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PLANKTON HARVESTING

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During the past several years proposals have been made from time to time that new sources of either bulk food material or specialized extracted products could be developed if it were possible to utilize the tremendous amounts of plankton which exist in sea water, thereby increasing the general supply and alleviating certain shortages. In all theories or ideas regarding the utilization of plankton as a source of food, the primary obstacle has been the means of collecting it. Clarke (1) estimates that a townet 2 meters in diameter, towed at a speed of 2 knots, would require a $2\frac{1}{2}$ hour period of filtering to collect the necessary organic matter to maintain a person one day. Hardy (2) thinks of plankton collecting with "huge stow nets" which have openings 18 feet square and bodies of 100 or more feet in length, streamed below an anchored boat or from the anchor chains of buoys. Juday (3), in his discussion of the utilization of aquatic food resources, with particular reference to fresh water plankton, considers collecting with "a large clarifier type of centrifuge at a rate of 1.5 cubic meters in two hours."

During 1942 the writer conducted a series of experiments with a view to designing a device which would permit the collection of plankton in large quantities with economical time and cost factors. At the beginning of the experiments townets, sand filters, flocculation and settling techniques as well as centrifugal devices were tried. These were rejected as impractical for either physical or economic reasons, or both. The requirements of a collecting system should be sturdiness, continuity of operation, relatively low cost from the standpoint of either original installation or maintenance, and the capacity for handling large quantities of sea water in a reasonable length of time.

The device which finally evolved meets most of the above requirements and is shown schematically in Figure 45. Fundamentally it

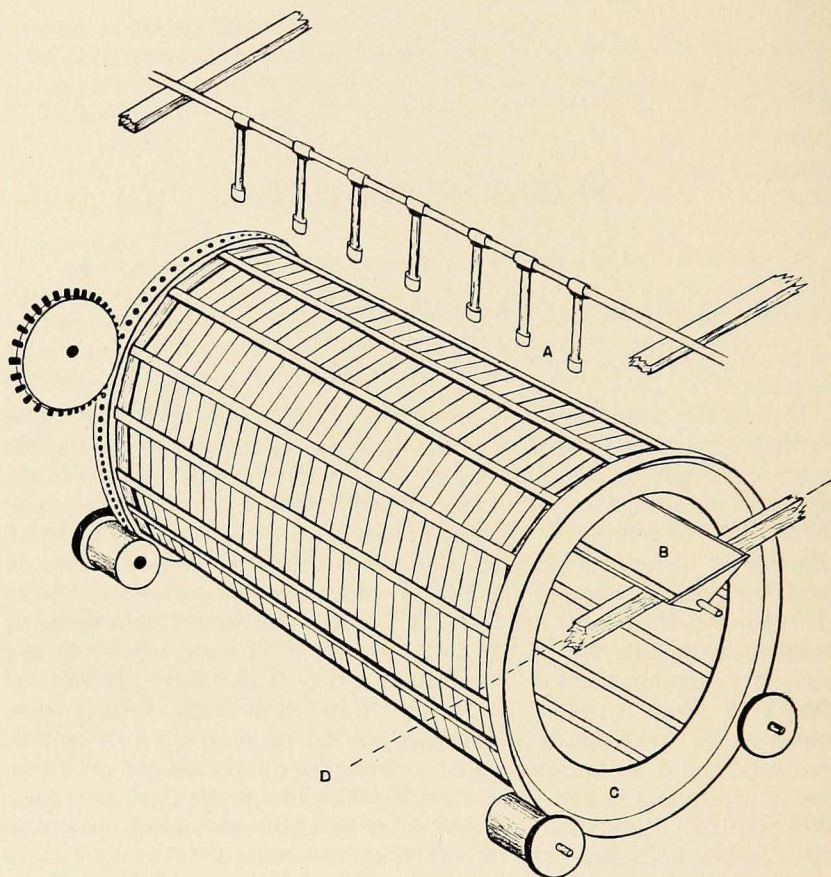


Figure 45. Freehand sketch of plankton harvesting machine. (A) spray nozzles; (B) collecting trough; (C) Flange to prevent backwash; (D) water line. Drawn by Y. H. Olsen.

consists of a large rotary screen, open at one end and closed at the other. Its sides are covered with a screen material. It is placed in the water so that its longitudinal axis is horizontal, and its open end is directed against either the existing current or one that is created artificially. Water entering the open end of the screen passes out through the sides and the plankton in the water stick to the inside of the screening material. By rotating the screen, each successive portion of the rotary screen to which the plankton is adhering is passed beneath a series of inwardly directed sprays. These sprays backwash the screening material into a trough. Various investigators have

estimated that the usual tonet used in scientific collecting is reduced to less than one percent of its filtering efficiency at the end of 3 minutes due to the plugging of the meshes by the plankton. This difficulty is obviously avoided in the rotary screen. It is turned at the rate of about one revolution per minute. If the screen is two-thirds submerged, then any given portion of the screen is under water for only 40 seconds, and consequently still has a comparatively high filtering efficiency as it emerges from the water.

Spray nozzles used with the screen were constructed so as to provide a thin flat spray of comparatively high velocity and low volume. A collar-like baffle reduced the aperture of the open end of the screen and prevented the entering water from washing back out. When operated in a current or a tideway, the only power used in the experimental models constructed so far was that required to rotate the screen and to drive the pump supplying water to the spray nozzles. It is conceivable that the use of a helical fin on the outside of the screen could eliminate even the power required to rotate it.

The first model rotary screen which the writer constructed was 4 feet in diameter and 4 feet long. It was covered with No. 15 triple X bolting cloth having 150 meshes per inch. Volumes of water up to 5,000 gallons per minute with a gradient of less than 1 inch through the screen were handled. The screening material was sewn to cotton tapes to form panels 48 inches long and 10 inches wide. The cotton tapes were used to fasten the panels to the frame work of the screen itself. As an added strengthening feature, linen cord was wrapped around the screen over the silk, successive turns being spaced from $1\frac{1}{4}$ inches to $1\frac{1}{2}$ inches apart. The screen was supported upon two trunions at each end and rotated by a sprocket which engaged in a ring fastened around one end. The screen was operated first in a brine canal having a velocity of about 2 feet per second. The screen with its mountings and spray nozzles was installed subsequently in a large wooden box which was provided with suitable weirs and manometers. The water that was filtered was pumped into this box in order to obtain accurate quantitative data on the amount of water filtered by the screen, and to estimate the efficiency of the screen as a filtering device. Table I shows the results of actual tests of the operation of this model.

A second model, 8 feet in diameter and 16 feet long, was constructed and suspended in a well in a large float. It was operated in a tideway and was provided with a motor-driven propeller at the mouth of the screen which forced water into it during that portion of the day when there was inadequate tidal flow. It was estimated that this 8 x 16

TABLE I—PLANKTON COLLECTION CONDITIONS AND YIELDS

Filter Run No.	Sept. 1942	Temperature		Wind		State	Sea	
		Sea	Air	Direction	Force		Degree	Direction
24	4	25.5	26.0	NE	0-1	Smooth	0-1	E
25	4	25.6	27.2	N	0-1	Smooth	0-1	NE
26	8	25.2	26.4	NW	0-1	Smooth	0	—
27	9	25.5	26.0	ENE	0-1	Smooth	0-1	—
28	10	25.4	26.0	W	0-1	Smooth	0-1	W
32	14	25.6	27.0	W	0-1	Smooth	0-1	W

* These data were obtained when the screen was operated in conjunction with a pump having a rated capacity of a thousand gallons per minute.

Tide Condition	Condition	Sky		Total Weight	
		Type	Extent	Flow Gallons*	Wet Cake in grams
Flooding	Overcast	Cumulus	4	32384	1021
Flooding	Overcast	Cumulus	8-9	32384	1214
Ebbing	Cloudy	Cumulo-stratus	4	48576	1279
Ebbing	Cloudy	0		23074	2546
Ebbing	Cloudy	0		12144	1529
Flooding	Cloudy	Cumulus	1-2	16192	1474

foot screen had a filtering capacity on the order of 25,000 gallons of water per minute, when properly backwashed and rotated at a rate of one revolution per minute. Spray nozzles were spaced about 9 inches apart so that the fan-shaped sprays from individual nozzles slightly overlapped. Pressure to the spray nozzles was about 45 pounds per square inch. Flow through the individual nozzles was approximately 2 quarts per nozzle per minute.

A second screen 4 feet in diameter and only 15 inches long provided with two spray nozzles was used in tandem with the 8 x 16 screen, thus providing a second concentrating step. The almost gelatinous material coming from the trough of the second concentrating screen was pumped through a 12 plate filter press, each plate having an area of 144 square inches. Cake from the filter press was subsequently treated chemically.

It is believed that a device such as this rotary screen provides a practical means of harvesting plankton economically.

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