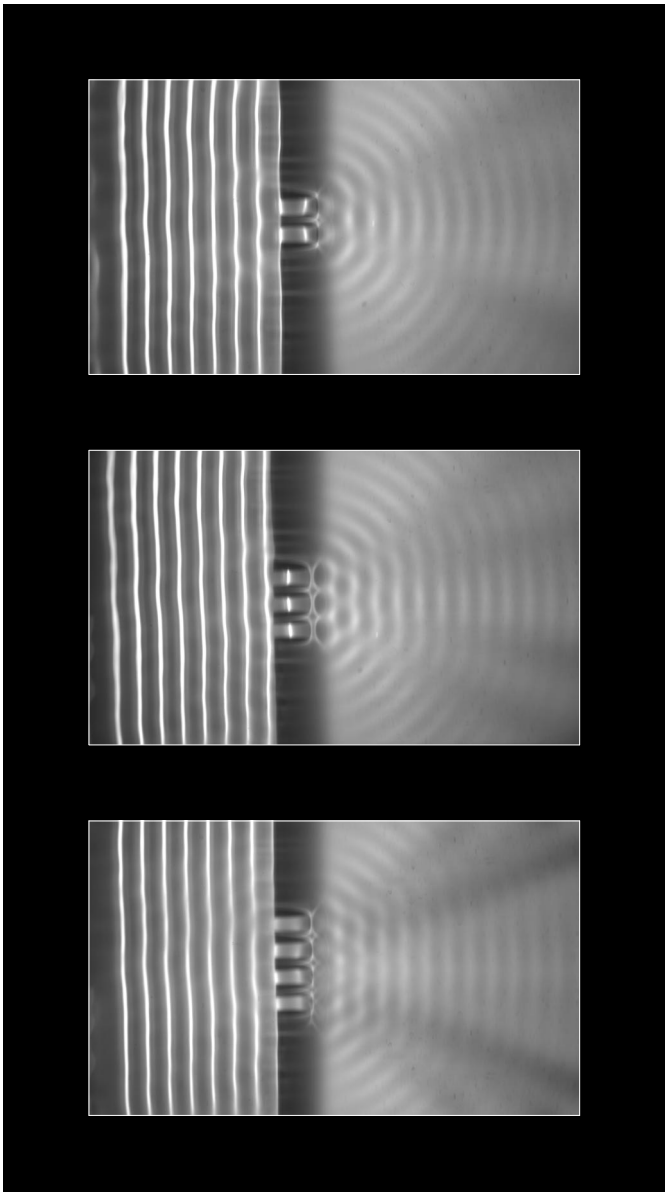
Diffraction of water waves at a multiple slit

Objects of the experiment

- Observing the interference of water waves at a double, triple and quadruple slit.
- Comparison of interference images.



Principles

When straight water waves strike an obstacle with two narrow slits, coherent circular waves are formed behind the slits. The superposing of circular waves gives rise to interference structures with clearly defined maxima and minima, whose positions depend on the slit spacing and the wavelength. The interference pattern is comparable to that of "Two-beam interference of water waves" (P1.6.5.1).

We can use the wave trough to compare the interference structures of double, triple and multiple slits. The interference structure changes as the number of slits n increases. The angles at which the maxima are located remain the same. However, the maxima are more and more clearly defined. In addition, an increasing number (n - 2) of secondary maxima are formed; their intensity decreases as n increases.

Fig. 1 Diffraction of water waves at a multiple slit (photographs)
Top: diffraction at a double slit
middle: diffraction at a triple slit
Bottom: diffraction at a quadruple slit.

Apparatus

1 Wave trough with motor stroboscope . . . 401 501

additionally required:

Dish soap

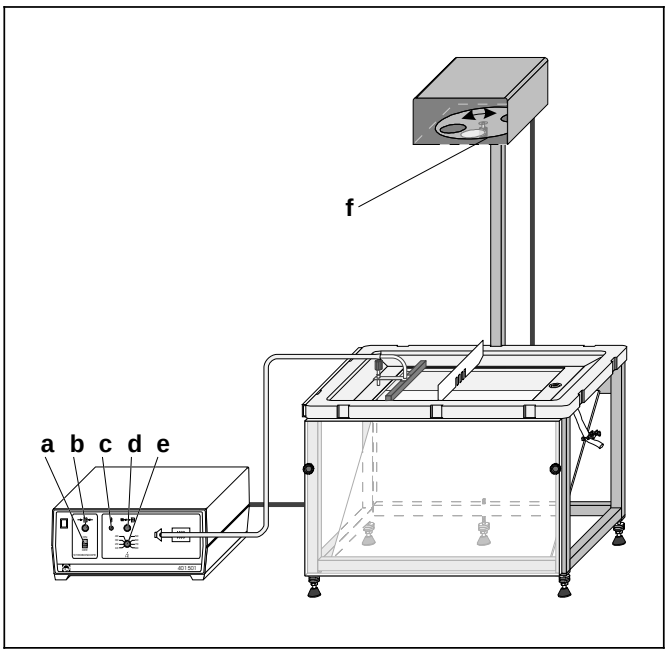
Setup

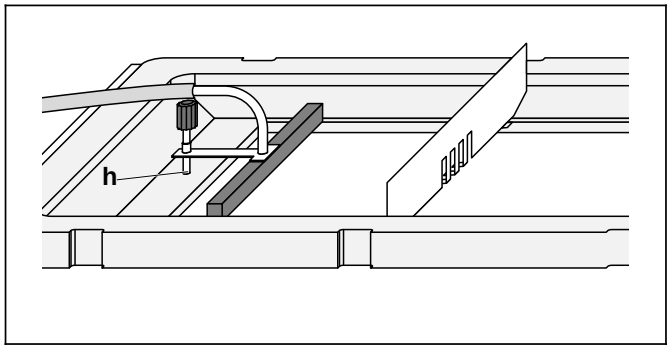
Set up the experiment as shown in Fig. 2.

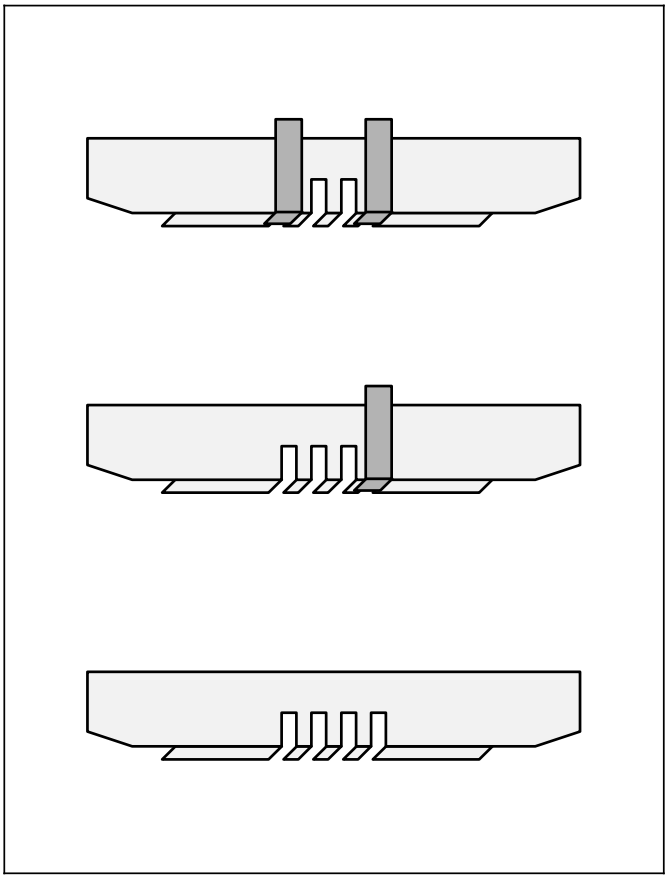
– Set up the wave trough so that it is not subject to shocks and vibrations; observe all information given in the Instruction Sheet.
– Place the obstacle with four slits in the center of the wave trough precisely under the lamp.
– Connect the exciter for straight waves as shown in Fig. 3 and set it up parallel to the obstacle at a distance of approx. 5 cm.

Carrying out the experiment

– Cover the two outer slits using the narrow cover slides as shown in Fig. 4 (top).
– If necessary, rotate the stroboscope disk out of the beam path using knurled screw **(f)** so that the glass pane in the bottom of the wave trough is completely illuminated.
– Using knob **(e)**, set a frequency of approx. 25 Hz, and carefully increase the excitation amplitude using knob **(d)** until wave fronts are clearly visible (see Instruction Sheet for wave trough).
– Vary the immersion depth as necessary with adjusting screw **(h)**.
– Observe the position and number of interference maxima and minima.
– Increase the number of slits to three by removing one of the cover slides.
– Observe the position and number of interference maxima and minima.
– Increase the number of slits to four by removing the remaining cover slide.
– Observe the position and number of interference maxima and minima.
– Repeat the experiment with different frequencies.







Measuring example

Fig. 1 shows three photographs with measurement examples.

Results

Behind a double slit, the circular waves superpose where they meet. The result is a wave image with clearly defined interference maxima and minima. If we add one or two more slits with the same spacing to the original two, weaker interference lines, called secondary maxima, occur between the main maxima. The number and direction of the main maxima remain the same. However, they become narrower, i.e. more sharply defined. The triple slit produces one secondary maximum, while the quadruple slit causes two secondary maxima.

Fig. 2 Experiment setup for interference of water waves at a multiple slit
- **a** Stroboscope switch
- **b** Knob (for fine adjustment of stroboscope frequency)
- **c** Pushbutton (single-wave excitation)
- **d** Knob (for adjusting amplitude of wave excitation)
- **e** Knob (for adjusting frequency of wave excitation)
- **f** Knurled screw (for manually turning stroboscope disk)

Fig. 3 Connecting and positioning the exciter for straight waves
- **h** Adjusting screw (for setting immersion depth)

Fig. 4 Multiple slit (viewed from exciter)
Top: double slit
Middle: triple slit:
Bottom: quadruple slit

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