ATTACHMENT TO THE ELECTROMYOGRAPH FOR INVESTIGATING DYNAMIC AND STATIC FORCES IN MUSCLES

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A dynamographic tensometric attachment to the electromyograph is described. By its use it is possible to record the electromyogram and dynamogram of investigated muscles simultaneously.

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Various types of dynamographs and attachments [1-9] which enable not only the magnitude of the muscular effort to be determined, but also the time during which it can be maintained at a definite level, are used to record muscular strength. However, nearly all dynamographs in use at the present time reflect

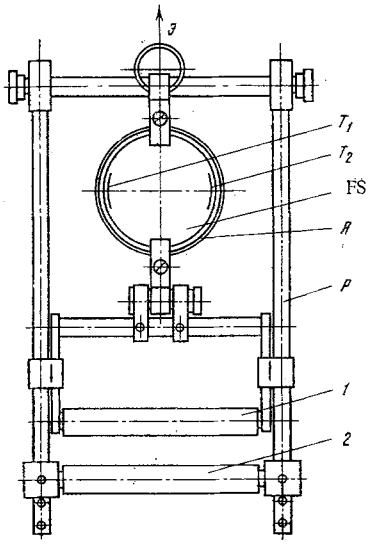

Fig. 1

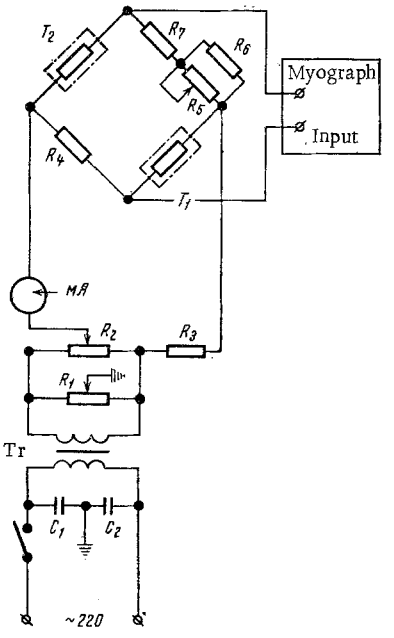

Fig. 2

Fig. 1. Mechanical part of the attachment. Explanation in text.

Fig. 2. Theoretical electrical circuit of attachment. $C_1 = C_2 = 0.1$ μF; $R_1 = R_2 = 200\,\Omega$; $R_3 = 51\,\Omega$; $R_4 = 100\,\Omega$; $R_5 = 47\,\Omega$; $R_6 \approx 1\,\Omega$; $R_7 = 99\,\Omega$. mA – E-59 milliammeter. T_1 and T_2 – tensometric sensors. PKB: 20-200.

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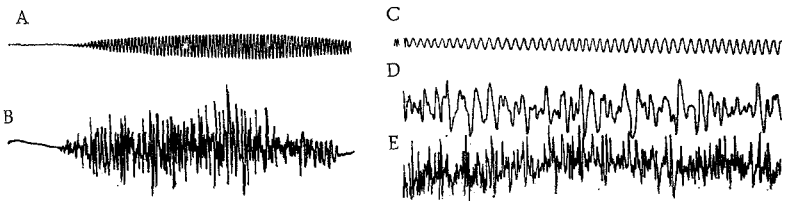

Fig. 3. Synchronous recording of DG and EMG from right biceps muscle. A) DG (dynamic work), 1 mm = 100 μV; B) EMG (recorded during dynamic work), 1 mm = 400 μV; C) DG (static work), 1 mm = 100 μV; D) EMG (cutaneous disk electrodes), 1 mm = 200 μV; E) EMG (implanted electrode), 1 mm = 200 μV.

only the slow changes in forces acting on the sensor of the instrument. In addition, if these instruments are used, the dynamogram (DG) is recorded separately from the electromyogram (EMG).

The object of the exercise was to record the EMG and DG simultaneously during both static and dynamic muscular contractions. For this purpose an attachment for the electromyograph was designed and built.

The proposed dynamographic attachment (Fig. 1) consists of the frame of a holder of a sensor element (F) with a suspended force sensor (FS). During measurement of the force of clenching the fist the hand grasps the handles (1) and (2), which transmit the applied effort to the force sensor. As a result of muscular contraction the steel ring (A) is deformed. These slight deformations produce changes in resistance of the tensometric sensors (T_1) and (T_2) secured with glue to the steel ring. The resulting imbalance signal is transmitted to the electromyograph, and a deflection of the beam corresponding to the magnitude of the muscular force is observed on the electromyograph monitor. A linear relationship exists between the relative deformation of the steel ring and the relative change in resistance of (T_1) and (T_2). After pressure has ceased to be exerted on the steel ring it reacquires its previous shape, so that the balance of the bridge of the wire resistors (T_1) and (T_2) is restored.

To investigate other groups of muscles, an expander (E), the elasticity of which can be regulated by means of straps, is attached to the PS. After very slight modifications to the mechanical part of the attachment, any groups of skeletal muscles can be investigated.

The electrical part of the attachment is shown in Fig. 2. The system is supplied from a 220-V power line. The instrument can be graduated by means of weights from 2 to 100 kg.

The suggested attachment possesses high sensitivity. Residual deformations of the steel ring have been abolished as far as possible, and by means of the resistor (R_5) the bridge with the tensometric sensors can be balanced on the isoelectric line on the electromyograph monitor. Since the sensitivity of tensometric sensors depends on the current, its value is established by the resistors (R_2) and checked by means of a milliammeter (Fig. 2). In this way all measurements can be made with identical sensitivity of the sensors.

By the use of this attachment it is possible to record muscular strength developed during work over a long period of time concurrently with the EMG on the same electromyograph tape, using both cutaneous and implanted electrodes (Fig. 3). As a result of calibration of the instrument relative to the DG recorded during examination of muscle forces in a particular rhythm (by means of a metronome), the quantity of muscular work done can be determined with sufficient accuracy.

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