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TECHNICAL NOTE

A MECHANICAL STRAIN GAUGE FOR RECORDING PENILE CIRCUMFERENCE CHANGE

Recording sexual behavior in which more than one person is involved is difficult, yet objective measures are important to research in the modification of deviant sexual behavior (Barlow, Leitenberg, and Agras, 1969). One of the responses comprising sexual behavior in males is penile erection, and Freund (1963) proposed that volume (or circumference) change during penile erection is a convenient measure of sexual arousal.

Penile circumference change is only one step in the chain of the male sexual response; however, it is a necessary precursor to any consummatory behavior. Penile erection to different stimuli should therefore be a valid indicator of the potential for further sexual activity involving that object.

Another advantage of penile circumference change as a measure of sexual arousal is its specificity. Galvanic skin response, often used as a measure of sexual arousal (Solyom and Beck, 1967), may be elicited by general emotional states not correlated with sexual arousal (Montagu and Coles, 1966; Lacey, Bateman, and Van Lehn, 1953), but penile erection during the waking state seems to occur infrequently in the absence of sexual arousal.

In order to measure penile circumference change conveniently and reliably, a simple, rugged strain gauge encompassed in a ring of pliant material has been developed. The ring surrounds the penis but does not constrict and causes no discomfort. As the circumference of the ring increases, a strain is generated at the gauge platform and recorded.

Previous devices suggested to record penile volume change (Freund, Knob, and Sedlarcek, 1965; Fisher, Gross, and Zuch, 1965) have several disadvantages. Freund's plethysmograph is cumbersome and restrictive. The mercury strain gauge originally suggested by Whitney (1949) and Fisher *et al.* (1965) and modified for portable use by Bancroft, Jones, and Pullen (1966) also presents difficulties. While it is less cumbersome than Freund's device, it requires an awkward piece of plastic approximately 3 by 2 in. (7.5 by 5 cm) to stabilize the tubing. Furthermore, the mercury gauge is expandable over only 10% of its resting length and tends to separate at the upper range of displacement regardless of the size of the tube's boring. The mercury gauge is also temperature sensitive, somewhat difficult to build and seal, the units corrode at their terminals, and at times it has been reported to be restrictive (Peterson, 1966). Because there is no restriction of expansion, the new gauge requires six times less force than the mercury gauge to achieve the same amount of expansion. The new gauge compliance is such that 1 ounce of force (0.278 N) increases the circumference by 78.3 mm.

A diagrammatic sketch of the apparatus is presented in Fig. 1. Elgiloy stock, a corrosion-resistant surgical spring material 0.003 in. (0.85 mm) thick, purchasable at the Elgin Watch Company, Elgin, Illinois, was chosen as the ring and support material because it shows no expansion with temperature. A double thickness at the gauge platform, 0.006 in. (1.7 mm) was used to prevent breaking of the gauges. Two Budd C6-141 strain gauges with a gauge factor of 1.02 were used, purchasable at the Budd Company, Phoenixville, Pa. It is important to use the recommended size gauges because smaller gauges have produced erratic results. The two 120.0-ohm gauges were wired in a series, the common point (6) used as the output terminal and the others (2 and 3) attached to the source voltage, as supplied by the polygraph or batteries. Thus, as the resistance of the strain gauge was altered by expansion of the ring, the voltage at pin 6 was increased (in millivolts) relative to pin 4. It was this difference that the Grass polygraph recorded. The gauges were installed using BLH SC-4 waterproof cement, purchasable at Baldwin, Lima, Hamilton Corp., Waltham, Mass. The completed assembly was tygon-dipped to make it less sensitive to handling and to provide a smooth coating to prevent skin irritation. The entire assembly weighed 0.125 ounce and cost approximately $25.00 to build. For further information about strain gauges, see Aronson and Nelson (1958).

For our purposes, the apparatus has been adapted for use with a Grass pre-amplifier, Model 7P1A, providing for convenient write out of circumference change utilizing the 20k ohm dc input. Two carefully matched, fixed 120-ohm resistors were used as the balance of the bridge, installed in the plug of the pre-amplifier connecting cable as shown in the "wiring view" of Fig. 1. The leads from the strain gauge were directly connected to the terminals of the pre-amplifier connecting cable, and the numbers shown in Fig. 1 are the pin numbers on the connecting plug of the polygraph. Figure 2 represents a photograph of the apparatus and the terminals of the connecting cable. Although it has not been attempted here, this apparatus can be adapted for portable use. A 6-v battery can be installed at points 2 and 3, and a zero-center microammeter installed at 6 and 4. Changes in the reading of the microammeter will indicate changes in circumference of the penis.

Calibration can be most conveniently determined by sliding the ring down a smooth surfaced, cone shaped, wooden object and noting the recordings from the ring

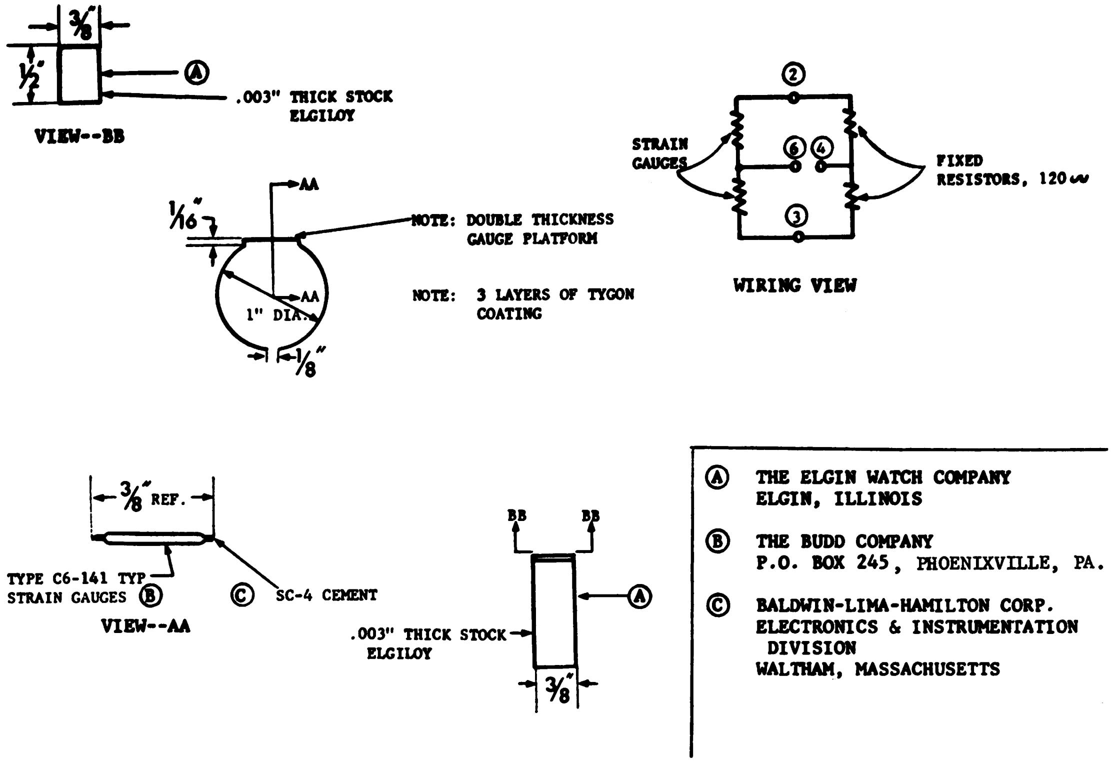


Fig. 1. Schematic diagram for strain gauge used to measure penile circumference change.

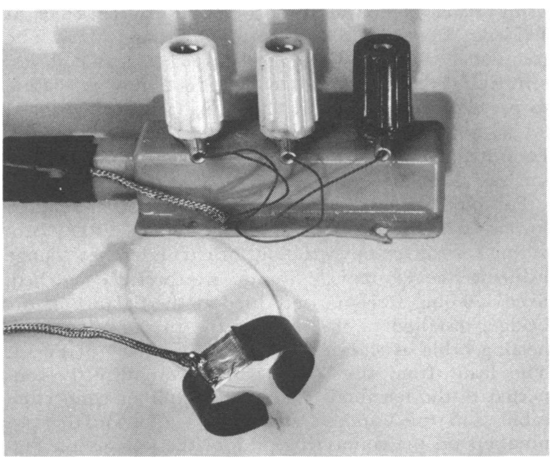
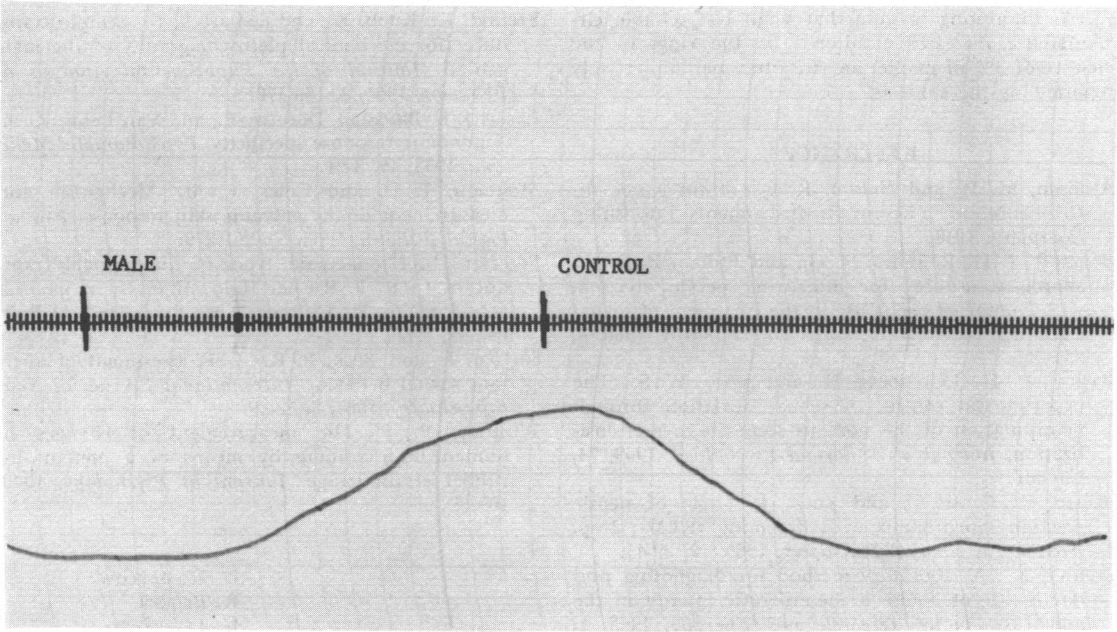


Fig. 2. Photograph of mounted strain gauge and connector terminals.

at known circumferences of the cone. Recordings from the ring are linear with circumference changes beyond the maximum range of penile circumference increase of 30 mm reported by Fisher, *et al.* (1965).

The placement of the ring is carried out by the subject at the approximate mid-shaft of the penis with the gauge on the dorsal side. This placement is important because alternative placements occasionally produce what appear to be decreases in circumference (negative pen deflections). This is caused by the ends of the ring failing to separate as circumference increases. Instead of expanding uniformly, the ring then becomes elongated in the shape of a long narrow circle that decreases strain at the gauges. This phenomenon does not occur if placement of the gauge is on the dorsal side.

In the usual procedure, the subject is seated in a comfortable chair and after placing the ring is asked to look at colored slides of normal heterosexual content and also slides representing the abnormal preference (*e.g.*, nude males for homosexuals). The subject is instructed to imagine himself in a sexually arousing situation with the person in the slide. Typically six slides, three heterosexual and three deviant, are presented in random order and length of exposure to the slide, determined for each subject before the experiment, may last from 1 to 2 min depending upon the subject's response latency. Once the optimal exposure time is determined it remains constant throughout the experiment. At the termination of the slide a neutral slide is projected. A second sexual slide is shown after a minimum of 30 sec or when volume displacement returns to baseline. This may take as long as 5 min. Consistent with Freund's (1967) observation, volume displacement does not always return to the previous baseline after erection, but rather levels off at a slightly greater displacement. Baselines may then be reset. Sample records from a session with a homosexual subject are presented in Fig. 3. The top record is a response to a male slide and the lower record a response



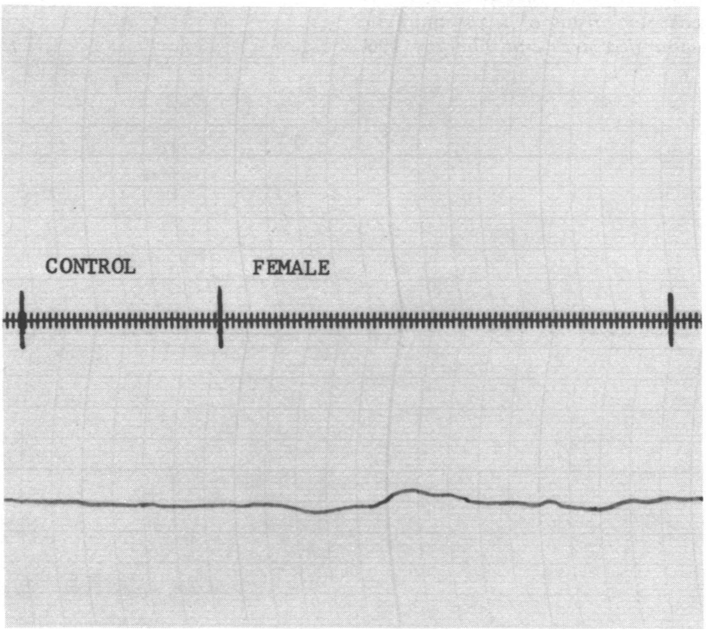


Fig. 3. Penile response of a homosexual to male and female slides as measured by the strain gauge.

to a female slide, both early in the experiment. Exposure to the slides lasted 70 sec for this subject and the vertical markings indicate a change in slide. The slide is identified in the record as male, female, or control, which in this case was a slide of blurred, black and white lines.

A response was scored as a percentage of maximum erection. Maximum erection was determined in several pre-experimental trials by the verbal report of the subject and visual confirmation by the experimenter. In all cases these reports agreed and the pen deflection was noted. The response must begin, but not necessarily reach its peak, during exposure to one of the sexual slides. The maximum response of the subject reported in Fig. 3 deflected the pen 40 mm. Therefore, the deflection of 25 mm in the top record represents a response of 62.5% and the deflection of 2 mm in the lower record a relatively small response of 5%.

It is interesting to note that small but reliable circumference increases monitored by the ring, in the vicinity of 3% of maximum, are often not subjectively reported by the subjects.

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