The circular waves emanating from two point wave generators interfere with each other. The interference pattern changes if the phase relationship of the two wave generators is changed.

Material

from the accessory set of 11260-99

2	Wave generator, single	
2	Dipper	

In addition, the following is also required

1	External vibration generator	11260-10
	Pencil	

Method

Two circular waves produced by two single, vibrating wave generators initially in phase $\Delta\varphi = 0°$) superimpose to form an interference pattern. A phase difference is then set between the two wave generators ($\Delta\varphi \neq 0°$) and the change in the interference pattern is observed.

Setup

The two mounting rods with single wave generator (dipper) are attached to the integrated exciter arm as well as to the external vibration generator. The two connection cables are used to connect the external vibration generator to the rear of the wave apparatus. The two wave generators are then positioned relative to the wave tray as shown in Fig. 1. To place the integrated exciter arm in the planned position the knurled exciter head is loosened, the exciter arm is rotated into the relevant position and then the exciter head is fixed in position again.

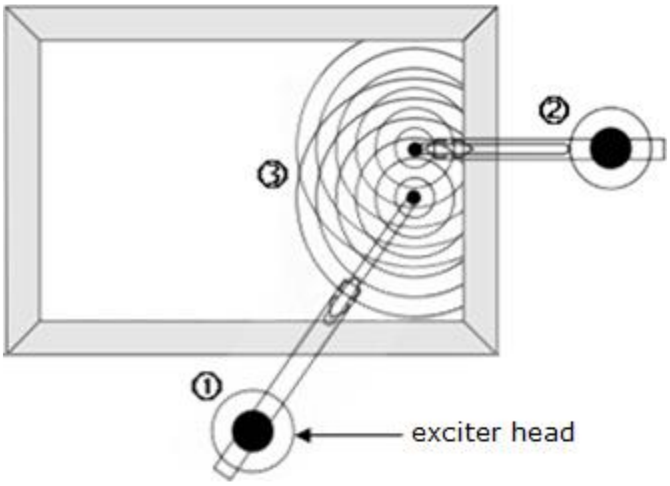

Figure 1: Experiment arrangement for demonstrating the effect of a phase difference $\Delta\varphi$ of two circular waves on their interference pattern. The circular waves produced by the integrated ① and by the external vibration generator ② superimpose to form a characteristic interference pattern ③.

Procedure

An exciter frequency of between 20 Hz and 25 Hz is set at the ripple tank and the stroboscopic light is switched on. The amplitude should be chosen so that a clear interference pattern results. At this moment both exciters oscillate in phase ($\Delta\varphi = 0°$).

A pencil is now used to draw several wave crests and troughs on a sheet of paper placed on the drawing table (Fig. 2). (It can be helpful to fix the sheet to the bench using strips of cellotape or similar means.) It is important to mark which stripes represent wave crests and which stripes represent wave troughs.

A phase difference $\Delta\varphi$ of 45°, 90°, 135°, 180°, 225°, 270°, 315° and 360° = 0° is then set one after the other and the interference pattern for each case is observed. In each case the wave crests and troughs of the visible interference pattern are then compared with the wave crests and troughs drawn on the sheet of paper ($\Delta\varphi = 0°$).

Results

It can be seen that with a set phase difference of ($\Delta\varphi \neq 0°$), the wave crests and troughs drawn on the sheet of paper no longer match the wave crests and troughs of the visible interference pattern. I.e. the visible interference pattern is shifted compared to the drawn on wave crests and troughs. This shift increases as the phase difference $\Delta\varphi$ increases.

If the phase difference is 180°, the wave crests and troughs of the interference pattern have reversed compared to the drawn on wave crests and troughs (Fig. 3). A wave trough in the interference pattern can now be seen at the point where a wave crest was drawn on the sheet and vice versa.

If the phase difference is further increased there is a further shift until, at a phase difference of $\Delta\varphi = 360° = 0°$, the drawn on wave crests and troughs once again match the wave crests and troughs of the interference pattern.

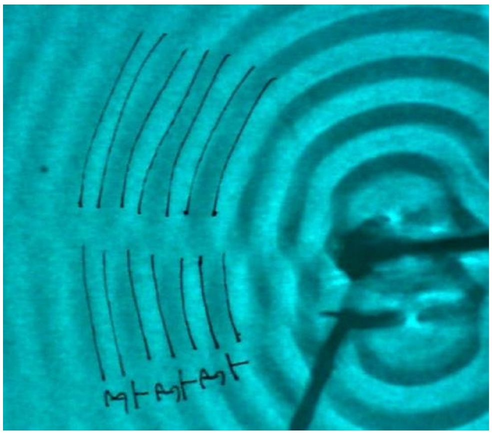

Figure 2: Snapshot as shown in Fig. 1 at a phase difference of $\Delta\varphi = 0°$. The interference pattern as well as the drawn on wave crests and troughs can be identified. The “T” denotes a wave trough, the “B” denotes a wave crest.

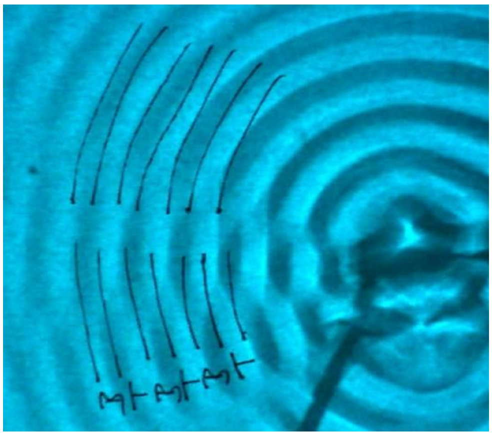

Figure 3: Snapshot as shown in Fig. 1 at a phase difference of $\Delta\varphi = 180°$. It can be seen that a wave trough of the interference pattern has now occurred at the position of a drawn on wave crest. The same applies accordingly for a drawn on wave crest.

Interpretation

With increasing phase difference the waves of the two exciter centres are shifted relative to each other, whereby a phase difference of 180° corresponds to a half wavelength and a phase difference of 360° corresponds to a whole wavelength, which is shown by the results in Fig. 2 and Fig. 3.

When two in phase circular waves are superimposed, a characteristic interference pattern results, whereby there are areas of constructive and destructive interference. The loci of constructive interference lie on hyperbolae, which are at a distance of $\Delta l = \lambda \cdot m$ $(m = 1, 2, 3, \ldots)$ from the exciter centres; loci of destructive interference lie on hyperbolae at a distance of $|\Delta l| = \frac{1}{2}\lambda, \frac{3}{2}\lambda, \frac{5}{2}\lambda, \ldots$ from the exciter centres (see OW 3.1).

If an area of constructive interference in in-phase circular waves is now compared with that of two circular waves with 180° phase shift, this phase shift causes the formation of wave crests at the positions where wave troughs can be seen with in-phase interference. The same applies to the formation of the wave troughs. The phase shift thus causes a shift of the wave crests and troughs.

At a phase shift of 360° the shift is then advanced so far that the wave crests and troughs can once again be seen in precisely the same place as with in-phase interference.

