MACHINE FOR FATIGUE TESTING PLASTICS UNDER AXIAL LOAD

I. P. Bareishis, P. P. Oldyrev,
and D.-V.A. Marchyulionis

UDC 620.17:678

A description is given of a machine for fatigue testing small specimens of polymeric materials under axial load at medium frequencies.

In order to investigate the fracture behavior of polymeric materials under cyclic loading it is necessary to test small-scale specimens. For example, such specimens are convenient for investigating the damage accumulation process by physical methods. The existing machines for applying axial cyclic loading to microspecimens are either not powerful enough for high-strength reinforced plastics or are not capable of asymmetric-cycle operation.

On the basis of the machine described in [1], workers at the Institute of Polymer Mechanics, Academy of Sciences of the Latvian SSR, have developed a design for a machine for fatigue testing single small-scale specimens in tension—compression with a maximum load amplitude P_a = 200 kgf. The electrical system of the machine was designed by the Department of Engineering Sciences of the A. Snechkus Kaunas Polytechnic Institute. The overall dimensions of the machine are 600 × 790 × 1180 mm. It weighs about 500 kg. The distance between grips is 40-70 mm, depending on the design. The power consumption of the motor is 2 kV at frequencies up to 20 cycles/sec. The frequency range of the cyclic load is from 0.1 to 20 cycles/sec.

The specimen can be loaded with any cycle asymmetry. The machine is equipped for automatic control.

The machine comprises static and cyclic loading mechanisms and automatic control elements. The mode of operation of the machine is illustrated by the diagram in Fig. 1. On base 1, which takes the form of a table, are mounted two columns 2, supporting the parts that form the test space. The specimen 3 is held in grips 4 and 5. The upper grip 5 is connected with the static loading mechanism 6, which consists of two crosspieces 7 joined by sleeves 8. The cycle asymmetry is preset manually by means of a worm adjustment 9. The static loading mechanism is attached to the columns by clamps 10. On the lower crosspiece 7 there is a retaining device 11 which secures grip 4 when the specimen fails in tension. For mounting flat specimens it is possible to use grips similar to those described in [2]. The bottom grip is connected with the cyclic loading mechanism, which consists of a rod-dynamometer 12, a spring cylinder 13, a connecting rod 14, and an eccentric mechanism 15. Power is provided by an electric motor 17 and drive belt 16. An eccentricity ranging from 0 to 10 mm is preset by means of an eccentric 18, a shaft 19, and a worm gear 20 mounted on a flywheel-pulley block 21. The eccentric 18 is connected with a worm pair 22 that serves for the manual adjustment of the bottom grip and as a link with the cycle counter 23.

The machine operates as follows. After the control circuit has been connected to the power supply by means of controller (potentiometer) 24 and thyristor switch 25, the required cyclic loading frequency is set. The signal from the ÉTO-2 thyristor switch starts up a P-32 dc motor 17. Connecting rod 14 transmits reciprocating motion to the spring cylinder 13. The force developed as a result of the deformation of the spring is transmitted to the specimen 3 through rod 12. This rod is rigidly connected to the middle turn of the spring, which ensures that the same forces are developed in tension and compression. The stiffness of the spring is selected according to the stiffness of the material tested. In order that

Institute of Polymer Mechanics, Academy of Sciences of the Latvian SSR, Riga. A. Snechkus Kaunas Polytechnic Institute. Translated from Mekhanika Polimerov, No. 3, pp. 556-558, May-June, 1976. Original article submitted September 16, 1975.

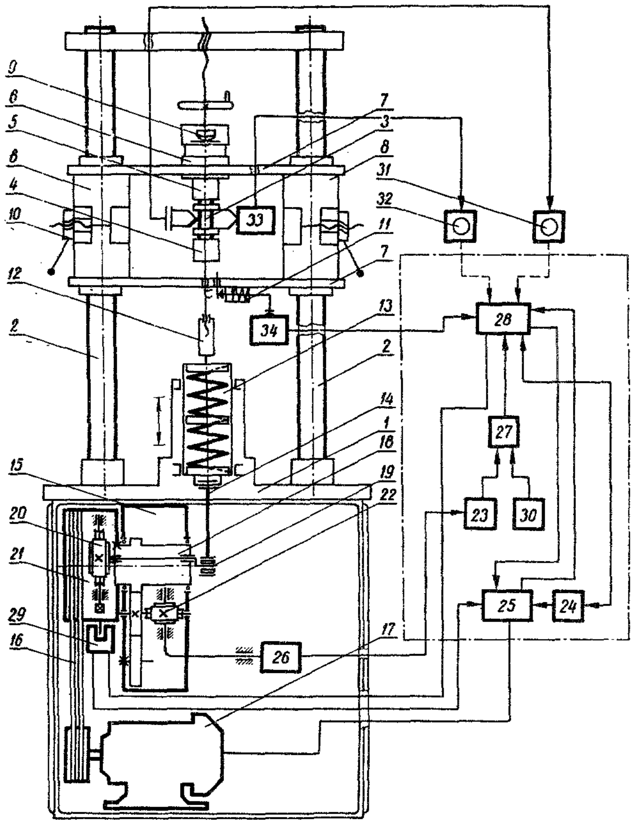

Fig. 1. Diagram illustrating the mode of operation of the machine.

at P_a = const the error does not exceed 3%, the stiffness of the spring should be not less than 32 times less than the stiffness of the specimen. The spring, together with the cylinder and the rod, can be quickly replaced. Thus it is sufficient to have a set of two cylinders.

The amplitude is controlled and the constant load component established by means of a dynamometer mounted on rod 12. In order to intensify the primary strain gauge signal the cross section of the rod is varied according to the load. The spring and dynamometer are calibrated by means of DOSM standard dynamometers (precision class 0.5) mounted in the machine in place of the specimen and grips. For calibration purposes the load is set by turning worm pair 20 and is read from a special scale on the worm wheel. The specified amplitude P_a is similarly preset before the machine is started up. Thermostating and strain-measuring devices can also be incorporated. The machine can also be adapted for rigid load transmission. For this purpose, rod 12 is connected directly to rod 14. The automatic controls make it possible to stop the machine after a given number of cycles, after a given time under load, or when a given specimen temperature or deformation is reached. There is also provision for control by the retaining device and return of the loading mechanism (unloading of the specimen) with automatic interruption of the test. The electrical circuitry of the control system is described in [3].

When the number of cycles is preset, the machine operates as follows. Pulses from detector 26 are fed to the cycle counter 23 and a register 27 operating on the countdown principle. When the given number of cycles is accumulated, a signal passes from the register 27 to a relay control unit 28 which signals switch 25 to slow down motor 17 and shift the unit 29 controlling the eccentric mechanism 15 into neutral. When eccentric mechanism 15 is in neutral, thyristor switch 25 cuts out and the machine stops.

To stop the machine after a specified time, the signals from a timer 30 are compared with those from register 27. To stop the machine after a certain specimen temperature or deformation has been reached, automatic potentiometer 31, which registers the heating of the specimen, or measuring bridge 32, which is connected with the strain measuring device 33, sends the appropriate signals to control unit 28.

When the specimen fails, the spring of the retaining mechanism 11 holds the grip in the lower position and through a cutout switch 34 signals the control unit 28 to stop the machine. Thus the fatigue fracture surface remains undamaged.

LITERATURE CITED

1. A. V. Stinskas, Ya. P. Baushis, and I. P. Bareishis, "Machine for testing plastics in fatigue," Zavod. Lab., No. 4, 499-500 (1972).
2. P. P. Oldyrev, "Grips for testing flat plastics specimens under axial load," Zavod. Lab., No. 9, 1156-1157 (1973).
3. I. P. Bareishis, D.-V. A. Marchyulionis, and A. P. Stirbis, "Automatic controls of a fatigue-testing machine," Zavod. Lab., No. 4, 609-610 (1976).