The electrodes are placed on an extremity, distal to a pneumatic blood pressure cuff. Systolic pressure is determined by inflating the cuff above the pressures at which pulsations disappear and then noting the point at which pulsations begin during slow deflation. Diastolic pressure is taken as the point at which the pulsations attain their maximum amplitude. This method of blood pressure determination has been of particular value with infants and small children in whom auscultatory or palpatory pressures may be difficult or impossible to obtain. The lower limit of systolic pressure at which plethysmographic pulsations may be obtained is usually 20–30 mm. Hg. A further use of the impedance plethysmograph as a monitoring aid is the observation of alterations in waveform occurring as a result of changes in peripheral resistance or cardiac output. In patients who are acutely hypovolemic from hemorrhage or who have a sudden decrease in cardiac output, an increase in the diastolic runoff time and disappearance of the dicrotic wave may occur. A similar increase in diastolic runoff time is seen as the result of vasopressor administration. A decrease in diastolic runoff time and an accentuation of the dicrotic wave is seen in plethysmographic tracings during deep ether or halothane anesthesia. These changes would not be evident by the usual methods of monitoring the circulation. The impedance plethysmograph has proven to be a useful diagnostic and teaching aid in the performance of sympathetic blocks and a valuable monitoring device particularly in pediatric anesthesia. The instrument provides a means of detecting changes in peripheral circulation which may occur as a result of alterations in such factors as blood volume or anesthetic depth.

Effect of Stimulus, Amplitude, Frequency, Duration, and Wave Form in Production of Electronarcosis. ALAN VAN POZNAK, M.D., AND JOSEPH F. ARTUSIO, JR., M.D., *Department of Anesthesiology, The New York Hospital-Cornell Medical Center, New York, New York.* Electronarcosis is in theory an attractive form of anesthesia because of the controllability of the anesthetic agent. In addition, there is no chemical to be excreted, detoxified, or distributed throughout the patient. While unconsciousness can easily be produced by many different types of electrical stimuli, there are frequently other effects which make electronarcosis appear less attractive than well managed general anesthesia. Untoward effects frequently seen include convulsions, rigidity, twitching, apnea, laryngospasm, bradycardia, arrhythmias, hypertension, and profuse salivation. Many workers have limited their investigation to a small portion of the electromagnetic spectrum. It was hoped that a more detailed examination of some of the electrical variables might suggest a type of current which would produce a more physiologic type of anesthesia. *Method:* Sine and triangular waves were generated with a Hewlett-Packard Function Generator. Square waves were generated with Grass S-4 stimulators which could be used to generate dissimilar synchronized pulses or modulated trains of identical pulses. These were observed on the screen of a Du-Mont type 322-A dual beam oscilloscope. In addition, an isolation transformer was used so that a DC bias could be introduced when desired. The stimuli were applied through silver or stainless steel electrodes through the mouth and to the shaven skin of the head of unmedicated and purposefully fed mongrel dogs. Clinical observation was made of the effects on respiration, heart rate, muscular activity, and analgesic action of the various wave forms. Because of the nature of the stimulus, monitoring of ECG or EEG was not done during the application of the current. Analgesia was considered adequate if there was no response to a clamp applied to the skin. The range of 1 to 10,000 cycles per second was studied. *Results:* The results were similar to those reported by many other workers. Stimuli strong enough to produce analgesic often bordered upon the convulsive threshold. Smooth regular respiration was rarely seen. Expiration was frequently forceful to the point that cyanosis developed. Laryngospasm occurred occasionally. Salivary secretions were profuse in all instances. The heart rate was usually rapid, but if a tonic seizure was induced the heart rate often became slow and irregular. Skin irritation and burning was occasionally present, but could be minimized by using moist electrodes. Recovery was rapid and uneventful. Trial of the stimuli upon the investigator's head confirmed the impres-

sion that the experience was painful. *Comment:* No truly anesthetic form of electric current was found in the range studied. By the introduction of overwhelming diffuse nonspecific stimulation, electricity may make the perceptive mechanisms temporarily unable to respond to other afferent stimuli. The controllability and reversibility of the state of electronarcosis justifies further investigation, even though these initial trials have made no significant advance. Perhaps electricity may never be used in the manner of a single anesthetic agent, but may become one of the components of some type of balanced anesthetic technique of the future utilizing physical as well as chemical forces.

Electronarcosis with Alternating Plus Direct Current. PERRY P. VOLPITTO, M.D., R. H. SMITH, M.D., ZACHARIAH W. GRAMLING, M.D., AND GEORGE W. SMITH, M.D. *Department of Anesthesiology and Division of Neurological Surgery, Medical College of Georgia and Eugene Talmadge Memorial Hospiatl, Augusta, Georgia.* We have previously described a method by which total analgesia in the dog has been produced with electrical current, together with the electronic circuit and the electrodes used (Anesthesiology 22: 163, 1961). Additional studies of electroencephalograms before and after electroanalgesia and microscopic sections of the dog's brain revealed no lesions which could be attributed to the passage of the electric current(Anesthesiology 22: 970, 1961). This progress report is based on an extension of our studies on another group of unpremedicated dogs. *Method:* The pattern of application of 100 cycles per second of electrical current was similar to our previous report. Twenty milliamperes of direct current was quickly applied, followed by 4 to 25 milliamperes of alternating current delivered smoothly without current surges, and a two-millisecond wave duration was routinely employed. The necessary amount of alternating current, superimposed on 20 milliamperes of direct current, could not be predicted from one dog to another. However, the amount of alternating current required to produce analgesia remained predictable and quite constant in the same animal when electroanalgesia was repeated at a different time. *Results:* In this group of dogs we noted little or no change in blood pressure, unless the animal was struggling. The only arrhythmia noted was a sinus arrhythmia. Alveolar P_{CO_2} remained within normal limits during the application of the current. Serial blood sugar determinations on blood taken before, during thirty to forty minutes of electroanalgesia, and one to two hours after application of the current revealed only a mild increase in blood sugar during the analgesia (15 to 25 mg. per cent). This finding was surprising and unexpected. This form of electroanalgesia has no depressant effect on the minute volume of the dog. Urinary output continues during the application of the current. To date no physiological derangements have occurred in our test animals. Our electronics experts are in the process of solving the problem of monitoring the EEG during the electroanalgesia. Our extension of this work to human beings is anticipated when this problem is solved. [Dr. Smith is now at the University of California Medical Center, San Francisco, California. This work was supported in part by grants from the Ohio Chemical & Surgical Equipment Company, and the Medical Research Foundation of Georgia.]

Cardiovascular Effects of Methoxyflurane Anesthesia. JOE A. WALKER, M.D., C. W. N. EGGERS, JR., M.D., AND CHARLES R. ALLEN, PH.D., M.D., *Department of Anesthesiology, University of Texas Medical Branch, Galveston, Texas.* The cardiovascular effects of methoxyflurane were studied in 5 male subjects, and the results compared to the cardiovascular effects produced by halothane. *Method:* Determinations of cardiac output, mean arterial pressure, blood *p*H, carbon dioxide content, oxygen content, percentage oxygen saturation of hemoglobin and hematocrit were made in all patients at a resting awake state. The subjects were then given a small dose of thiopental (150–200 mg.) intravenously, intubated and allowed to stabilize at similar levels of surgical anesthesia for 40 to 60 minutes. Levels of anesthesia were judged clinically and measured by electroencephalogram. All patients were monitored with continuous recordings of arterial blood pressure,