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Responses of Mammalian Nerve to Strong Shocks.

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In peripheral mammalian nerve, differential depression may be produced by strong tetanic shocks from an induction coil, which at proper strength block conduction in all myelinated fibers and allow all non-myelinated fibers still to conduct. The mammalian vagus nerve may be arranged, still attached peripherally to the body, on 3 sets of electrodes; stimulating electrodes next the body, a pair of lead electrodes at the cut central end, and a pair of blocking electrodes between. The ascending action currents due to respiratory inspiration, recorded at 500 mm./mv. amplification, are 5 to 10 mm. in amplitude (cat). These may be blocked temporarily and reversibly, to record base-line noise. The responses may be rendered monophasic by application of 1% cocaine to the killed end of the nerve.

Single strong shocks are then applied. If the myelinated fibers are blocked, only single C waves are recorded. If they are not blocked, each stimulus is usually followed not only by the A, B, and C waves characteristic of this nerve's normal action potential, but by a further random discharge that may last for several tenths of a second. These discharges resemble the respiratory discharges in form of the individual waves, which appear to be too brief to be assignable to non-myelinated fibers. Respiratory rate or depth does not change. The effects of successive shocks are summed, until after 5 or 10, at ⅛ second intervals, the discharge may last several seconds, and become greater in amplitude and in apparent frequency than the respiratory discharge itself. In some cases shocks slightly above the maximal for the C wave block the nerve at the stimulating electrode to the extent that for many seconds no respiratory discharges can be recorded, but this random discharge following each shock persists. In one nerve it has resulted from shocks too weak to stimulate non-myelinated fibers. It must, therefore, be due to myelinated fibers. These random discharges fail as the nerve deteriorates before the failure of the typical volley action current.

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It is of interest to know whether these responses are assignable only to the larger more irritable fibers of the nerve, such as pass through the recurrent laryngeal to skeletal muscle, or whether fibers of the size range of pain fibers may be involved. The afferent fibers from the lungs and other viscera below the recurrent laryngeal are nearly all of smaller size, from 8 to 9 mm. down. After cutting between the jugular and nodose ganglia, the fibers of larger size are eliminated by degeneration, leaving at the level of stimulation as arranged above only fibers of smaller size. Shocks sufficiently strong to stimulate the non-myelinated fibers of such nerves also produce a persistent random discharge in the myelinated fibers remaining, greater in intensity than the respiratory discharges.

Fibers of the pain fiber size range are therefore capable of being stimulated to a persistent repetitive after discharge of long duration, by shocks of strength necessary to stimulate non-myelinated fibers. Experimental procedures in which both myelinated and non-myelinated fibers are caused to respond are therefore equivocal, in that the addition of non-myelinated fiber responses as the strength of shock is increased may be accompanied by an unpredictable increase in the responses of myelinated fibers. These responses, while large in total number, are so low in amplitude as to be unnoticeable at the amplification usually employed to record C wave responses.

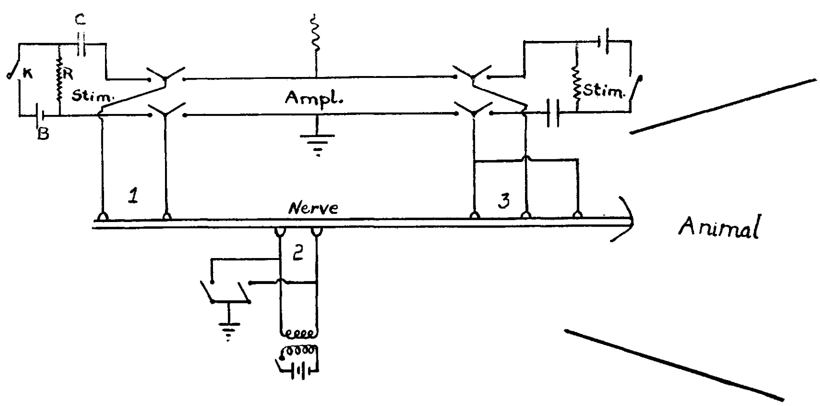

FIG. 1.

Arrangement of nerve and apparatus for differentiating between responses of myelinated and non-myelinated fibers. 1 and 3, stimulating and lead electrodes, interchangeable by double-throw switches above. 2, blocking electrodes, 3 volts on primary of coil connected for faradization, secondary set at about 6 for nerve of usual size of cat vagus or saphenous. The nerve may be blocked next to body to eliminate respiratory waves of vagus, and stimulated at middle point, by exchanging the leads from 2 and 3. C, variable condenser whose charge stimulates, B, tapped battery, R, high resistance for slow discharge of condenser between stimuli, K, key on rotating interruptor.

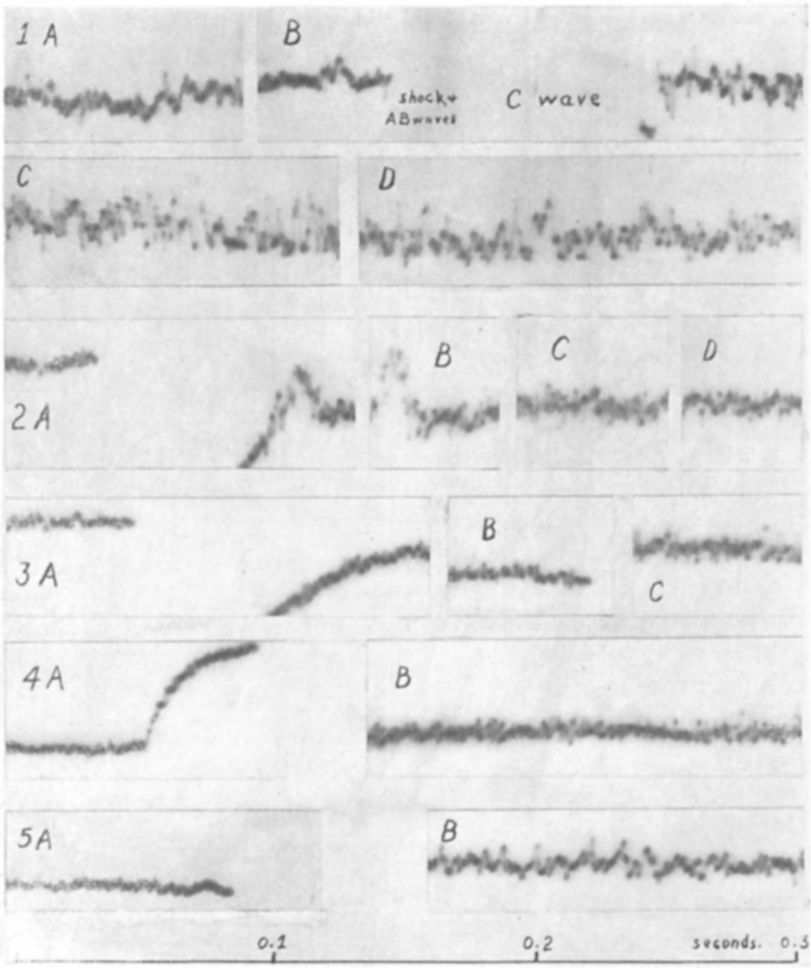

FIG. 2.

Random discharges in myelinated fibers following strong shocks to the cat vagus. 1-3, 500 mm./mv. 4-5, 350 mm./mv., reduced about ½ in reproduction.

1. A, respiratory record, maximum during inspiration. B, stimulus of just maximal strength for non-myelinated fibers, delivered toward end of inspiration. C, 0.375 seconds after a second shock, which fell 0.125 seconds after the shock of B. D, 1.25 seconds after second shock. Nerve functionally attached to body. The A, B, and C waves immediately following the shock pass far off the record.

2. Respiratory waves blocked next to body. A, first of 8 shocks of C strength. Elevation recorded is negative after potential of C wave. B, after fifth shock at 0.125 intervals. C, after eighth shock. D, one second after eighth shock.

3. An unusually sensitive nerve, shocks just below C strength. A, first shock. B, sixth shock. C, after tenth.

4. Induction coil faradization at strength sufficient to block myelinated fibers, ⅕ second duration. A, the first deflection is opening of ground switch, followed by stimulation. B, ½ second later. The nerve had been crushed next to body to eliminate the respiratory record.

5. A, start of faradization as above. B, 1.5 seconds later. The nerve had been cut from the body. 4A and 5A show base line noise level with and without the animal in electrical connection with the nerve. Cathode ray oscillograph, continuous strip records on bromide paper, 0.6 meters per second.