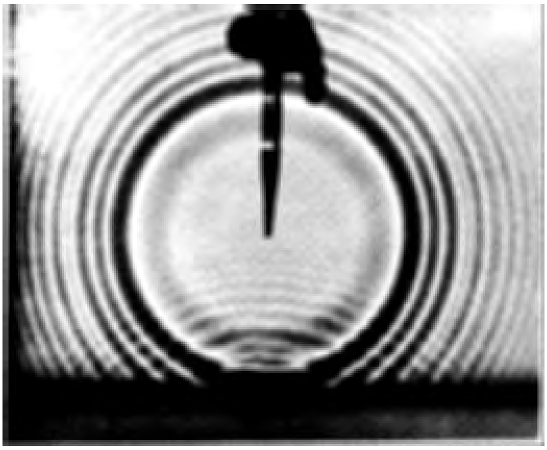
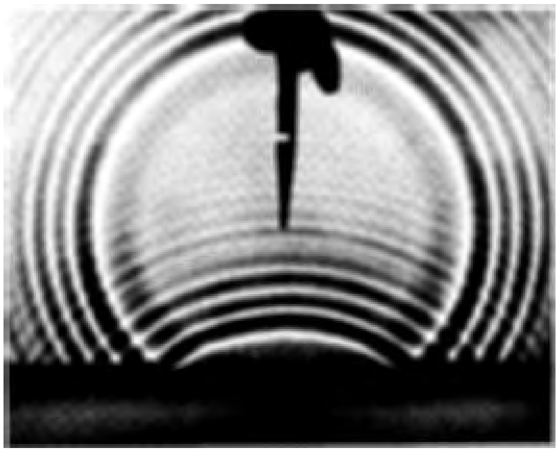




17–9. Reflection of a circular pulse from a straight barrier. In the photograph at the left, the pulse is approaching the barrier, while at the right a part of it has been reflected.

and 12–10.) By using curved barriers or combinations of two or more straight barriers, we can demonstrate with the ripple tank all of the phenomena of reflection that we studied in connection with light. Just as the formation of images by mirrors followed from the laws of reflection in optics, so does the corresponding formation of images by "mirrors" in the ripple tank.

17–4. Speed of Propagation and Periodic Waves

Waves in different media propagate with different speeds. For example, we can see the waves on a coil spring speed up when we stretch the coil, and we can see the waves in a rubber hose slow down when we fill it with water. In this section we shall learn how to make quantitative measurements of the speed of water waves in the ripple tank. There are several ways of going about such a measurement.

One way is to generate a straight pulse and measure with a stop watch the time t the pulse takes to travel a specified distance l. The speed v is then equal to the distance traveled divided by the time taken:

$$v = l/t\,.$$

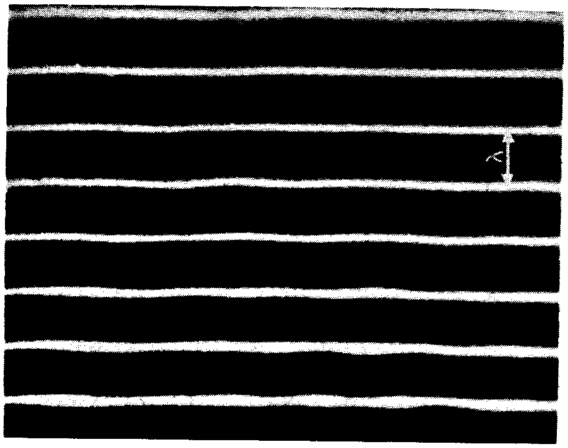
Another way is to generate two pulses, one after the other. By the time the second pulse is generated (after a time t) the first pulse has traveled a distance l. From then on both pulses travel along, while the distance l between them remains the same. We can measure this distance with a ruler, and again $v = l/t$. These methods are simple in principle, but in practice it is rather difficult to follow the pulses and measure the distances and times required.

A third method is to generate pulses one after another at equal time intervals T. In doing this, the wave generator repeats its motion once every interval T. Such a motion is called *periodic*, and the time interval T is called the *period*. Another way of describing this periodic motion is to tell how often the motion repeats itself in a unit time interval; that is, by giving the *frequency* f of repetition. For example, if the motion repeats every 1/10 sec, the frequency is ten times per second. In general $f = 1/T$.

Let us now concentrate on some point in the tank. The pulses produced by the generator move toward this point, and they pass the point with the same frequency with which they leave the source. If ten are sent out each second, ten will pass each second. The frequency of the wave is therefore also given by $f = 1/T$, and T is the time between the passage of successive waves. Furthermore, as the waves move, the distance between any two adjacent pulses is always the same and is called the *wave length* λ (lambda). The wave pattern which we have been describing is called a periodic straight wave (Fig. 17–10).

We can obtain the speed of a periodic wave in a manner similar to that which we used for a pair of pulses. We know that the pulses are separated by a distance λ and that each pulse moves over this distance in a time T. Hence the speed of propagation is

$$v = \lambda/T.$$



17–10. Periodic straight waves moving across a ripple tank.

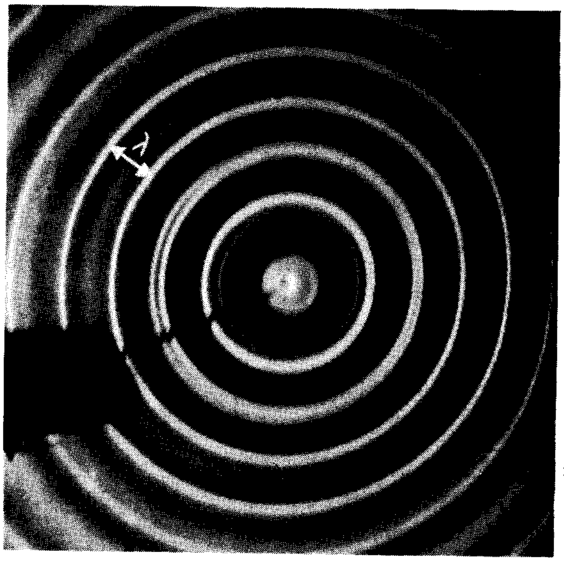
Using the relation $f = 1/T$, we find that

$$v = f\lambda,$$

or that the speed of propagation of a periodic wave is the product of the frequency and the wave length.

The relation that we have just obtained is by no means restricted to waves in a ripple tank. It is equally good for *any* periodic wave. Such things as the straightness of the wave, the nature of the ripple tank, and the properties of the water did not come into the argument from which we got our result. In particular, we could have followed the same procedure with circular periodic waves and would have found the relationship $v = f\lambda$ again. In this case the wave length is measured along the radius (Fig. 17–11); and we find it is equal to the wave length of a straight wave of the same frequency. The speed of circular waves is therefore equal to that of straight waves in the same medium. Furthermore, we could have applied the above arguments to any other kind of periodic waves — for example, periodic waves on coils — and we would have the same relation $v = f\lambda$.

Now we come to the advantage of the above relation for the measurement of v. Imagine that instead of watching the wave continuously we look at it through a shutter which is closed most of the time and opens periodically for short time intervals. The stroboscope described in Chapter 2 is such a device. The first time the shutter opens we will get a glimpse of the wave pattern in a certain position. During the time the shutter is closed, all of the pulses will move a distance equal to their



17–11. Periodic circular waves.

speed times the time the shutter is closed (Fig. 17–12). If we look through the shutter while it is periodically opening and closing, the pattern will usually appear to move. Suppose, however, that the period of the shutter is just the same as that of the wave. Then, during the time the shutter is closed, every pulse just moves up to the position of the pulse ahead of it, and we see the same pattern every time the shutter opens. That is, we

17–12. Crests of a periodic wave seen at successive openings *A* and *B* of a stroboscope shutter. In the top diagram the frequency of the stroboscope is greater than that of the waves. At the bottom, it is the same. The dashed lines, of course, are not visible.