



Wave machine

11211.00

Operating Instructions



Fig. 1

1 PURPOSE AND DESCRIPTION

The wave machine serves to demonstrate wave propagation by means of coupled oscillators. The use of electronic measuring instruments allows the period and frequency to be accurately and reproducibly determined.

2 FUNCTION ELEMENTS AND OPERATING ELEMENTS

2.1 The oscillatory system

The oscillatory system consists of 48 identical, ring-shaped oscillators 1, whose centres lie equidistant apart on a horizontally taughened, thin steel wire 3, and which are coupled to each other by continuous elastic bands. Coloured numbered discs mark the zero line when the system is at rest, and make the wave train which results from excitation visible even from some distance.

2.2 Excitation

The excitation of the oscillatory system is normally carried out on the first oscillator. This oscillator is therefore furnished with two pins 2, which each have a circular groove for holding connecting rod 4 for mechanical excitation. The top pin is normally used for this purpose. Fig. 3 enables the movement to be described: The drive rod 6 is turned back and forth by the rotation of the tappet 8 and the resulting movement of the tappet shaft 8.1. This back and forth turning movement is transmitted to the first oscillator via the driving lever 5 and the connecting rod 4. The extent to which the drive rod turns, and so also the amplitude of the oscillator displacement, can be changed by adjustment of the position of the tappet shaft in the longitudinal slit 7.1 in turning lever 7. The shorter the distance from the drive rod, the greater the extent to which the drive rod turns. In some experiments, it is necessary to mechanically excite the last oscillator, this is therefore also furnished with a grooved pin

above the centre of the oscillator, and the mode of its movement on excitation is as described for the first oscillator. Drive rod 6 consists of two rods, the inner ends of which are held in the coupling counterpart 9. The end of the drive rod leading to the first oscillator is firmly connected in the coupling by an Allen screw 9.1 and the end of the drive rod leading to the last oscillator is fixed by a milled screw 9.2. The wave machine is factory adjusted so that when the driving lever 5 is vertically upright, the turning lever 7 points exactly vertical downwards.

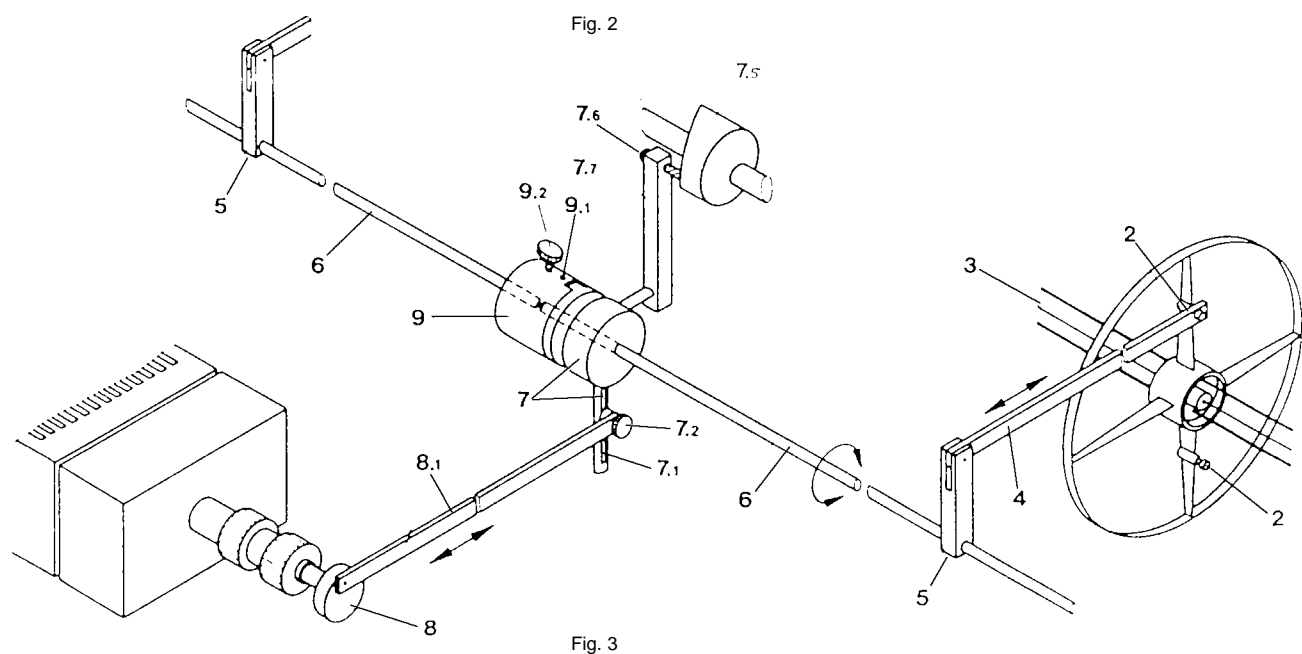
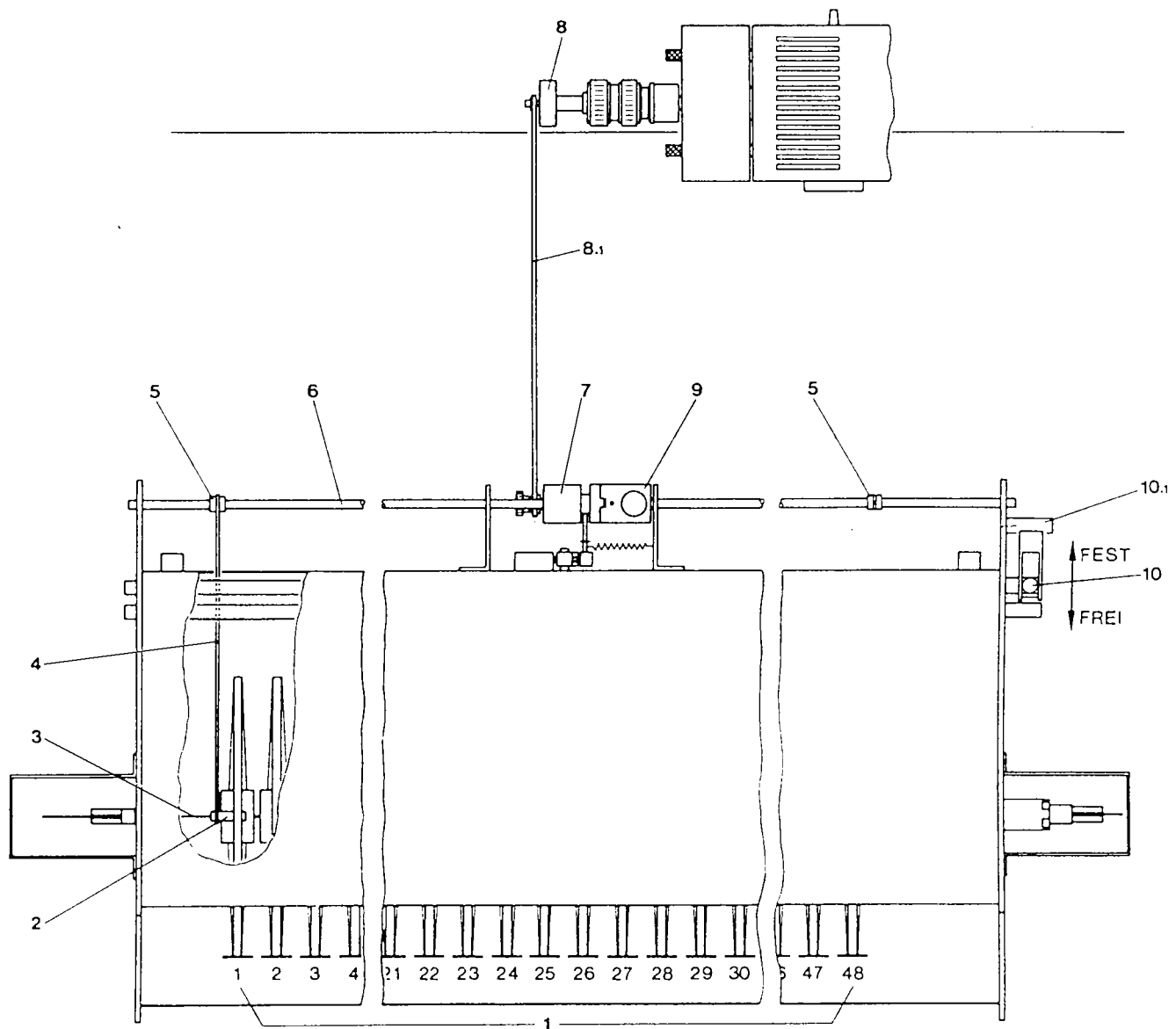
When the first and last oscillators are to be excited simultaneously - when the phase relationship between the two propagated waves are to be varied - it is necessary to change the relative position of the two driving levers 5 to each other. As these are fixed on the drive rods, this change must be made by loosening the milled screw 9.2 and appropriately turning the drive rod to the last oscillator. Do not loosen the Allen screw 9.1. Three connecting rods are supplied with the wave machine, two of these are identical straight rods and the other is an angled rod. The straight connecting rods are used - apart from the excitation of the first oscillator - to fix the last oscillator or also for two-sided, cophasal excitation. The angled connecting rod is required in the case of two-sided, opposite phase excitation.

2.2.1 One-sided excitation of the oscillating system

Connect the first oscillator to the motor with a straight connecting rod 4.

When experiments are to be carried out with a „fixed end“, lock the last oscillator at its zero position with the second straight connecting rod; to do this, clip the inclined slit of the rod to the back of the housing.

For experiments with a „free end“, do not engage a connecting rod to the last oscillator.



2.2.2 Excitation from both sides

The phase relationship between the waves propagated at the start and at the end is dependent on the relative positions of the two driving levers 5 to each other. It is exactly 0° or 180° when the levers are exactly parallel to each other. The required phase angle between the first and last oscillator can be set after milled screw 9.2 has been loosened.

- Cophasal excitation: Connect straight connecting rods to the first and last oscillators.
- Opposite phase excitation: Connect the last oscillator to the turning lever with a straight connecting rod; for excitation of the first oscillator, use the angled connecting rod with its longer arm fitted to the driving lever and the shorter arm to the lower pin of the oscillator.

2.3 Braking system and drive clutch

The braking system enables all of the oscillators to be simultaneously arrested in the position they are in at any moment on time, so that the oscillators depict the wave as it was at the instant of arrest, or the displacement from equilibrium. When the brake is rapidly applied using the brake arm 10, a braking strip with a spongy covering suddenly blocks the oscillators, the lever is arrested in this position. At the same time, the motor clutch is disengaged. Screw 7.6 allows the clutch to be optimally adjusted, so that whereas disengagement can occur with certainty, the displacement of the turning lever 7 is not unnecessarily large, i.e. tension in the tappet shaft 8.1 is avoided.

The brake arm is locked by a clamp in the „hold“ position, and can only be freed manually after lifting up the clamp. The brake system then automatically returns to its initial state and releases the oscillating system. At the same time, the drive is again engaged.

2.4 Damping system

To avoid unwanted reflections at the end of the oscillating system, the wave machine can be operated with liquid damping which is proportional to the speed. For this, the last five oscillators (44 ... 48) are fitted with damping plates of graded size. The plates are at their deepest point when the oscillators are in their rest position, and then dip into water in a water-filled trough which is inserted under the oscillators. The numbered discs on oscillators 42 and 43 have the sides towards each other slightly cut back, so that they do not hit the side wall of the damping trough. When experiments are to be carried out with particularly energy-rich waves, damping can be increased by adding glycerol to the water as required. When experiments have been completed, allow the damping liquid to run out through the tubing into a sufficiently large vessel (2 l capacity).

3 HANDLING

When unpacking the wave machine, be sure to take the two packages containing accessories out of the packaging. They contain three connecting rods (two straight, one angled), a tappet with tappet shaft, two attachable diaphragms, a damping trough with drainage tubing and tubing clips as well as an Allen key (SW 2).

The wave machine can be excited manually or with a motor.

3.1 Positioning

The footprint of the wave machine is 132 cm wide and 35 cm deep. Place it on a surface which is stable and as horizontal as possible. When it is to be used with automatic periodic permanent excitation, position it approximately 30 cm away from the back edge of the table, to leave space for the mounting of the motor behind the wave machine (see Fig. 2).

3.2 Motor drive

First fix the tappet shaft 8.1 to turning lever 7. To do this, completely loosen milled screw 7.2 to free the guide pin with thread 7.4 (Fig. 4). Position the tappet shaft on the guide pin and fix it about half way up the longitudinal slit with the milled screw.

Fit out the laboratory motor (11030.93) with the appropriate gearing, holding the shaft of it in the motor grip (refer to the Operating Instructions supplied with the motor for details on how to handle it!).

Hold the motor at the back edge of the table with a table clamp, with the motor positioned so that the axis of rotation is parallel to the edge of the table and at the same height as the point of application chosen for the tappet shaft in the longitudinal slit 7.1. When the table is very low, the laboratory motor can also be held in a support base -PASS-(02005.55). Fix the 10 mm bolt of the tappet in the grip of the motor or gearing. The position of the tappet shaft should be vertical to the motor axis and to the drive rod, which have been set parallel to each other, with turning lever 7 engaged; if necessary, appropriately re-position the motor along the table edge.

When it is important to you that the oscillating system is excited with a symmetrical amplitude, the following two conditions must be fulfilled:

- Driving lever 5 must point vertically upwards when turning lever 7 points vertically downwards.
- Turning lever 7 must point vertically upwards when the eccentrically turning holding pin for tappet shaft 8.1 is at the highest and lowest points of its circulatory movement.

The first condition is fulfilled by the factory adjustment; should this adjustment has been changed at any time, loosen the Allen screw to appropriately turn the turning lever on the drive rod.

The second condition is fulfilled when the motor is at the correct distance from the wave machine.

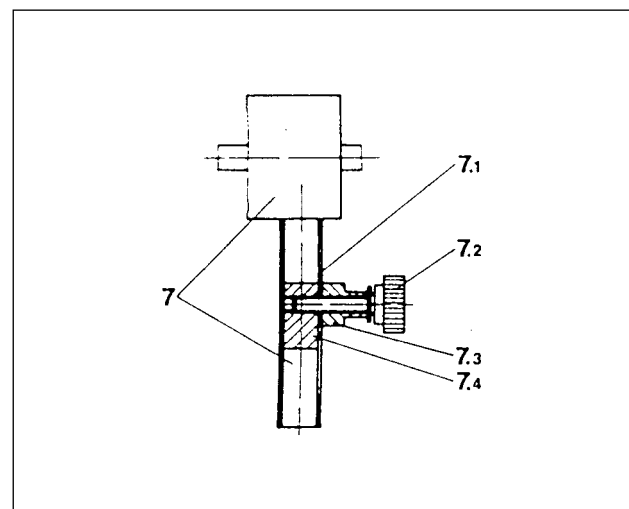


Fig. 4

3.3 Measurement devices

Light barriers and electronic counters can be used with the wave machine to demonstrate and perform measurements of periods and frequency, without any mechanical retroaction on the oscillating system. Each wave machine is supplied with two diaphragms which serve as switching diaphragms for light barriers. For this purpose, spread them out and clip their slit onto the numbered plates of the oscillators of your choice.

3.4 Storage

When the wave machine is not used for some time, we recommend that it be stored somewhere where it - and in particular the oscillating system - is not exposed to direct sunlight.

Ensure that the brake arm is not applied, as the bearing wire of the oscillating system is then additionally burdened.

3.5 Service

The wave machine requires no service. Only when „free end“ experiments are carried out, increased friction resulting from rubber rubbings can make itself disturbingly noticeable. In this case, we recommend that you clean the elastic band seating behind the last oscillator. To do this, draw the elastic band clamp off to the right and clean the bearing surfaces of the oppositely moving parts with a clean cloth and oil them a little (e.g. with a few drops of sewing machine oil).

Caution: Never abruptly let go of a bearing plate, as the re-coiling of this would damage the sensitive ball bearings.

4 LITERATURE

Information on request
Versuchseinheiten Physik
„Transversalwellen 2“

16050.51

5 LIST OF EQUIPMENT

The following list includes only the most important accessories used in connection with the wave machine. A complete list of the equipment required for various experiments is given in the experimental literature.

Wave machine	11211.00
Laboratory motor, 220 V AC	11030.93
Gearing 100/1, for 11030.93	11027.00
Gearing 30/1, for 11030.93	11029.00
Light barrier	11207.02
or	
Fork light barrier, compact	11207.20
Digital counter, 4 decades	13600.93
or	
Time measuring instrument, 4-4	13605.93

6 NOTE ON THE GUARANTEE

We guarantee the instrument supplied by us for a period of 6 months. This guarantee does not cover natural wear nor damage resulting from improper handling.

The manufacturer can only be held responsible for the function and safety characteristics of the instrument, when maintenance, repairs and changes to the instrument are only carried out by the manufacturer or by personnel who have been explicitly authorized by him to do so.