APPARATUS AND METHODS EMPLOYED AT THE MARINE FISH HATCHERY AT FLÖDEVIG, NORWAY

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The main point in artificial propagation of marine fishes is to hatch the greatest possible number of fry at the least expense. To attain this end the spawning fish must be treated so that they can yield the greatest number of well-developed eggs; the fertilization must be perfect; the incubators must be able to hatch the greatest number of fry in the smallest space, must be easy of access, and easily cleaned. The following description of the Flödevig hatchery for salt-water fish will show how far the above-stated conditions have been attained.

Main features of equipment.—The Flödevig hatchery is situated on the seacoast near Arendal, Norway. The principal parts are a main building, having on the lower floor 42 hatching apparatus, a water wheel, and an aquarium, and on the upper floor, an office, laboratory, egg collector, etc.; an engine house with boiler and pump capable of delivering about 100,000 liters of sea water per hour; a spawning pond, dimensions 19 by 6 by 3 meters; and a larger pond 34 by 22 by 5 meters, used as a reservoir for sea water. (Fig. 1.) These several parts will be more fully described later on.

Beginning the season's work.—When the spawning season commences, early in February, the pump is set going and the ponds filled with sea water. To insure as far as possible a high and uniform salinity, the water is pumped up from the bottom of the bay, a depth of about 8 fathoms. If the weather has been cold, the concrete walls of the ponds will have a temperature below freezing point; and if so, the pumping must go on for several days until they have the same temperature as the water pumped in.

The spawning pond must be covered to keep out snow, rain, and to some extent, light. Direct sunlight is apt to blind the fish.

The spawners and the spawning pond.—When the pond is in order, the spawners are put in and may now be left to themselves. The proportion between male and female is something like 1 to 4. The fish must be fed regularly, say three or four times a week. Herring are chiefly used, but other fish containing much oily matter, as saithe, whiting, or haddock, are preferable. The pond at Flödevig will hold about 350 cubic meters of water,

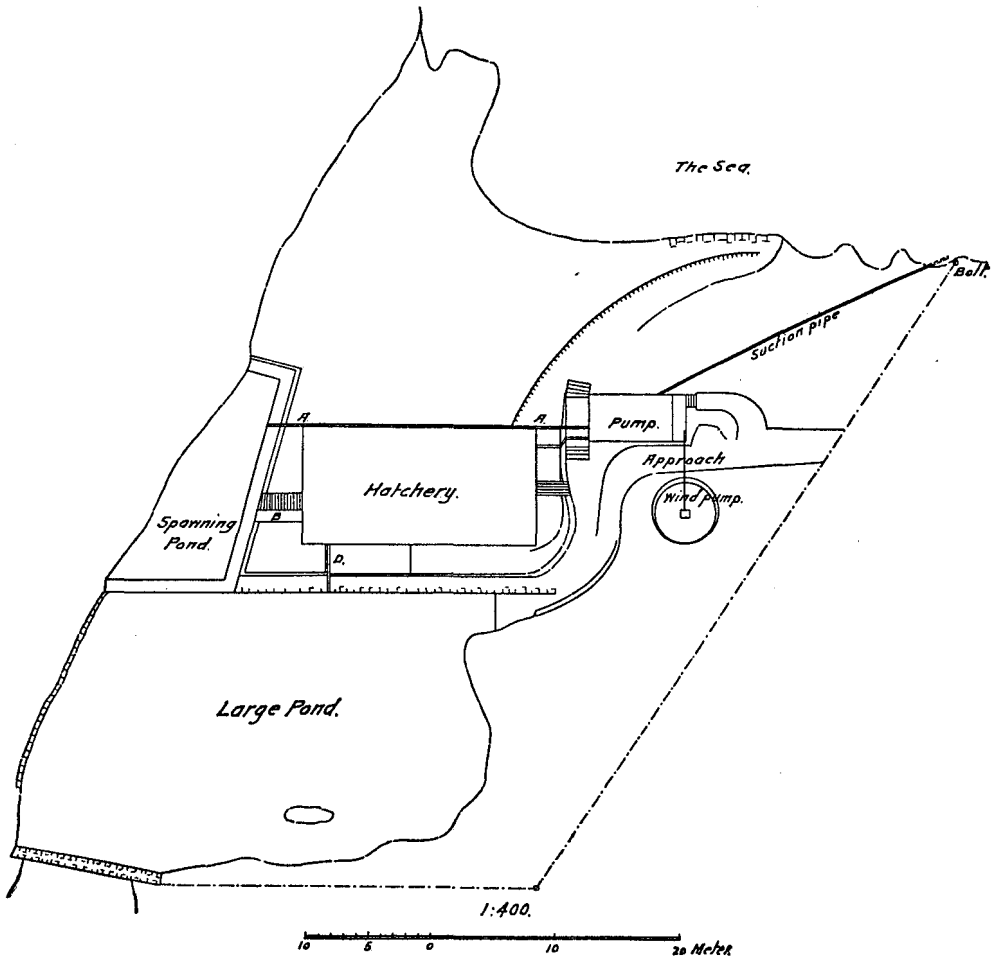

FIG. 1.—Plan of Flödevig hatching station.

sufficient for about 2,000 spawners of medium size. The water supply must be regular and proportionate to the number of fish—at Flödevig 30,000 to 50,000 liters per hour.

In feeding the fish a certain quantity of food and offal will sink to the bottom, and together with unimpregnated eggs, excrement from the fish,

etc., pollute the bottom layer of the water. To prevent the spawners from coming in contact with this the pond is provided with a wooden flooring, about 1 foot over and above the highest part of the bottom, and with a

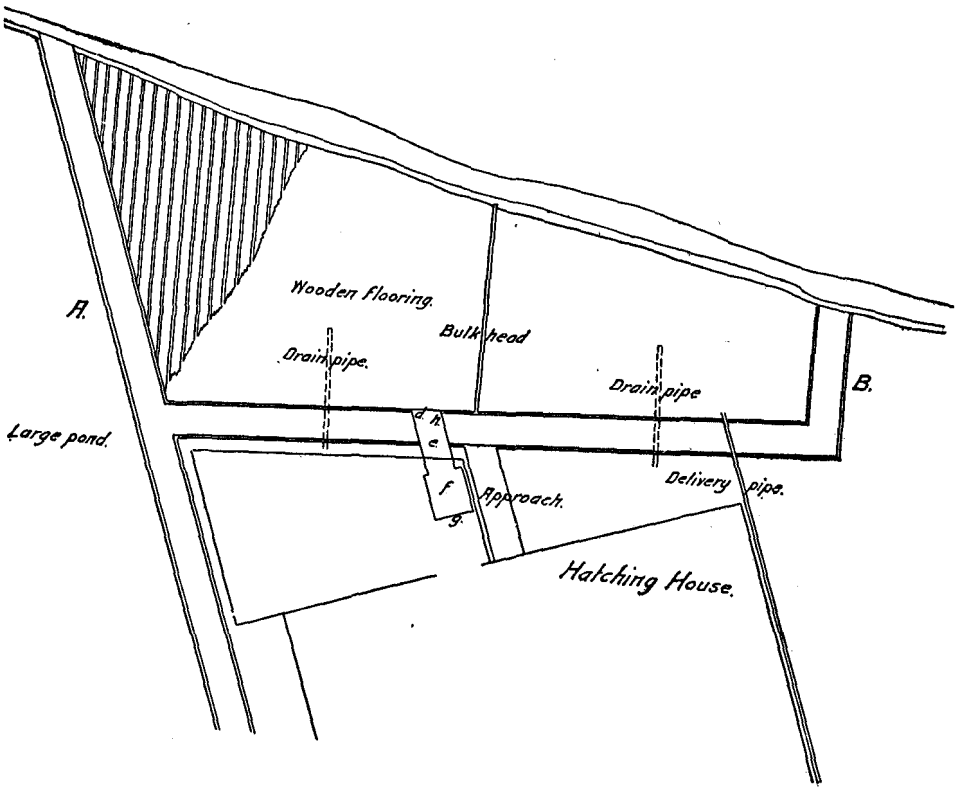

FIG. 2.—Spawning pond. (Plan.)

space between the boards of about 1½ inches. Through these openings the impurities will sink down into a sort of funnel-shaped cellars, provided with

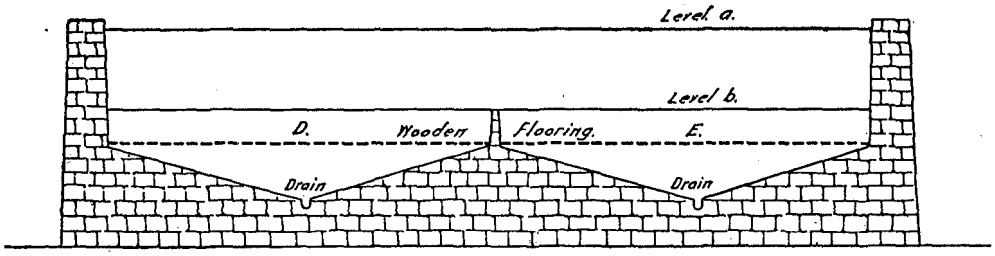

FIG. 3.—Same as figure 2, showing section A–B.

4-inch drainpipes in their lowest part. (Fig. 2 and 3.) These drains are opened about a quarter of an hour every day. In spite of these precautions, however, the bottom water will, after a time, be contaminated to a

degree that becomes dangerous to the fish, and a thorough cleaning out becomes necessary. This is effected in the following manner:

The drains are opened and the water, the surface of which usually is at level *a*, is allowed to run out till it reaches level *b*. (Fig. 3.) The pond is then, by the watertight bulkhead, divided into two compartments, *D* and *E*, and with a number of fish in each compartment. Supposing *D* is to be cleaned first, the water in *E*, under continual renewal, is kept level with the top of the bulkhead, while it is lowered still more in compartment *D*, until about 1 foot above the flooring. The fish are then caught with dip nets and lifted over the bulkhead into *E*. After this is done, all the water is let out from *D*, and the place scrubbed and washed thoroughly. To facilitate the work, the middle part of the flooring ought to be made like a hatch to be lifted off, as cleaning underneath is necessary.

After cleaning, compartment *D* is filled again, the fish lifted in, and *E* cleaned out in the same manner. How often this is to be repeated depends on the number of fish in the pond, the nature of the food, and on the specific gravity and temperature of the water. I have never had occasion to do it more than three times in the season; usually once or twice.

The spawning.—With the exception of the necessary handling when cleaning the pond, the spawners need not be touched during the whole season. If properly fed, and with a constant renewal of the water, they soon will become accustomed to their prison life, and in a short time be so tame that they will take food out of the hand. Consequently the fish will thrive well, and the development of the reproductive organs, as well as the spawning, will proceed in the ordinary manner, just as if the fish were living under natural conditions.

The pond, however, has one great advantage. All the eggs are sure to be impregnated, as the whole volume of water, practically speaking, is filled with sperm, a result of the great number of spawners crowded together in a narrow space.

The cod generally spawn in the evening between 8 and 11 o'clock, and, provided the water has a specific gravity of 1.021 or more, the eggs will float up and form a thin layer on the surface of the pond.

Collection of the eggs.—I have mentioned above that the pond receives from 30,000 to 50,000 liters of water per hour. The outlet is shown at *d* (fig. 2), and is formed as a depression or cut in the front wall, 3 feet wide and 1½ feet deep. Its continuation is a wooden chute *e* of the same dimensions leading into a receiver *f* somewhat broader and deeper than the chute. From this the outflow is through an iron pipe *g*, placed so that its upper end regulates the height of the water in the pond. (See also fig. 4 and 5.)

In the receiver *f* the egg collector (fig. 1, pl. CI) is placed in such a manner that its open end fits exactly to the open end of the chute. The bottom and

back end as well as both sides of the collector are covered with silk gauze no. 40. All water coming from the pond will thus have to flow into the collector, and as this will act as a strainer the eggs will be kept back, while the water continues its course through the gauze netting toward the overflow pipe *g*. As the opening in the wall as well as in the chute is deep and wide, the outflowing current would be too slow to bring all the eggs in the pond into the collector in a

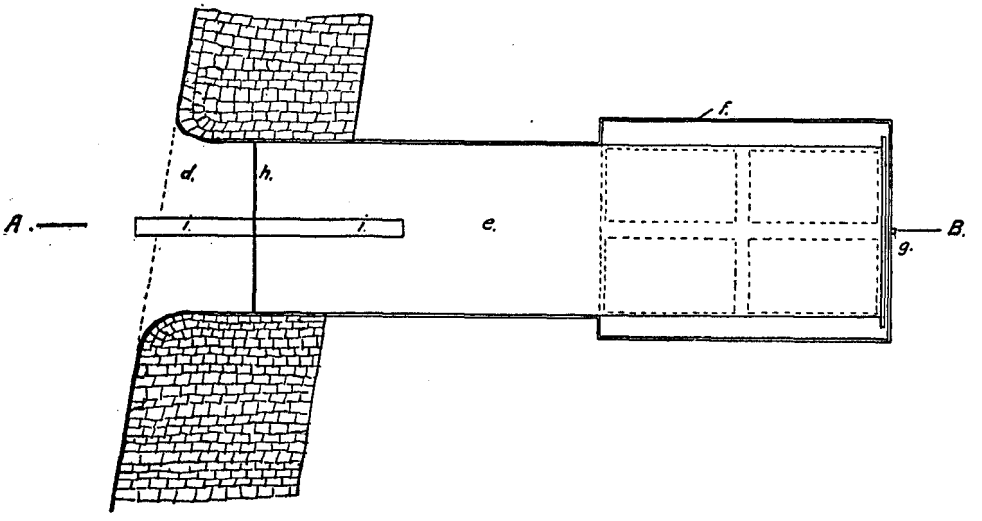

FIG. 4.—Device for installation of egg collector. (Plan.)

reasonable time. To remedy this, a partition or dam has been placed at *h* (fig. 4 and 5), and at the same height as the upper end of the overflow pipe. Instead of a slow current 18 inches deep, we will now have a strong current half an inch deep, and as the eggs float at or near the surface of the water, all of them will in a short time, say two or three hours, be drawn into the collector.

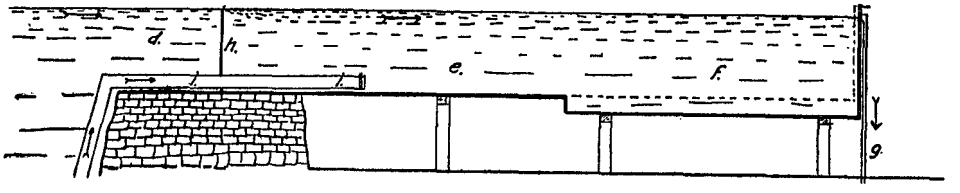

FIG. 5.—Same as figure 4, showing section A-B.

I have mentioned above that the cod spawn in the evening. Consequently all the eggs would be in the collector at about midnight, and have to remain there crowded together till the men arrive in the morning. As this is not desirable, the surface outflow is stopped in the evening and the wooden pipe (fig. 2), which draws the water from a greater depth, is opened, and thus the eggs will remain quietly at the surface of the pond till morning when the surface current is turned on again by closing the wooden pipe.

Cleaning the eggs.—It can not be avoided that a certain quantity of fatty matter, always floating on the surface of the pond, will be drawn into the collector along with the eggs, and form a layer on top of the water. The greater part of it can easily be removed with a stick passed horizontally along the surface, but some will always be left and have to be taken up along with the eggs, in the sort of shovel, covered with silk gauze, which is used for this purpose.

The eggs and whatever is mixed with them are put into an oval bath or a similar vessel, not too deep, and with just enough water to keep them floating. Fresh water is then poured on, which causes the eggs to sink, while the fatty matter remains at the surface. This is poured off, fresh water again added,

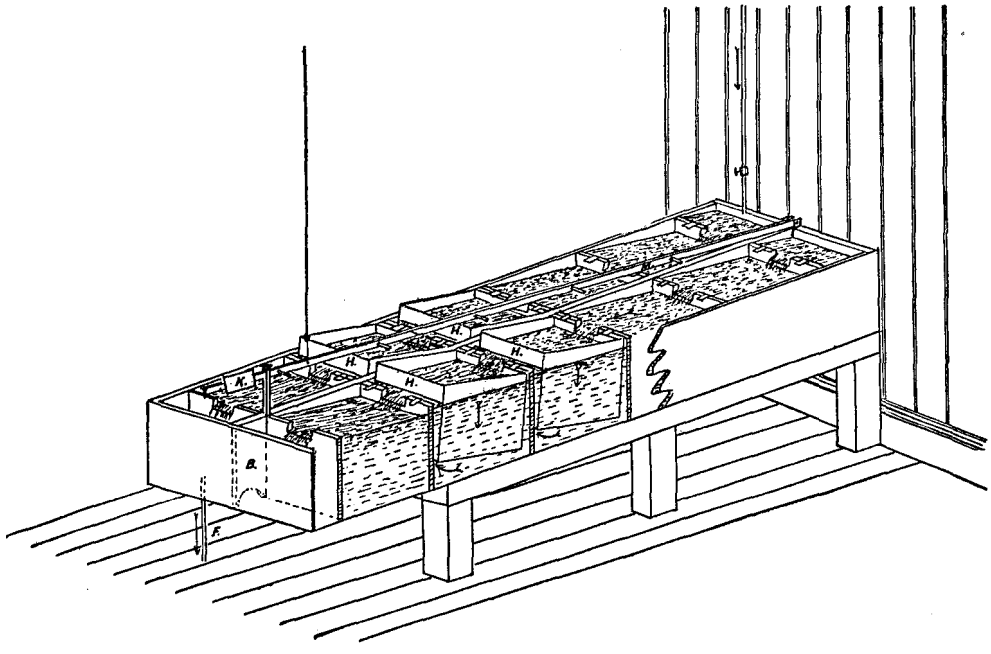

FIG. 6.—Hatching apparatus.

and when this process has been repeated two or three times, the eggs will be clean. After this the vessel is filled with sea water, and, if necessary, a little salt is added. The eggs will now float at the surface and may be taken out and measured as usual. The collector has to be taken out and cleaned one or two times a day.

The hatching apparatus.—If cod eggs were scarce and difficult to obtain, the main point would be to hatch the greatest possible per cent of the eggs. As this is not the case, the question must be to hatch the greatest number of fry for area of hatchery and hatching apparatus, and at the least possible expense. It is from this point of view that the methods used at Flödevig have been invented. The hatching apparatus shown in figure 6 is 7 feet 6 inches

long, 2 feet 3 inches broad, and 11 inches deep inside. By a partition board in the middle it is divided lengthwise in two compartments. These are again divided crosswise in 7 compartments each, the first and last pair being 4 and the others 15 inches long. They are all watertight with the exception that the smaller ones communicate with each other through an aperture in the center-board *B*.

In the top of each of the transverse boards is a depression 1 inch deep and 3 inches wide, into which is fixed a brass spout (fig. 8).

The egg box, or incubator, shown in figure 7, is 12½ inches long, 11½ inches wide, and 10½ inches deep, and made of five-eighths inch white pine. The bottom is covered with silk gauze. It has, similar to the partition board, a depression in the upper edge, also fitted with a brass spout, just large enough to pass outside the former. The incubator is hinged to the transverse board as shown in figure 8.

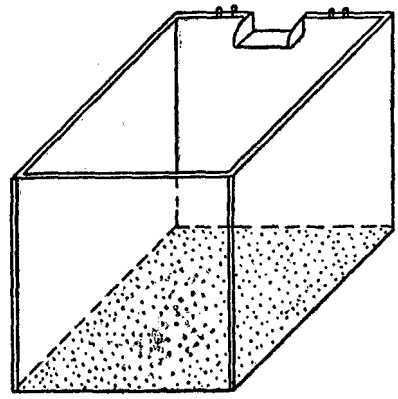

FIG. 7.—Egg box, or incubator.

When the apparatus has been placed in position—slanting 3½ inches—and the water turned on, the small compartments become filled, after which the water passes through the spouts into the next compartments, and so on until the whole of the apparatus is full and the superfluous water escapes through the drain *F*.

As the incubators are made of light wood the loose end will float up and have a position as shown at *H*, figure 6. The circulation of the water after the

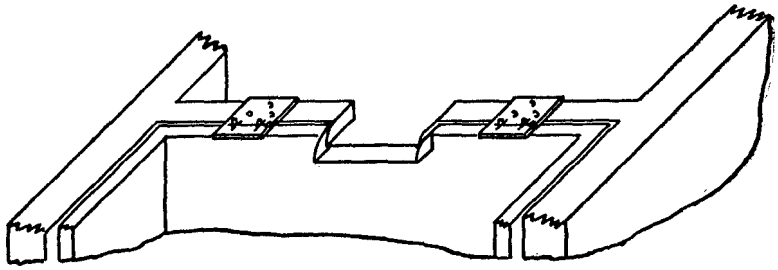

FIG. 8.—Mode of fastening incubator.

apparatus is set going is shown by arrows. As the current is regular, eddies will be formed and the eggs be crowded together in the dead corners, where a great many would die from suffocation. To avoid this an up-and-down movement of the loose end of the incubators has been contrived in the following manner:

An iron rod (*M*), a couple of inches shorter than the apparatus, is joined to this at the upper end and passes down the center between the series of boxes.

It has five transverse pins, resting on the free edges of the boxes, and is weighted sufficiently at *K* to keep the boxes down in the water. On the contrary, when the rod is raised the boxes will float up. The movement of the rod is brought about by an eccentric (fig. 2, pl. CI), which revolves about twice in a minute and is so arranged that the rise of the rod is slow, while the drop is sudden. This up-and-down movement of the free end of the incubators will make the current irregular, break up the eddies, and keep the eggs in continual motion. The eccentric wheel is driven by a waterwheel that utilizes the outflow water from the egg collector described above.

Hatching.—The usual quantity of cod eggs put into each of the small boxes is 1½ liters, equal to 675,000. The quantity may be raised to 2 liters, but this is rather too much if the specific gravity of the water is low, which very often is the case on this coast. To avoid difficulties in this respect, the water for the hatching boxes is never taken direct from the pumps but from the large pond, which is used as a reservoir and has its overflow pipe placed in its lower part. A temporary fall in the salinity of the water in the sea, even for several days, will by this arrangement hardly be felt. About three days after the eggs have been placed in the incubators, the dead ones will have fallen to the bottom and a cleaning out becomes necessary. This will have to be repeated at intervals as may be required and is easily done, as the incubators can be unshackled in a moment and the eggs are very hardy, so no great care is needed.

When the eggs begin to hatch, the incubators will have to be watched more closely, as the empty shells are apt to fall to the bottom and clog the netting, and a cleaning every day then becomes necessary. At this period great care is needed, as the fry are very tender. The number of days required for hatching the eggs varies according to temperature; at 3° C. to 4° C. the fry will be out in twenty to twenty-five days. The loss in the apparatus during hatching depends very much on the specific gravity of the water, and on the whole the net output of fry will vary between 60 and 65 per cent. The fry are liberated when 5 to 6 days old.

Cost of hatching cod eggs.—As the Flödevig hatchery has been rebuilt and altered several times, it is rather difficult to say how much money has been spent upon it. With the present prices of work and material I should say that a similar station in full working order could be put up for about $5,500. The cost of productions was for the first year about $60 per million of fry, but this price was soon reduced to one-fifth, and at present the fry can be hatched for about $6 per million. In this price everything connected with the work is included.

In 1898 the hatchery produced 412,000,000 of fry from 1,312 liters (590,000,000) of eggs, and under ordinary circumstances and with an expenditure of 12,000 kroner, or $3,150, a similar quantity could be produced every year.

Conclusion.—The above description refers to the Flödevig hatchery in its present state. It would be a long story to mention all the experiments, successful or otherwise, which step by step have led to the present condition of affairs. It is sufficient to say that improvements have been made from year to year and are still going on, so that the Flödevig hatchery, instead of being regarded as an old institution, rather must be looked upon as a growing concern, capable of further development. If the great expectations so justly combined with the question of artificial propagation of marine fishes shall ever be realized to their full extent, the work must be carried on upon an immense scale, and this will first be possible when the expenses have been reduced to a minimum.

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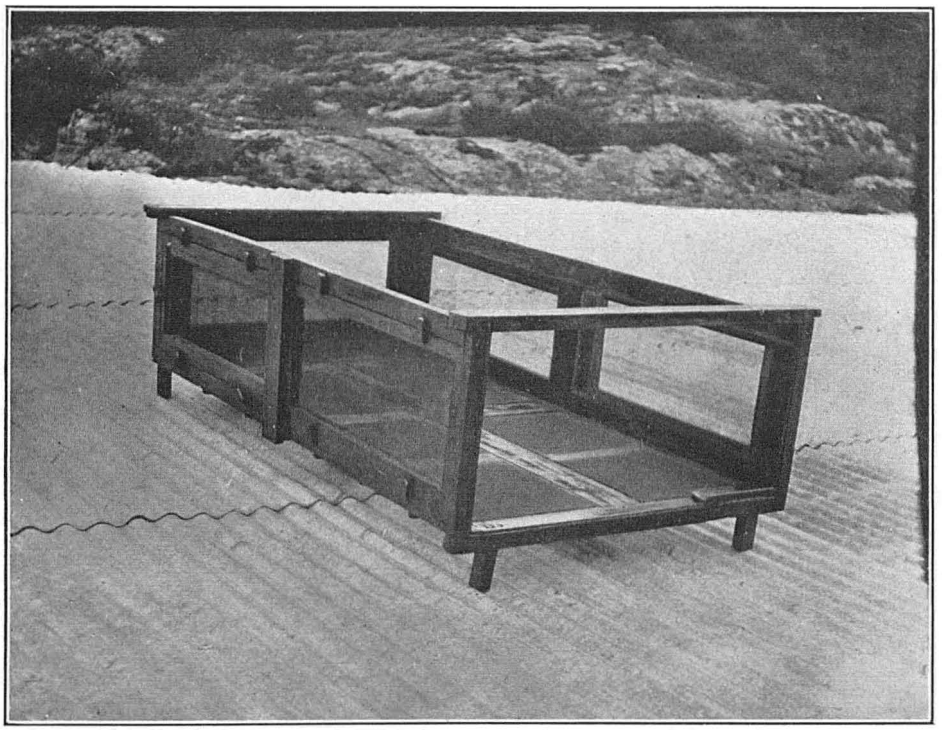

FIG. 1.—Egg collector used at Flödevig, Norway.

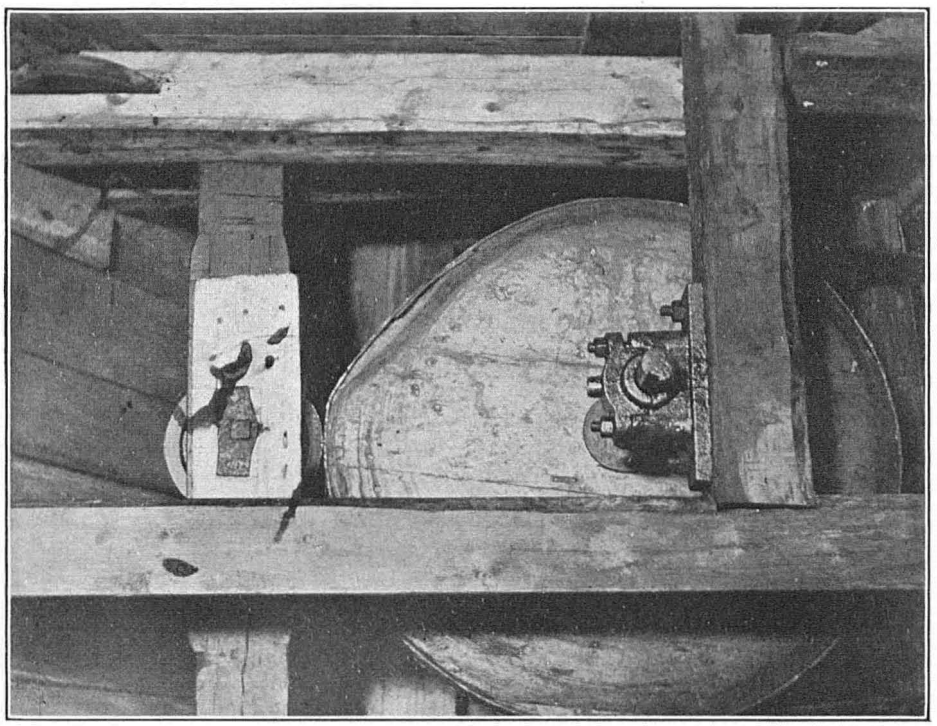

FIG. 2.—Eccentric wheel providing circulation of water in hatching boxes. Flödevig, Norway.