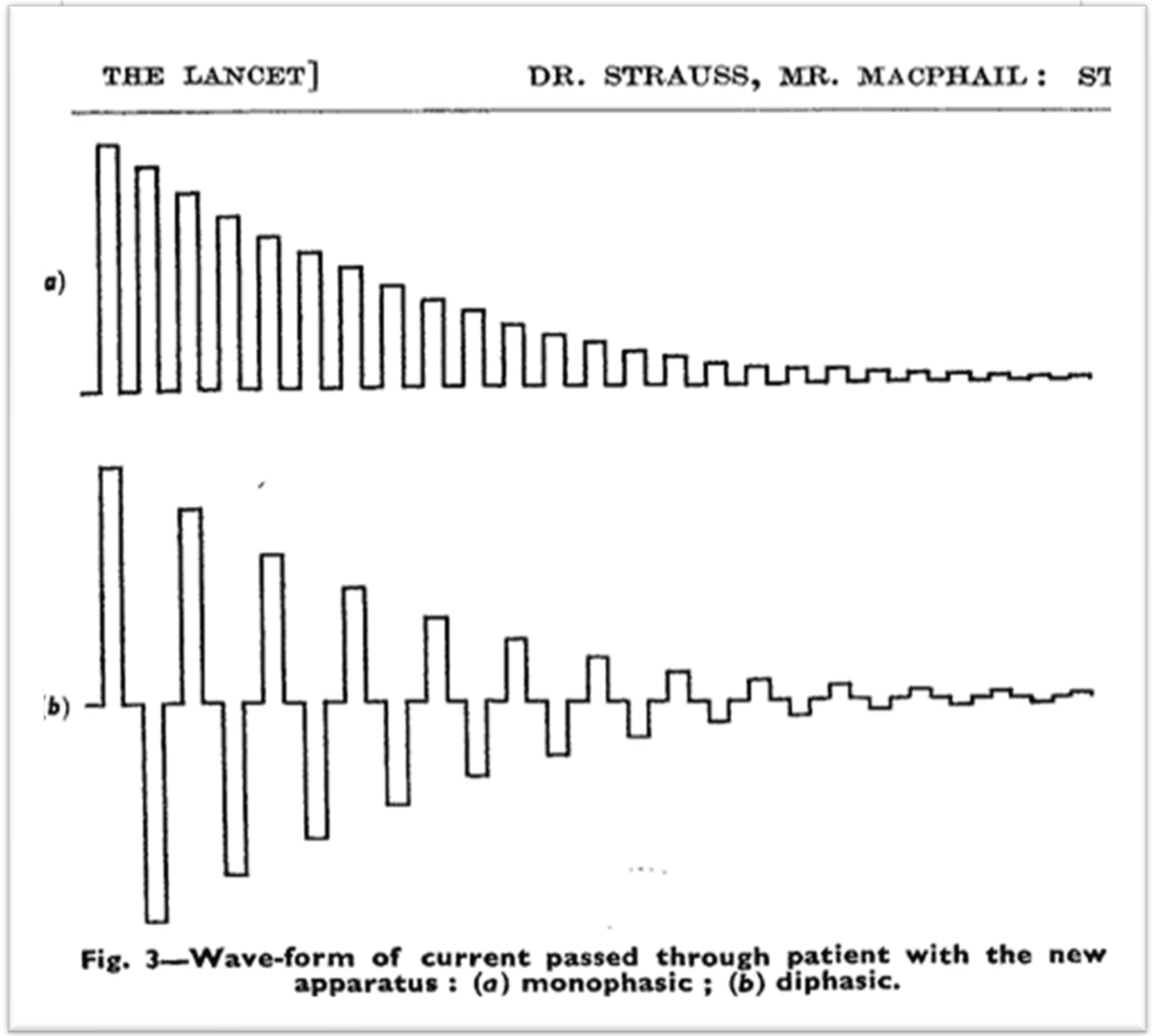


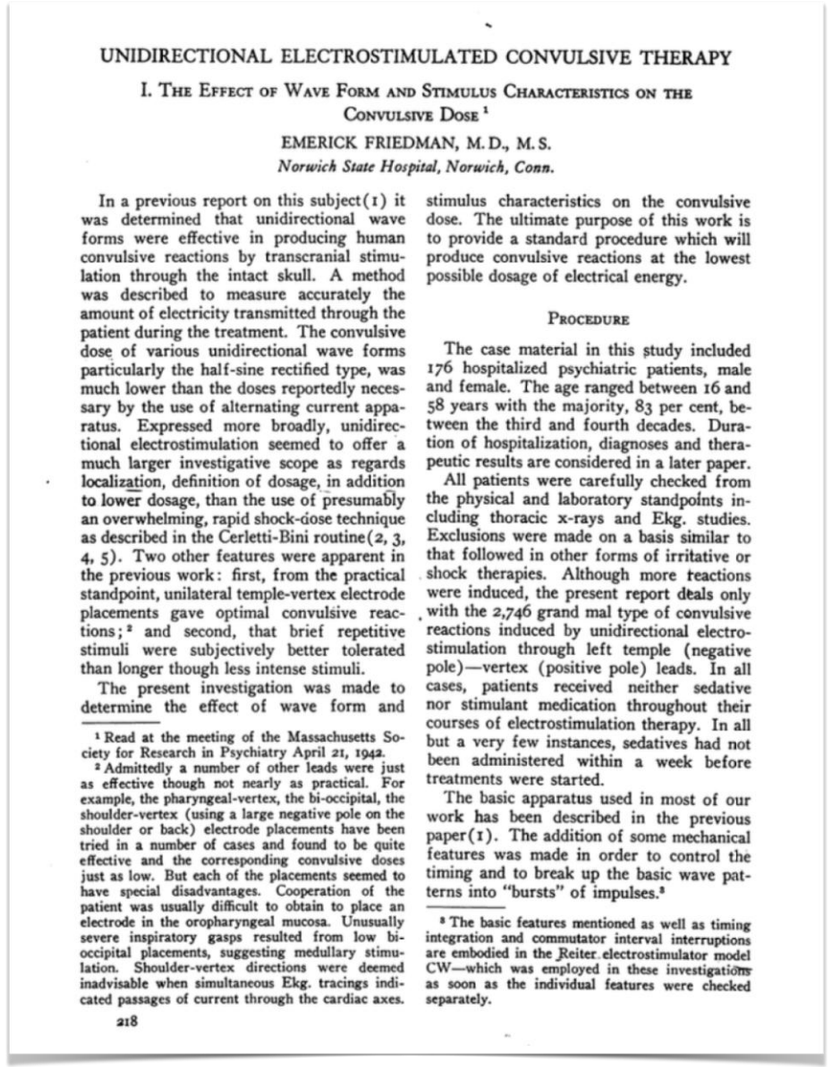
Fig. 3—Wave-form of current passed through patient with the new apparatus : (*a*) monophasic ; (*b*) diphasic.

Steep wave electroplexity

- The convulsions are less violent and sooner over
- Recovery from the fit is more tranquil and more rapid
- Monophasic current appears to produce slightly less confusion and makes for a quieter recovery
- Diphasic current, because of its large peak-to-peak swing, guarantees a major reaction in subjects who are agitated and very restless

Strauss & MacPhail, *Lancet*, 1946

Electrode Configuration



UNIDIRECTIONAL ELECTROSTIMULATED CONVULSIVE THERAPY

I. The Effect of Wave Form and Stimulus Characteristics on the Convulsive Dose [1]

EMERICK FRIEDMAN, M.D., M.S.
Norwich State Hospital, Norwich, Conn.

In a previous report on this subject(1) it was determined that unidirectional wave forms were effective in producing human convulsive reactions by transcranial stimulation through the intact skull. A method was described to measure accurately the amount of electricity transmitted through the patient during the treatment. The convulsive dose of various unidirectional wave forms particularly the half-sine rectified type, was much lower than the doses reportedly necessary by the use of alternating current apparatus. Expressed more broadly, unidirectional electrostimulation seemed to offer a much larger investigative scope as regards localization, definition of dosage, in addition to lower dosage, than the use of presumably an overwhelming, rapid shock-dose technique as described in the Cerletti-Bini routine(2, 3, 4, 5). Two other features were apparent in the previous work: first, from the practical standpoint, unilateral temple-vertex electrode placements gave optimal convulsive reactions;[2] and second, that brief repetitive stimuli were subjectively better tolerated than longer though less intense stimuli.

The present investigation was made to determine the effect of wave form and stimulus characteristics on the convulsive dose. The ultimate purpose of this work is to provide a standard procedure which will produce convulsive reactions at the lowest possible dosage of electrical energy.

PROCEDURE

The case material in this study included 176 hospitalized psychiatric patients, male and female. The age ranged between 16 and 58 years with the majority, 83 per cent, between the third and fourth decades. Duration of hospitalization, diagnoses and therapeutic results are considered in a later paper.

All patients were carefully checked from the physical and laboratory standpoints including thoracic x-rays and Ekg. studies. Exclusions were made on a basis similar to that followed in other forms of irritative or shock therapies. Although more reactions were induced, the present report deals only with the 2,746 grand mal type of convulsive reactions induced by unidirectional electrostimulation through left temple (negative pole)—vertex (positive pole) leads. In all cases, patients received neither sedative nor stimulant medication throughout their courses of electrostimulation therapy. In all but a very few instances, sedatives had not been administered within a week before treatments were started.

The basic apparatus used in most of our work has been described in the previous paper(1). The addition of some mechanical features was made in order to control the timing and to break up the basic wave patterns into "bursts" of impulses.[3]

[1] Read at the meeting of the Massachusetts Society for Research in Psychiatry April 21, 1942.

[2] Admittedly a number of other leads were just as effective though not nearly as practical. For example, the pharyngeal-vertex, the bi-occipital, the shoulder-vertex (using a large negative pole on the shoulder or back) electrode placements have been tried in a number of cases and found to be quite effective and the corresponding convulsive doses just as low. But each of the placements seemed to have special disadvantages. Cooperation of the patient was usually difficult to obtain to place an electrode in the oropharyngeal mucosa. Unusually severe inspiratory gasps resulted from low bi-occipital placements, suggesting medullary stimulation. Shoulder-vertex directions were deemed inadvisable when simultaneous Ekg. tracings indicated passages of current through the cardiac axes.

[3] The basic features mentioned as well as timing integration and commutator interval interruptions are embodied in the Reiter electrostimulator model CW—which was employed in these investigations as soon as the individual features were checked separately.

“

… from the practical standpoint, unilateral temple–vertex electrode placements gave optimal convulsive reactions…

Admittedly a number of other leads were just as effective though not nearly as practical.

For example, **pharyngeal–vertex**, the **bi-occipital**, the **shoulder–vertex** (using a large negative pole on the shoulder or back) electrode placements have been tried in a number of cases and found to be quite effective…

Friedman & Wilcox, *J Nerv Ment Dis*, 1942

Monopolar Electro-Shock Therapy

JOSEPH EPSTEIN, M.D.
New York, New York

Since the introduction of electro-convulsive shock therapy, constant research has been directed towards two goals. First, to find how or why it is effective; and second, to refine it so that it will retain, or even increase, its therapeutic efficacy and simultaneously be freed from its hazards. A number of explanations have been offered to account for the remedial effects of electroshock. It is highly doubtful whether the convulsion per se is the basis for the therapeutic result. What is more likely is that, in association with the violent explosive state of the nervous system, there are liberated certain substances or hormones which play a part in the recovery of the individual.

complication is, of course, death due to cardiac failure. Others include respiratory failure so severe as to require artificial respiration, fractures of long bones or of the pelvis, and spinal compression fractures, as well as severe disabling pains in the back, chest, or shoulders.

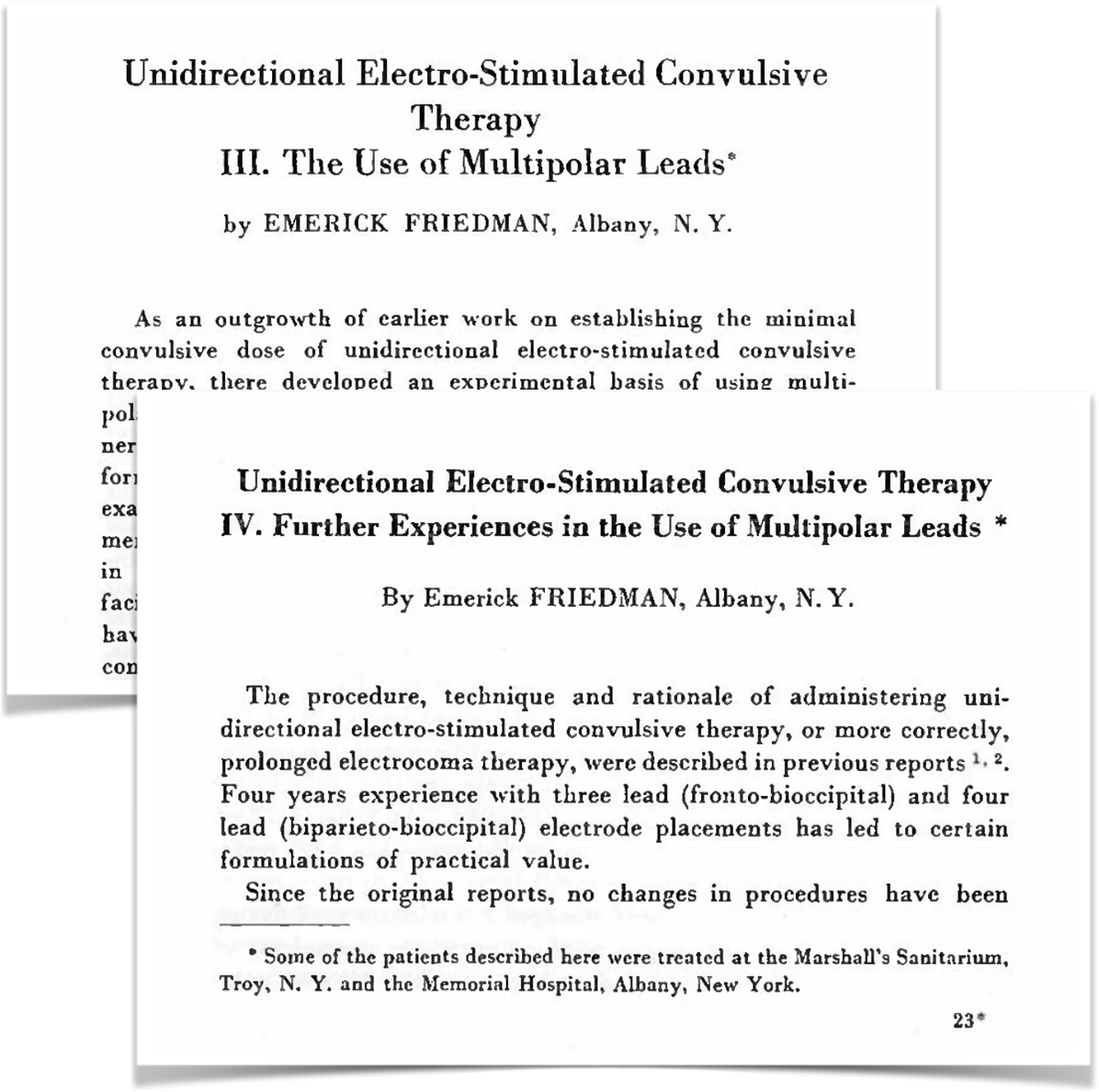
Psychological complications consist in confusion, amnesia, loss of word choice, and forgetfulness, which at times is present to a frightening degree, causing humiliation and embarrassment to the patient. They may see strangers and think they have met them before; they see acquaintances and forget their names. Friends talking to them, refer to an incident of the day before, and

An indifferent, cuff-shaped electrode is applied to the right forearm.

The active electrode to certain areas of the skull and conducting the current through the medulla and brain stim.

By conducting the current through the region of the vertex, the motor strip is stimulated, along with the thalamic nuclei, and a convulsion is rapidly induced with very small amounts of current.

Epstein, *Dis Nerv Syst*, 1955



Unidirectional Electro-Stimulated Convulsive Therapy
III. The Use of Multipolar Leads*

by EMERICK FRIEDMAN, Albany, N. Y.

As an outgrowth of earlier work on establishing the minimal convulsive dose of unidirectional electro-stimulated convulsive therapy, there developed an experimental basis of using multi-

Unidirectional Electro-Stimulated Convulsive Therapy
IV. Further Experiences in the Use of Multipolar Leads *

By Emerick FRIEDMAN, Albany, N. Y.

The procedure, technique and rationale of administering unidirectional electro-stimulated convulsive therapy, or more correctly, prolonged electrocoma therapy, were described in previous reports [1, 2]. Four years experience with three lead (fronto-bioccipital) and four lead (biparieto-bioccipital) electrode placements has led to certain formulations of practical value.

Since the original reports, no changes in procedures have been

* Some of the patients described here were treated at the Marshall's Sanitarium, Troy, N. Y. and the Memorial Hospital, Albany, New York.

23*

- Naso-pharyngeal biparietal (bioccipital) stimulation
- Fronto–bioccipital (ethmoid–mastoid): useful in chronic addiction to sedatives or alcohol
- Biparieto–bioccipital: useful for acute psychosis
- Still essentially two electrodes, but split into 4 leads
- Reiter CW47 stimulator, set to 5 mA and quickly raised to 20 mA and left at that level for 20–30 s. If generalized tonus started, the current was lowered so that only a steady clonic response was maintained. After 30 s, the current slowly reduced until respiration started.

Friedman, *Confin Neurol*, 1952, 1953

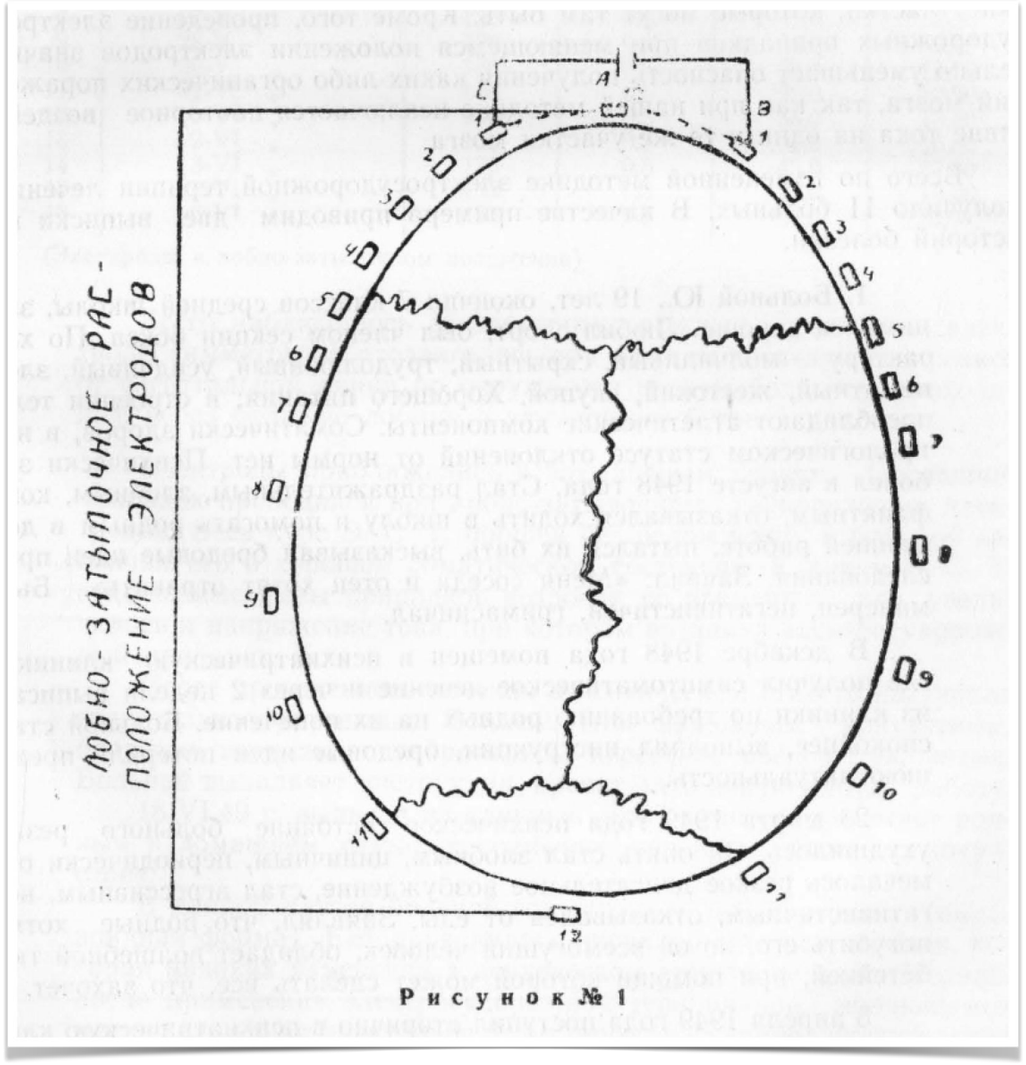
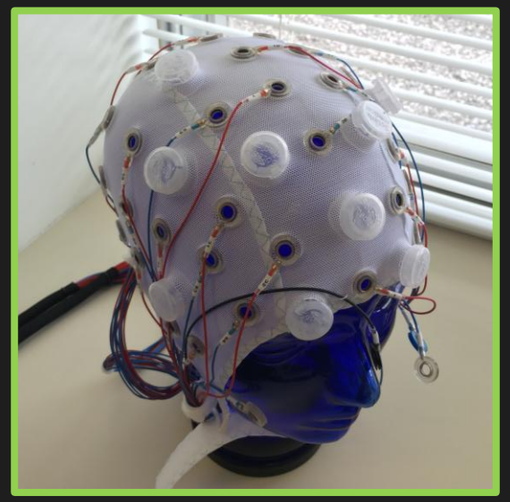
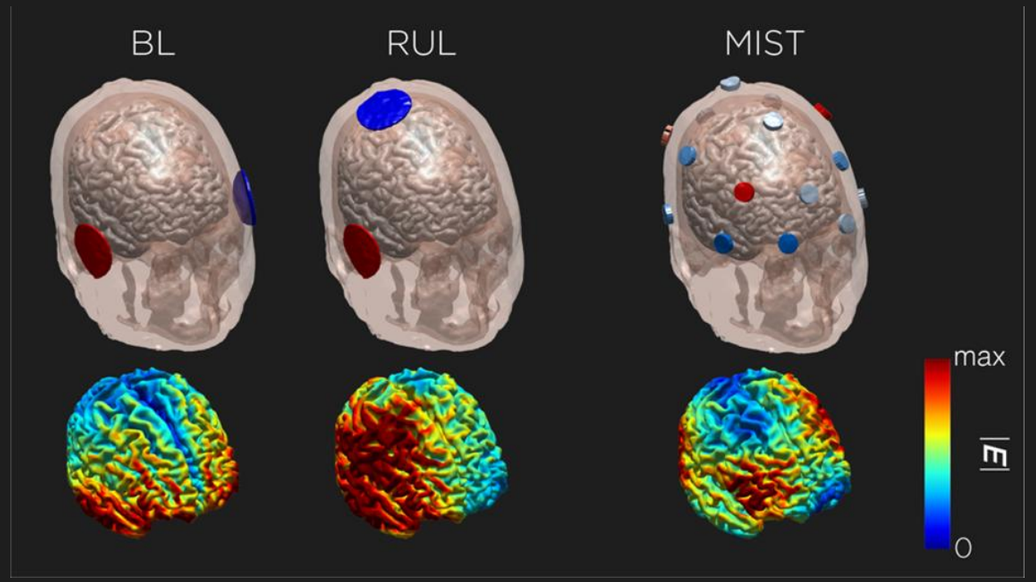


Рисунок № 1

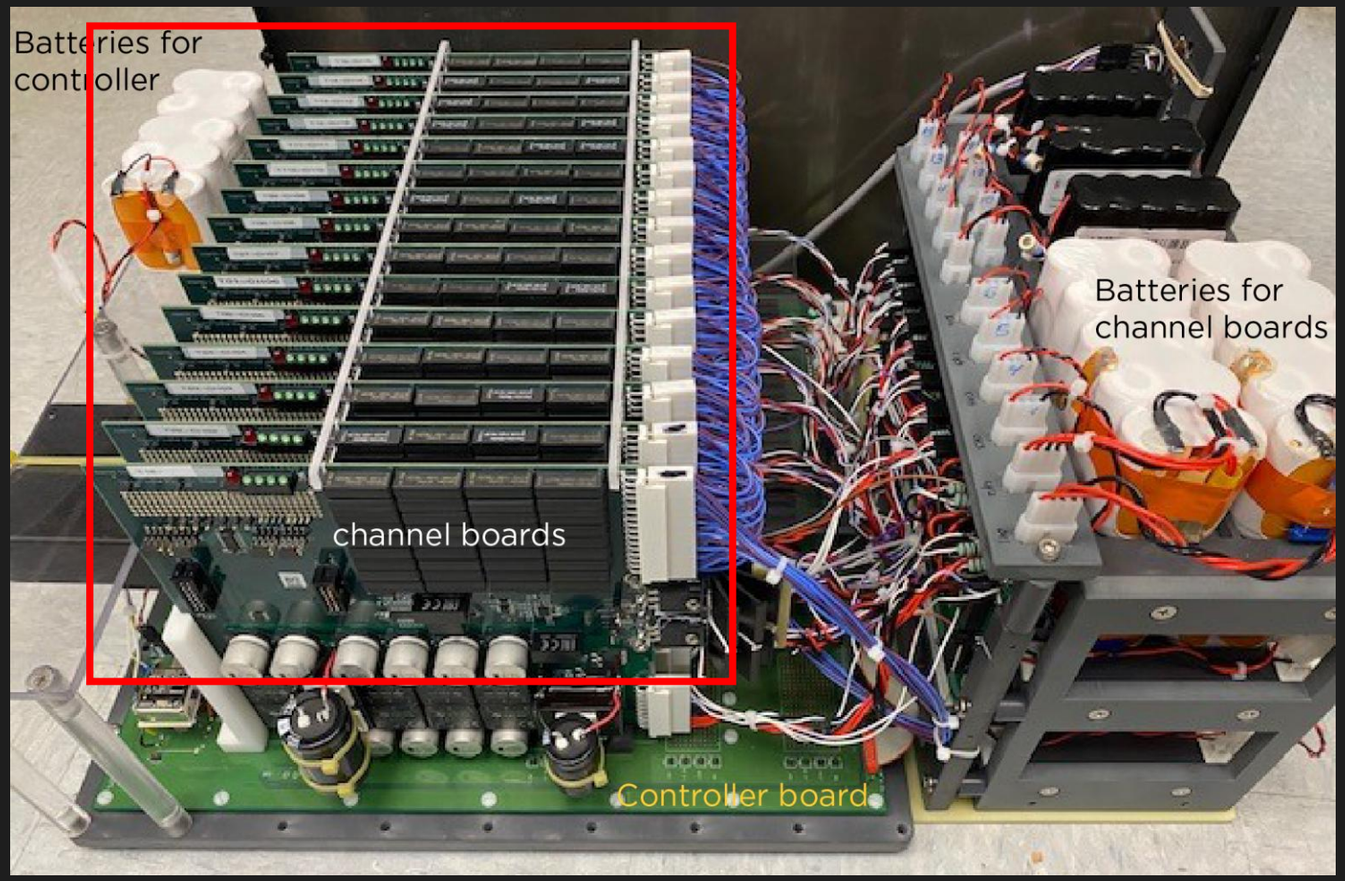
Rozhnov, *Kirghiz State Medical Institute Proceedings, Frunze*, 1951

Multichannel Individualized Stimulation Therapy (MIST)

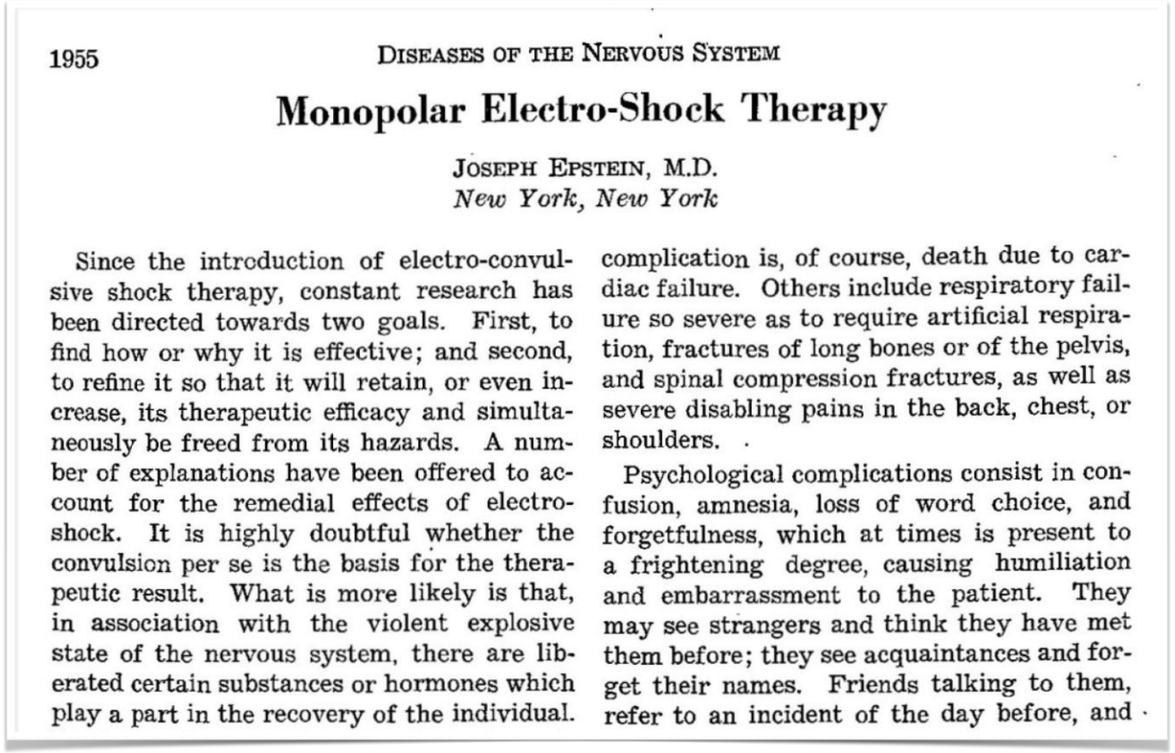




15 independently programmable current sources



Subconvulsive & Augmented Stimulation



1955 DISEASES OF THE NERVOUS SYSTEM

Monopolar Electro-Shock Therapy

JOSEPH EPSTEIN, M.D.
New York, New York

Since the introduction of electro-convulsive shock therapy, constant research has been directed towards two goals. First, to find how or why it is effective; and second, to refine it so that it will retain, or even increase, its therapeutic efficacy and simultaneously be freed from its hazards. A number of explanations have been offered to account for the remedial effects of electroshock. It is highly doubtful whether the convulsion per se is the basis for the therapeutic result. What is more likely is that, in association with the violent explosive state of the nervous system, there are liberated certain substances or hormones which play a part in the recovery of the individual.

complication is, of course, death due to cardiac failure. Others include respiratory failure so severe as to require artificial respiration, fractures of long bones or of the pelvis, and spinal compression fractures, as well as severe disabling pains in the back, chest, or shoulders.

Psychological complications consist in confusion, amnesia, loss of word choice, and forgetfulness, which at times is present to a frightening degree, causing humiliation and embarrassment to the patient. They may see strangers and think they have met them before; they see acquaintances and forget their names. Friends talking to them, refer to an incident of the day before, and

“

Used subconvulsive stimulation applied to various frontal areas exclusively. We felt that non-convulsive method was effective in many cases but was not as efficient as the convulsive method.

We also noticed that by “topping off” the non-convulsive treatments toward the end of a series with one or two convulsions, sudden dramatic recovery frequently ensued.

Epstein, *Dis Nerv Syst*, 1955

Monopolar Electro-Shock Therapy

JOSEPH EPSTEIN, M.D.
New York, New York

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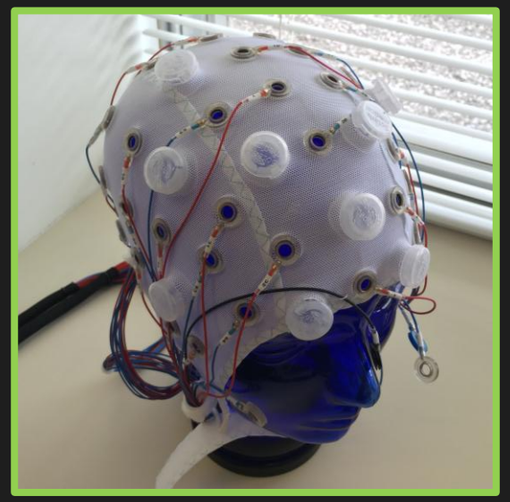
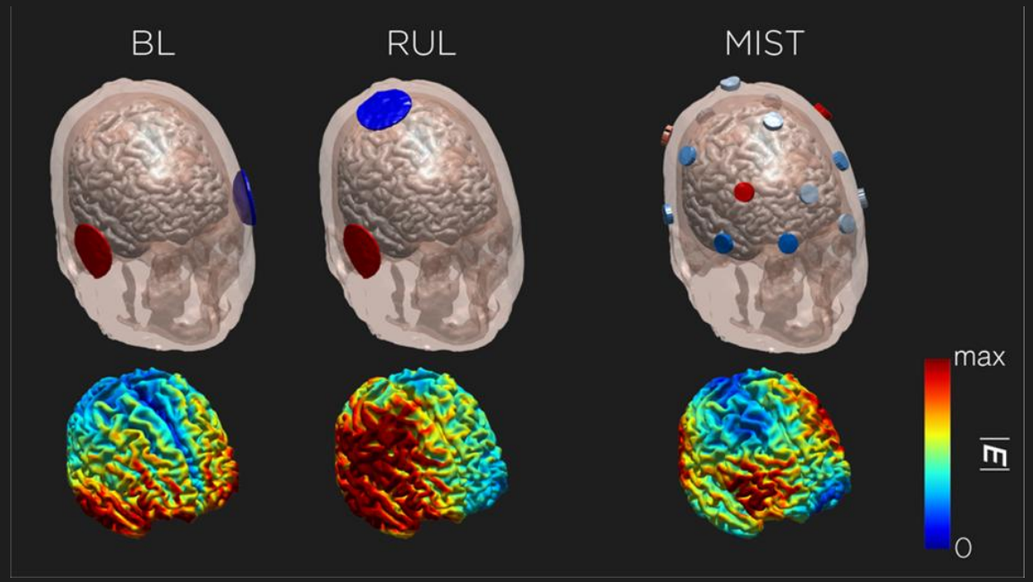
Schizophrenics, and others for whom the prognosis is not so favorable, are given the combined treatment.

This consists in first inducing a convulsion and utilizing the minute or two after the termination of the seizure, and while the patient is still comatose, to apply frontal subconvulsive stimulations. We have had many social recoveries in schizophrenics through this combined method.

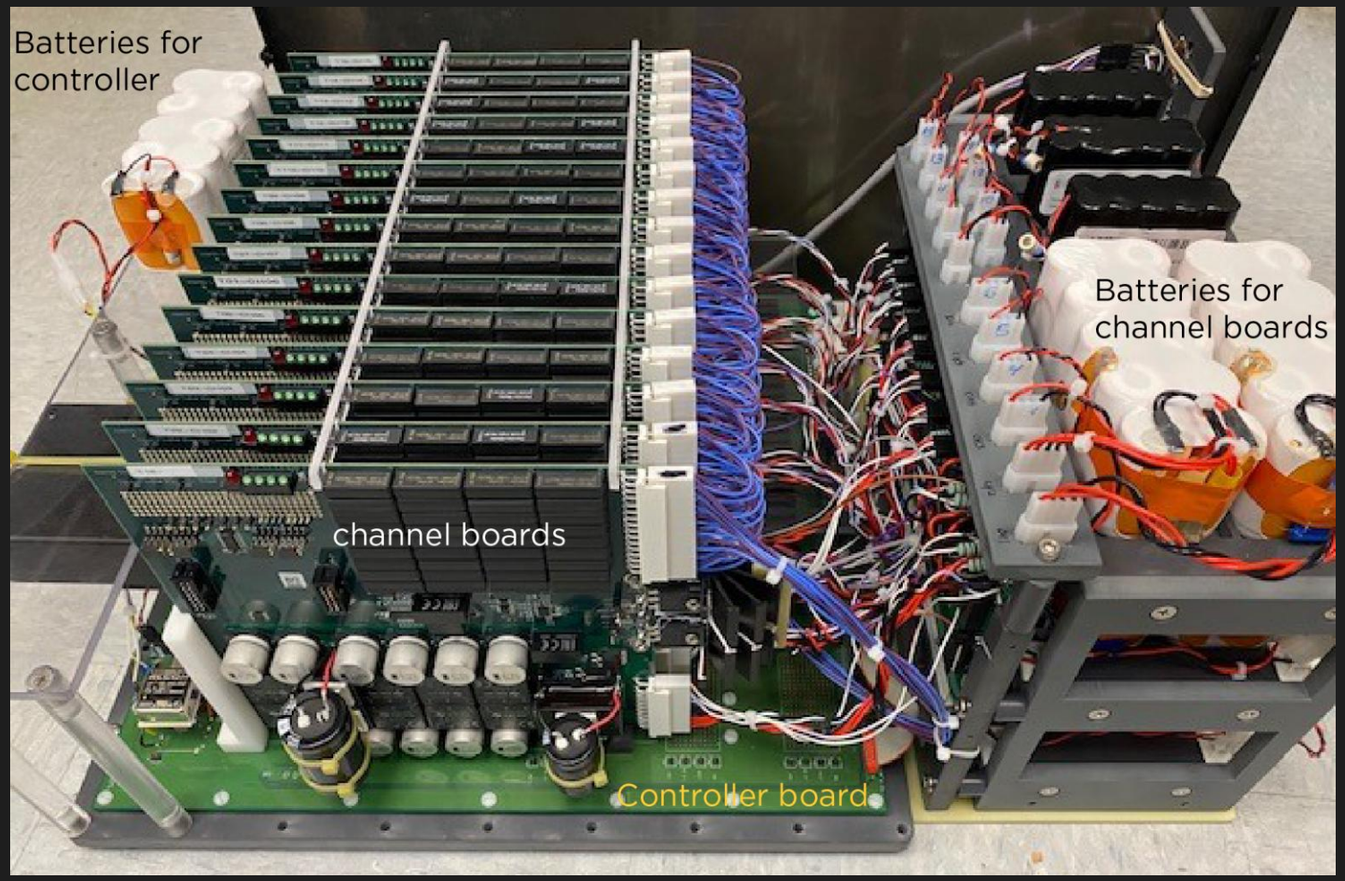
Epstein, *Dis Nerv Syst*, 1955

MIST has built-in tES!





15 independently programmable current sources



ECT Time Machine

- Early ECT had amplitude control, waveform flexibility, even multielectrode configurations were experimented
- Along the way, we lost those ideas
- Tomorrow’s devices, like PROTECT and MIST, brings back good ideas, rediscovered and re-engineered with modern precision, safety, and computational design