An Application of Autosyns to Multi-Channel Physiological Recording.* (18624)

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The properties of the self-synchronous motor (known by such trade names as "Autosyn", "Selsyn", etc.) have been described by Blackburn(1) and others(2,3). Bowman(4) used these devices to record mechanical myograms on a cathode ray oscilloscope. The present paper describes the application of autosyns to obtain simultaneous ink-written records of several physiological phenomena on moving paper. The recorder to be described appears to have certain advantages over the smoked-drum or ink-writing kymograph customarily employed in the physiological laboratory.

The basic elements of a typical channel of this recorder are two autosyns of the Bendix-Pioneer Type AY-1. One of these is used as a motion take-off device (synchro generator), the other is used as a driving mechanism (synchro motor) for the ink-writing pens. With the autosyns connected as shown in Fig. 1A, a rotation of the shaft of one through a given angle causes a simultaneous rotation of the shaft of the other through this same angle. Displacements ranging from less than one millimeter to more than 10 cm have been recorded by using suitable lever arms on the motion pick-up autosyn.

For slowly changing phenomena such as respiration, overall error in angle of rotation of recording autosyn shaft for a given rotation of pickup shaft is less than 2 degrees.

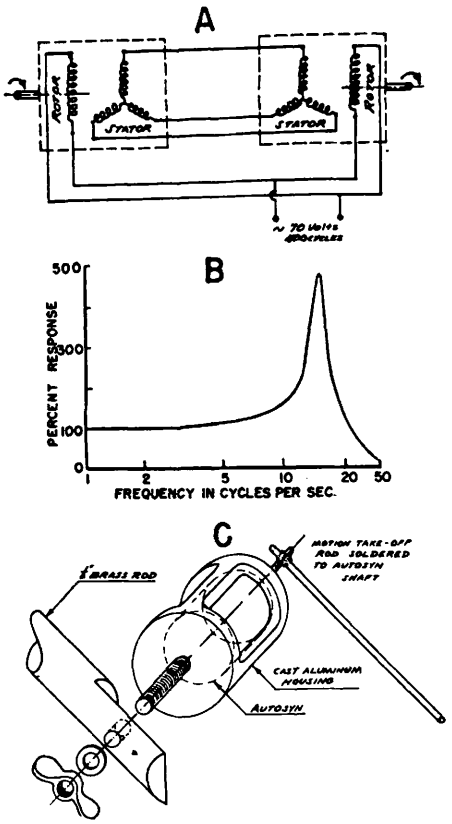

FIG. 1. A. Electrical schematic of typical channel. B. Response of typical channel as a function of frequency. C. Exploded view of autosyn mount.

For more rapid motion, the fidelity of the record is a function of the character of the movement. Fig. 1B shows the overall amplitude vs. frequency curve of a typical channel. This was obtained by driving the pickup autosyn with a sine wave cam connected to the shaft of a variable speed motor. The sharp resonance in the response curve at 15 cycles per second indicates that some overshoot is to be expected in the recording of rapidly decelerating motion.‡ However, in recording the knee jerk of the cat no such overshoot has been observed. Direct measurement of the

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1. Blackburn, J. F., *ed., Mass. Inst. Tech. Radiation Lab. Series,* 1949, v17, 310.

2. Greenwood, I. A., *ed., Mass. Inst. Tech. Radiation Lab. Series,* 1948, v21, 225.

3. James, H. M., *ed., Mass. Inst. Tech. Radiation Lab. Series,* 1947, v25.

4. Bowman, R. L., *Science,* 1948, v108, 310.

excursions of the paw above and below its resting position showed that the damped oscillations in the knee jerk record of Fig. 2B represent the actual motion of the paw and are not artifacts introduced by the recording system.

Fig. 1A shows seventy volts at 400 cycles applied to the rotors of all autosyns. This voltage considerably exceeds that for which the autosyns were designed (26 volts at 400 cycles), but it is used in order to achieve sufficiently stiff coupling between motion take-off and recorder autosyns. No serious temperature rise has been observed as a result of this overload. The total 400 cycle current to a 4-channel system (*i.e.*, 8 autosyns) is 1.5 amperes at 70 volts. With power factor correction this current can be reduced to about one ampere.

As shown in the detail of Fig. 1C, a steel rod about 1/32″ in diameter is soldered at right angles to the rotor shaft of each motion take-off autosyn and serves as the mechanical linkage to the movement to be recorded. The sensitivity of a recording channel (*i.e.*, ratio of angle of rotation of autosyn shaft to total displacement due to physiological activity) is then easily adjustable by varying the distance from the rotor shaft along the steel rod to the point of application of the displacement. This allows one to vary the amplitude of the record at will in order to facilitate initial settings or to compensate for gross physiological changes which may occur in the course of an experiment. The motion take-off autosyn is mounted on a ½″ rod which is fixed by a universal clamp to a ring stand or an upright on the animal board. The case (stator) of the pickup autosyn can be rotated

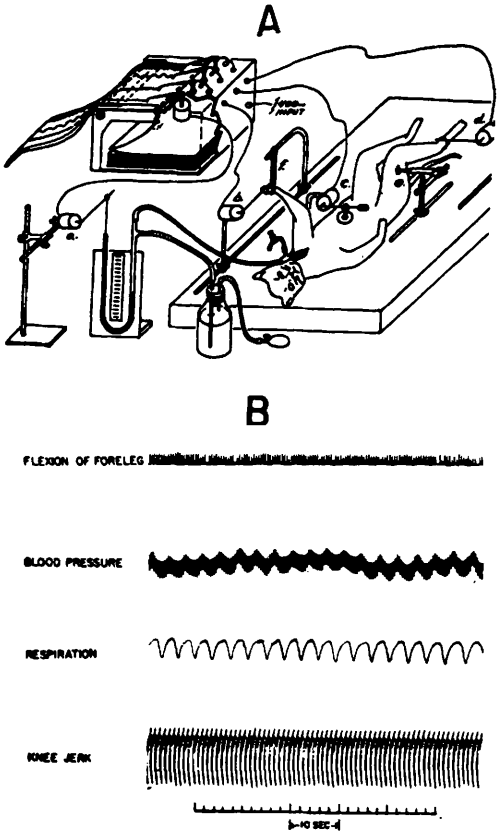

FIG. 2. A. Sketch showing autosyn take-off units, a, b, c, and d, which are used for the recording of: blood pressure from the carotid artery, movement of the foreleg evoked by stimulation of the contralateral motor cortex, respiration and patellar tendon reflex. In the figure, e shows the drill inserted into the cat's femur to stabilize the leg during prolonged elicitation of the knee jerk, and f shows support rod and elastic return for forelimb movement. B. Records from typical experiment. Foreleg flexion evoked by stimulation of the motor cortex of the opposite side 2 times per second. Blood pressure and heart rate recording from carotid artery. Note respiratoy fluctuations in pressure tracing. Pressure at highest point during inspiration. 176 mm Hg., at lowest point during expiration, 164 mm Hg. Record of knee jerk obtained by energizing a solenoid once per second, thus allowing the reflex hammer to strike the patellar tendon at that rate.

with respect to the supporting rod on an axis co-axial with that of the rotor. This motion allows zero adjustment of the pen regardless of the initial angular position of the take-off shaft. In general the take-off autosyn is mounted in whatever position is necessary to cause its pickup rod to move in a plane which is perpendicular to that of the

‡ We have recently tested another system of recording which uses a take-off autosyn, carrier generator and phase detector feeding into a standard multi-channel electroencephalograph. In this instance the resonant peak is absent since the overall frequency response is that of the electroencephalograph itself (*i.e.*, good to about 80 cycles per second). Such a system has the added advantage of allowing the recording of mechanical displacements simultaneously with the EEG, EMG, EKG, etc.(5)

5. McCawley, E. L., Riley, J. A., and Mauro, A., *Yale J. Biol. and Med.*, 1950, v22, 411.

displacement to be recorded.

Schematic representation of a complete 4-channel recording system is shown in Fig. 2A. It utilizes 8 autosyns, 4 of which drive the recording pens, the remaining 4 of which serve as motion take-off devices. The recording autosyns are mounted beneath the top of the paper puller with their shafts extending vertically upward through holes in the top plate to connect with the pens.

A typical record showing carotid blood pressure, respiration, knee jerk, and cortically evoked forelimb movement is shown in Fig. 2B. The blood pressure record was obtained by coupling a take-off autosyn to a float riding the column of mercury in the manometer. From such a record, pulse rate and respiratory variations of blood pressure and pulse are also obtainable. Respiration was obtained by strapping a cork on the animal's chest or abdomen and placing the autosyn shaft in a slot in the cork. Knee jerk and forelimb movement were obtained by slipping the shaft of the pickup unit beneath several turns of rubber band wrapped around the extremity.

In our experience it has been possible to prepare a typical mammalian experiment more satisfactorily with the autosyn recorder than with the standard ink-writing kymograph and routine physiological recording levers, tambours, etc. We attribute this to several factors: (1) The apparatus obviates complicated mechanical, pneumatic, and hydraulic couplings between the source of the displacement and the recording system. (2) The recording system can be physically separated from the source of the movement, thus avoiding crowding around the animal table. (3) The motion pickup autosyns are easily adjusted to fit the direction of the movement. (4) The sensitivity of the autosyns makes small displacements recordable. (5) The fixed mounting of the recording pens avoids the necessity of lining up pens, or obtaining simultaneous ordinates, and facilitates the reading of the records. (6) The autosyns are simple to operate and require practically no maintenance.

Summary. An apparatus has been described which employs autosyns for the recording of displacements produced by physiological activity. The apparatus appears to have certain advantages over the kymographs customarily used for such recordings.

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Effect of Adrenocorticotropin on Thyroidal Collection of I_{131} in the Adrenalectomized and Intact Rat.* (18625)

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This report is concerned with the effect of the administration of adrenocorticotropin on the collection of I_{131} by the thyroid gland of both adrenalectomized and intact rats.

Methods. Male rats of the Wistar strain (Carworth Farms) were placed on a low-iodine minimally goitrogenic (Steenbock) diet for a period of 2 weeks(2). They were then weighed and divided into 4 groups: Group 1, control intact; Group 2, adrenocorticotropin treated intact; Group 3, control adrenalectomized; and Group 4, adrenocorticotropin treated adrenalectomized. Bilateral adrenalectomy was carried out in the usual fashion employing a dorsal approach. In addition to

* This investigation was supported by a research grant from the National Institutes of Health, Public Health Service.

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1. Soffer, L. J., Volterra, M., Gabrilove, J. L., Pollack, A., and Jacobs, M., PROC. SOC. EXP. BIOL. AND MED., 1947, v64, 446.

2. Soffer, L. J., Gabrilove, J. L., and Jailer, J. W., PROC. SOC. EXP. BIOL. AND MED., 1949, v71, 117.