PROBLEMS OF THE AUTOMATION OF METROLOGICAL MACHINE SUPPORT FOR STRENGTH TESTS

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The principles of the construction and the characteristic features of the operation of an automated system proposed by the author for metrological support of machines for strength tests, which makes it possible to carry out complex monitoring of force-measurement errors, and the presetting and adjustment of test loads, are examined. The characteristic features of continuous and stepwise methods of loading with automated verification are analyzed. Use of the continuous method with slowing of the loading in the vicinity of datum points is recommended as most promising. A procedure is developed for determination of the limiting value of the loading rate with verification, disregarding the dynamic error.

The following are critical problems facing domestic industry: an increase in the manufacture of machinery for testing the strength of material specimens, machine components, and full-scale designs under conditions approaching the operating conditions (according to Sergienko and Fongauz [1], the demands of the national economy for testing equipment are no more than 45% fulfilled at the present time); and, an increase in the operational qualities of testing equipment, for example, high-precision support for the reproduction of assigned testing effects, which guarantees the validity (reliability, objectivity) of the test results.

Establishment of requirements for the accuracy of the reproduction and maintenance of test regimes dictates the need to raise the effectiveness of metrological inspection beyond the testing facilities. Normalization of the accuracy characteristics of the testing machines is required, and a mandatory primary assessment of their values, as well as periodic monitoring of in-service invariability is proposed in connection with this problem statement.

Verification of testing machines is one of the basic problems involving metrological test support. It is precisely in this stage that a list of accuracy characteristics, which reflect most fully the actual properties of the testing machines and which make it possible to evaluate their relationship to requirements for the accuracy of the reproduction of the test regime, is established. Moreover, their actual values and correspondence to the requirements for the testing of articles are determined.

Solution of problems involving an increase in the manufacture of testing machines and improvement in their quality depend to a certain degree on the technical level and possibilities of usable systems for the metrological support of testing equipment, for example, on the level of automation of verification processes.

In effect, sufficiently complete automated systems for the metrological support of testing machines (ASMSTM) make it possible:

- to accelerate the technological process of verifying testing machines, which is one of the time-consuming and critical stages of their development (for example, due to an increase in the productivity of verifying equipment, a reduction in the volume of verification work in connection with increased reliability of the data obtained during automated verification), and, in turn, to contribute the growth of production possibilities for the manufacture and an increase in the manufacture of testing equipment; and,

- to reduce the error generated in verifying measurement channels and sensors used in testing machines, due to elimination of subjective factors during the measurements (as compared with nonautomated verification currently in practice, which calls for visual operator monitoring via a reference instrument), the acquisition of more representative data on errors and the use of more complete (although more complex) methods of the statistical processing of measurement results after a rather short time interval.

Fig. 1. Structural diagram of automated system for metro-
logical support of testing machines as a whole (a) and its
data-assembly and -processing unit (b).

Using ASMSTM, which makes it possible to obtain rather detailed data on the characteristics of devices used to measure force, strain, and displacement, it is possible to improve the accuracy of measurements during the operation of testing machines (by correcting all readings of the measuring devices on the basis of verification data with reference equipment, just as a reduction in errors during verification, the quality of the testing machines is improved due to an increase in the validity of test data).

Automation of verification provides for significant saving. Owing to use of means of automated verification, therefore, the Curtis Instrument Co. has generated a 250,000-dollar saving by reducing outlays for verification, and by improving the validity of the results and in-service effectiveness [2]. The annual saving realized at the O. K. Antonov Special Design Office for the implementation of an automated system for the metrological support of strain dynamometers used for the strength testing of aircraft has reached 46,000 rubles [3].

The construction principles of the ASMSTM developed by the author, which provides for the possibility of complex metrological control of the testing machine being verified in accordance with such parameters as force-measurement error, and the assignment and regulation of loads applied to the object being tested (to date, domestic industry does not have similar automated systems for complex metrological support of testing machines), are discussed below.

The structural diagram of a testing machine being verified and ASMSTM is shown in Fig. 1a. The testing machine being verified (for example, an IK-type of testing machine built by the Armavirsk Plant) contains the following: base 1, force exciter (force hydraulic cylinder) 2 with an actuator (servovalve) 3, force-measuring device (resistance-type force transducer) 4, excitable-load selector 5, automated load regulator 6, which is constructed of successively connected devices 7 for comparing the assigned and actual load values, control-signal shaper 8, and power amplifier 9.

The ASMSTM includes the following: reference force-measuring device (for example, a resistance-type transducer as the effective force-measuring device) 10, which is established in the power circuit of the machine being verified in series with effective force-measuring device 4 (in lieu of the specimen being tested); programmed controller 11 with manual input 12 for