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DEPARTMENT OF THE INTERIOR

SOLAR STILL CONSTRUCTION

BY

NEW YORK UNIVERSITY

UNDER CONTRACTS NO. 14-01-001-68 AND 102

OFFICE OF SALINE WATER

RESEARCH AND DEVELOPMENT PROGRESS REPORT NO. 33

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DEPARTMENT OF THE INTERIOR

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SALINE WATER RESEARCH AND DEVELOPMENT PROGRESS REPORT NO. 33

SOLAR STILL CONSTRUCTION

BY

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FOR

OFFICE OF SALINE WATER

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AUGUST 1959

FOREWORD

This is the thirty-third of a series of reports designed to present accounts of progress on saline water conversion with the expectation that the exchange of such data will contribute to the long-range development of economical processes applicable to large-scale, low-cost demineralization of sea or other saline water.

Except for editing, the data herein are as contained in reports submitted, by New York University under Contract No. 14-01-001-68 and 102 covering research carried out through December 31, 1956. The data and conclusions given in this report are essentially those of the contractor and are not necessarily endorsed by the Department of the Interior.

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SOIAR STILL CONSTRUCTION

1. Introduction

The following specifications and design of solar stills is the final conclusion of previous R&D Reports (13 and 31). Additional material of pertinent interest is presented in "Solar Still Theory and New Research" which appeared as part of the Proceedings of the 1957 Symposium on Saline Water Conversion (publication No. 568, National Academy of Sciences).

It is recommended that persons engaged in construction of solar stills described in this Report, should read the above mentioned previous Reports, to avoid duplication of efforts which have been already made previously.

It should be mentioned that the basic principles of the inflatable, floating still, - used as emergency equipment for aircraft, - have been described by the writer (R&D Report No. 13).

2. The amount of solar radiation and the water yield

The Weather Bureau measures the daily amounts of solar radiation, - received on a horizontal surface. Monthly averages have been computed, as shown in Table 1 for Miami, Florida. The location of the test installations of the Office of Saline Water at Daytona Beach, Florida is sufficiently close to Miami that the Miami irradiation data can be used. As a matter of fact, according to Visher's Climatic Atlas solar irradiation is somewhat less at Daytona Beach, particularly in the winter. '

Tilted surfaces receive more solar radiation than horizontal surfaces. The year-around "optimum tilt" of a surface for solar energy interception (leaving out the effect of atmospheric absorption and scattering) is equal to the geographical latitude. In Florida a tilt of 25° from the horizontal, facing South, should produce the most favorable conditions. Table 1 shows the results of calculations for this angle.

The theoretical maximum water yield can be computed by using the factor of 1070 BTU per pound of water, assuming that the total amount of solar energy can be used for evaporation at 100 percent efficiency. This efficiency cannot be attained by single effect stills, due to inherent losses in:

(a) Transmission and operational heat loss.

(b) Heating of excess feed water (although this can be partly eliminated with heat exchangers, preheating the feed water).

Approximate calculations, converting solar radiation measurements from horizontal data to 25° tilt, indicate that as a yearly average 20% more distillate can be expected with solar stills tilted at 25°. During the winter months the yield is more than 50% greater.

Table 1

Average daily solar radiation Btu/sq. ft. on horizontal and 25° tilted surface, at Miami, Florida, and the maximum theoretical water yield of solar stills, calculated on the basis that the efficiency is 100%, when one pound distilled water requires 1070 Btu.

Month	Average Solar Radiation Btu/sq. ft. day Horizontal (measured)	25° Tilt (Approximate calculation)	Calculated at 100% efficiency, daily water yield per sq. ft. Horizontal	25° tilt
Jan.	1100	1700	1.03	1.59
Feb.	1284	1750	1.19	1.64
Mar.	1535	1860	1.43	1.74
Apr.	1756	1880	1.64	1.76
May	1852	1860	1.73	1.74
June	1771	1760	1.66	1.65
July	1749	1760	1.64	1.65
Aug.	1716	1860	1.60	1.74
Sept.	1528	1860	1.43	1.74
Oct.	1351	1850	1.26	1.73
Nov.	1232	1730	1.15	1.62
Dec.	1085	1700	1.01	1.59
Yearly Average	1497	1800	1.40	1.68

It should be emphasized that 100% efficiency is, of course, not obtainable, with single effect solar stills, or with any fuel operated single effect still. Multiple effect stills reuse the heat, released during the condensation of distilled water, and, therefore, they can be more efficient.

The highest efficiency, - experimentally obtained by the writer and reported by others - is around 72% during the noon hours on clear days. The average daily efficiency is around 60 to 65% on clear days, with tilted stills of best design. Horizontal stills of "roof-type" construction may reach an efficiency of 67% on clear days around noon hours, but the average efficiency is lower for the entire day.

The efficiency should be computed by measuring (with a pyrheliometer) the total daily amount of solar radiation falling on the solar still, or reflected to it by mirrors, or other reflecting surfaces. The total solar radiation, expressed in Btu's should be compared to the amount of distilled water produced during the entire day, using the factor of 1070 Btu per one pound distilled water.

3. Structural components of the single effect solar still

Solar stills of any design have the following structural components:

(1) Framework and stand.

(2) Condenser, which can be the entire surface envelope of the still, or part of it.

(3) Evaporator, which is generally the absorber of solar radiation.

(4) Saline water feeder.

(5) Brine collector.

(6) Distilled water collector.

Accessory devices include the following:

(7) Saline water storage tank, pump and flow regulator.

(8) Brine collecting device.

(9) Distilled Water collecting device.

Measuring devices are needed to determine the:

(a) Amount of saline feed water.

(b) Amount of distillate.

(c) Amount of brine.

(d) Amount of solar radiation.

Additional records may be made of the daily temperature, wind velocity, rainfall. Occasional temperature measurements may be made of various parts of one section of the still, to establish temperature relationship with wind velocity and solar radiation, if this is desired.

The major decision to be made is the selection of the solar radiation transmitting part, which is in itself part of the condenser. This part must have the following properties:

Highest transmission for solar radiation.

Low transmission for heat reradiation.

Perfect water wettability.

Durability and weatherability under continuous exposure to wind, sun, dust.

Relatively low cost.

Light weight and low transportation cost.

Glass meets all these requirements, except the last one.

Plastics have been tested by contractors of the Office of Saline Water, with results that indicate the need for improved film materials, which should be durable, weatherable and water-wettable. A Florida "life" of at least 10 years would be desirable, at a cost which is not greater than that of glass. Water-wettable surfaces have been produced by various coating methods, but their "life", weatherability and durability should be subject to further prolonged tests.

For these reasons glass is recommended as the solar energy transmitting surface. The use of glass requires rigid frameworks and rigid supports, which in turn establish the design, as outlined in the following specifications.

4. Glass covered flat, tilted solar still

The attached drawings show the structural components and their relationship. Specification of the components is given in detail.

(1) Framework and stand:

The framework of the still is made of 1" x 4" structural lumber (actual dimensions 7/8" x 3-5/8"). Redwood is used, because it is durable. The frame is made to support 4 glass panes, each 24" x 36", resting in recessed channels cut into the wood. Each frame is made of:

2 side pieces, each 7' 11.5" long

top and bottom pieces, each 36.75" long.

The frame is assembled with waterproof adhesive and brass wood-screws, as shown.

The stand is made of concrete posts, sunk into the ground. Rust resisting mounting bolts are used to fasten the frames to the posts. The posts are connected with 2" x 4" structural lumber as support for the backs of the stills. Pairs of stills are mounted closely together, at a tilt of 25° from the horizontal. At the posts air spaces are left to diminish wind resistance.

(2) Condenser:

The front of the condenser is made of 24" x 36" glass panes. Preferably window glass of low iron content should be used, as fabricated by St. Gobain Company, Pittsburgh, Pa.

In experiments carried out in New York and Long Island, single-strength glass was used, which is available in larger quantities at a cost of about 12 cents/sq. ft. For more permanent installation, double-strength glass is recommended. The price of the glass varies greatly. If it is obtained directly from the factory, double-strength glass costs about 18 cents per sq. ft.

The glass is placed directly into the recessed channel, cut into the supporting wood, with the exception of the bottom edge, which is closed with U-shaped gaskets. (Saran glass mounting strip, made by Dow Chemical Company.) The glass is attached to the sides and top of the frame with redwood strips, 1.2" x 1", with brass wood-screws.

The glass panes are aligned together with butt-joints. The joints are covered with Weatherable Mylar tape, made by Permacel-LePage's, Inc., New Brunswick, New Jersey.

The glass must be entirely clean before the tape is applied and should not be wet, otherwise the tape does not adhere. It is essential that the glass edges should fit together, without any space, or dirt between the edges. After the tape is mounted it should be pressed to the glass and the still should be left under the sun, without being fed with water for at least 4 hours. During this time the tape is heated and "sets", adhering very firmly to the glass.

The back side of the condenser is made of aluminum, forming a pan to fit the opening of the wood frame. The pan is made 3-5/8" deep to fit the frame. The edges of this pan are folded ("bread-pan" fold) to eliminate leaks. The back outer surface of the sheet aluminum is painted white, to protect it against atmospheric corrosion and to increase heat loss from it. The top edge of the pan is in close contact with the glass cover. On the bottom side of the still the aluminum is made longer to fold over the top of the wood frame. This part collects and channels away any rain water. The bottom mounting U-gasket, around the edge of the glass, presses against the aluminum pan, forming tight closure. At one corner of the lower bottom edge of the pan an outlet tube of 1/4" inside diameter is attached, by any leak-proof manner, to permit outflow of the distilled water.

(3) Evaporator - absorber

The evaporator absorber is made of black "Chromspun" acetate fabric, which does not fade under sunlight. (Made by Eastman Chemical Products, Kingsport, Tenn.) This material is available either as woven cloth, weighing 3 to 4 ounces per sq. yard, or as nonwoven material at a cost of 2.5 to 5 cents per sq. ft. The fabric is 36 inches wide, shrinks slightly when wet and "crinkles", which is helpful in distributing the saline feed water over the entire evaporator surface.

The fabric is mounted on the evaporator support, made of 0.020" thick sheet aluminum 36" wide, 8 ft. long. The support is folded upward, with 1/2" edges, to fit the 35" wide opening of the frame. The upturned edges are attached with aluminum screws to the sides of the frame. The top edge of the sheet is folded, to reinforce it, while the bottom is folded to form the brine collecting channel. A clearance of one inch is left between the top and bottom edges of the support and the frame, to provide for air and vapor circulation. On the front side the support is coated with flat black paint and a thin film of MYLAR (0.001", possibly thinner) is laminated to it with Mylar cement (Bond-Master L-218) made by Rubber and Asbestos Corporation, 225 Belleville Avenue, Bloomfield, N. J.

The purpose of the Mylar coating is to prevent corrosion of aluminum by saline waters. Any other saline water resistant coating of black color can be used, provided it is durable. The edges of the black fabric can be cemented to the Mylar cover of the aluminum sheet, to prevent slipping.

(4) Saline water feeder

Saline water is piped from the storage tank through a main distributing pipe, made of black, rigid plastic material, capable of resisting corrosion. The pipe has branch outlets of 1/4 inch inside diameter at each still frame. The pipe is fastened to the lower bottom edge of the stills, with corrosion resistant clips. The outlets are connected to flexible vinylite tubing, (1/4" i.d.), passing through a hole, drilled into the bottom part of the frame. The tubes are placed into the brine collecting channel and serve the purpose of preheating the saline feed water, with the heat of the brine. The feed tubes are led upward, under the black fabric of the evaporator, terminating in a glass capillary, which is attached firmly, and placed into the saline water distributing channel.

The capillary is the flow rate governor, as described in greater detail in R&D Report No. 31. It operates by using the fluidity of the water, which increases at higher temperature, when more water flows through the capillary. When the sun does not shine, the feed water is colder and therefore less water will flow into the feeding channel, in proportion to the amount of sunshine.

It is expected that at the Florida location at least 4 to 5 gallons of water will be distilled daily, by each still on clear days, during the summer months. The maximum hourly feeding rate should be around 0.8 gallon per hour, = 6.7 lb/hour, = 3000 cc/hour. The temperature of the water will be around 140°F. The flow of water is given by Poiseuille's law, which in it's simplest form is

$$V/t = \frac{397\,H\,r^4}{n\,L}$$

V/t flow rate cc/sec

H height of water in tank above capillary outlet. (cm)

L length of capillary (cm)

r radius of capillary (cm)

n coefficient of viscosity at 140°F. = 0.00469 (gr/(cm x sec.))

In the above case V/t = 0.83 and if the capillary has a diameter of 0.6 mm (r = 0.03 cm) H/L = 12.

In other words, if the water level in the tank is 12 ft above the capillary orifice, the length of the capillary should be one ft. It should be remembered that if the capillary is tested at lower temperatures, the flow rate will be less. At 75°F. for instance it is just half of the above rate, or 1500 cc/hour.

It should be mentioned that capillaries less than 0.05 cm in diameter should not be used, because they may be plugged easily by fine particles. To avoid dirt or rust the saline water should pass through a filter, before it reaches the distributing pipes.

The saline water distributing channel is made of 0.020" thick sheet aluminum painted black on top and coated with laminated or cemented Mylar 0.001" thick. Mylar protects the channel against corrosion. The channel can also be made of black thermosetting plastic.

The channel is closed at both ends and fastened to the frame of the still. The black fabric of the evaporator is folded near its top edge around a strip of thicker wicking material, which in turn is bent into the feeding channel, as shown in the drawing. Heavier black flannel, can be used for this purpose. The wick should be uniformly distributed in the channel and should not be wedged tightly, otherwise wicking will be impeded.

Preliminary tests should be made with one still to determine whether the flow rate is uniform over the "Chromspun" black fabric. Dry "islands" should be avoided. The saline feed water can be mixed with a small amount of wetting agent, such as Aerosol O.T. one percent solution in water. One quart of this solution can be added to 10 gallons feed water. (Dilute washing compounds, such as "Dreft" or "Tide" can serve the same purpose.) During the first trial run the stills should be fed with saline water, mixed with the wetting agent, or detergent, to remove any oily film that can be present on the fabric.

To provide uniform feeding the top feed distributing channel must be nearly horizontal. When it is tilted, more feed water will flow on the lower side, as can be expected.

(5) <u>The brine collector</u>

The brine collector is a U-shaped bent pocket, formed on the lower edge of the Mylar lined aluminum support, holding the evaporator fabric. It is essential that this part be protected against corrosion and should not leak. A plastic tube of 1/4" i.d. is cemented into the lowest point, conducting away the brine through an opening, drilled into the bottom edge of the frame. The plastic tube connects with the brine collecting tube of larger diameter, being attached to inlets drilled into the larger pipe. This pipe slants slightly to carry away the brine and is attached to the lower support of the stills.

(6) <u>Distilled water collector</u>

The condensing distilled water trickles down the inside of the glass and the inside of the aluminum pan and collects at the lower bottom edge of the pan. The water outflow pipe (1/4 inch i.d.) is welded to the lowest point, to prevent accumulation of distilled water within the still. The pipes are connected to a common water conduit, made of rigid plastic piping of sufficient diameter to handle the flow-rate.

(7) <u>Saline water storage tank</u>

Redwood tank is traditionally the best for this purpose. The tank should be covered. The outflow valve should be rust and corrosion resistant. The saline feed water should be filtered to remove small particles which may plug the capillary feeding devices. The tank should have a level or volume indicator to measure the amount of feed water entering the still. Saline water, or sea water is lifted by a marine-type corrosion resistant pump capable of delivering at least 6 gallons daily per still section. The flow is to be regulated manually, by a valve, which should be closed about one hour after sunset and opened shortly after sunrise. In sufficiently large installations this operation can be controlled by a photoelectric relay of the "Sun-switch" type (made by Sun-Switch Company, Cambridge, Mass.)

(8) Brine collecting devices

It is necessary to measure the amount of brine flowing from the still, to determine whether the still operated without excessive over-feeding.

(9) Distilled water collecting tank

This tank can be made of redwood for larger installations. For smaller installations a rust-proof water tank can be used, and the amount of distillate should be measured daily. Several measuring devices can be used, such as the "Tankometer" (made by Uehling Instrument Co., 483 Getty Ave., Patterson, New Jersey) or equivalent.

5- Operation of the Still

(1) Correlation of measured data

On clear days the flat, tilted still operates within a short time after sunrise. The reason for this is that the porous absorber holds only a small amount of saline water which is heated rapidly by the rising sun. The saline feed water should be turned on soon after sunrise, to prevent drying of the evaporator. At the beginning of the day the capillary flow rate governor admits smaller amounts of feed, about one third the amount that flows during the noon hours. When sunset approaches, the flow-rate decreases again. The saline feed water should be turned off after sunset. Distillation may continue for a short time after sunset. Some distillate may be obtained during the night, when the glass cover is cooled by radiation loss to the night sky. The condensation of dew frequently has been observed and when the dew is heavy it is collected by the rain collector of the still.

The amount of fresh water (W) and the collected brine (Br) should equal the amount of feed water (F), (measured in pounds)

$$W + Br = F$$

If this relationship does not hold, it may be due to vapor leaks and the mounting of the glass should be made tighter, to eliminate them. Obvious leaks in the brine, or distillate channels should be corrected, immediately.

The daily amount of sunshine, (measured by a pyrheliometer, following the method employed by the U. S. Weather Bureau), is computed for the entire evaporator area of the stills. (S)

At the theoretical 100% efficiency the amount of water in pounds = S/1070.

The operating efficiency = $\frac{W}{S/1070}$

Temperature distribution within the still has been measured and reported in previous Reports. The temperature of the evaporator seldom exceeds 150°F., while the temperature of the front and back condenser surfaces is generally 20 to 30°F. lower than the evaporator. Higher temperatures are obtained when the ambient temperature is higher and when the velocity of the wind is low.

(2) Cleaning

The evaporator of the flat, tilted still is self-cleaning: formations of insoluble crusts do not occur, because they are washed away by the saline feed water. If the still runs dry, (due to lack of feed water), salt is deposited on the porous fabric, but this can be easily washed away by feeding the still during the night for a few hours. The glass surface probably does not require cleaning at the Florida location. Occasional rains wash the glass sufficiently. The filter for saline water should be cleaned periodically.

(3) Maintenance

Connections for the saline feed water, brine and distilled water pipes should be checked periodically for leaks. These connections should be tight and leak-proof, because a leaky still cannot operate correctly. For this reason the attachment of the outlet tubes must be made carefully, to avoid the need for repairs.

6. Multiple effect still

R&D Reports No. 13 and 31 contain design variations and experimental results with multiple effect stills. It is recommended that these reports should be read before considering the following designs and specifications, based on Figure 10 of Report No. 31.

The multiple effect still of this design combines the collection of solar energy with a 10 effect still. For maximum annual production the still should be tilted at 25° from the horizontal, if used in Southern Florida.

On the basis of experimental results, it is expected that the efficiency of such a still may be at least 6 times as great as the efficiency of a single effect solar still, both of equal solar energy intercepting area. From the economical point of view, the cost of fabricating the multiple effect still should be less than 6 times as great as that of a single effect still.

The principle of the multiple effect still is briefly summarized as follows: Solar radiation is intercepted on a flat, black absorber, mounted on a rigid frame, protected in front against heat losses by one or two air-spaced glass panes, or other transparent layers. The back side of the black absorber is covered with a thin porous layer, fed with saline water, serving as the evaporator of the first effect. The condenser of the first effect forms one side of a thin water impervious layer, mounted on another rigid frame. The other side of the same layer is covered with porous fabric, fed with saline water, forming the evaporator of the second effect. Successive frames are aligned and pressed together like the frames of a filter press.

The evaporator layers are fed with controlled amounts of saline water. Concentrated brine is collected from the lower edge of the evaporators. Distillate from the condensing layers should be collected into separate channels. The efficiency of such a device depends upon the following requirements:

(a) The spacing between successive effects should be small.

(b) The alignment should be perfect, the frames being gasketed to diminish vapor loss, or air circulation.

(c) Saline water feeding should be uniform over the entire evaporator area.

(d) Saline water feeding should decrease between successive effects, with maximum feeding at the first effect.

(e) The porous layers should be thin, yet should have excellent wicking action.

(f) The heat carried away by the condensate should be reused.

7. Structural components of the multiple effect still

The multiple effect still consists of the following components:

(1) Solar radiation collector.

(2) Frames of successive effects.

(3) Saline water feeder and heat exchanger.

(4) Saline water feed regulator.

(5) Brine collection.

(6) Distilled water collection.

(7) Assembly and insulating cover.

The deciding factor in design is the selection of the water impervious thin film, separating the condenser of one effect from the evaporator of the next effect.

Polyester film (E. I. duPont de Nemours Co's "Mylar") and sheet aluminum have been tested in previous experiments. Polyester film is dimensionally stable and resists the action of saline water and brine. It must be laminated to thin porous material, to distribute saline feed water evenly, on the evaporating side.

Sheet aluminum must be coated on the saline water side with a coating or film to eliminate corrosion, Polyester film can be used for this purpose, followed by a laminated layer of porous material. On the distilled water side no coating, or porous fabric is needed, because corrosion does not occur.

Polyester film is less cumbersome to apply and for this reason it is recommended, in the form of 0.005 inch thick film. This is available in widths of 48 inches, in continuous rolls. The films can be cemented to wood or to other materials (Bondmaster L-218 cement). Wood is recommended as the structural material for frames. The selection of these materials determines the design factors.

(1) Solar radiation collector

The black absorber of the collector is made of 0.005 inch thick "weatherable" Mylar film, painted black on the front surface facing solar radiation. The film is mounted on a frame, as described below. On the outer side, facing the sun, the film is covered with another layer of "weatherable" Mylar film, cemented to a wood frame, forming an air space 3/4 inch wide. The external cover is made of glass panes for greater weather and wind resistance, forming a second air-space 1/2 inch wide. The double "window", in front of the black film, has an over-all heat loss coefficient of 0.55 to 0.65, depending upon temperature and wind velocity. It transmits 75% of the incident solar radiation (as an average for the day). On clear days, around the noon hours, the following conditions can be expected.

	Thermal energy Btu/Sq. ft. hour
Incident solar radiation	300
Transmitted	225
Outward heat loss from black surface at 200°F. to ambient at 100°F.	65
Net heat available for evaporation	160

Efficiency 160/300 = 53.5%

The efficiency of the solar collector process is 53.5% under these conditions. The hourly amount of distillate evaporated in the first effect is around 160/110 = 0.145 lb/sq. ft. = 62 cc/per sq. ft. The feeding rate of the first effect of a 20 sq. ft. solar still should be about 3.5 lb/hr or 1600 cc/hr. Ten effect still should produce about 2.0 to 2.5 gallon water per hour.

(2) Frames of successive effects

The frames are made of wood 1/2" x 1¼", as shown in the the drawings. They are assembled with waterproof cement. The completed frames (numbering 11) are superimposed, with the frames of the "window" and holes are drilled for lateral bolts, holding the assembly together.

Mylar film 0.005 inch thick is folded as shown in Dwg. No. 4; the folds must be exact with close tolerances to avoid vapor leaks. The wood frames and Mylar are coated with cement, (Bondmaster L-218, or equivalent) at the places which are to be joined and pressed together. The interior edges of the wood frame are also coated with cement to make them water-proof.

Thin porous material is now laminated to the Mylar film, using the least amount of cement required. The wick material can be cotton flannel, or more durable, but light weight Orlon fabric or felt can be used. The porous fabric folded into the feeder channel is either double folded, or reinforced with a thick wicking material strip.

(3) Saline water feeder

Saline water is fed to each saline water channel through Vinylite tubes, terminating in the channel. Tygon tubing B 44-3 grade, suitable for hot liquids and beverages, is made by U. S. Stoneware Company. Tubes of 1/4 inch inside diameter and 3/8 inch outside diameter were found to be suitable. The tubes descend between the Mylar films near the edge of the wood frame, are placed into the fresh water collecting channel to act as heat exchangers and finally led upward to the saline water feed regulator.

(4) Saline water feed regulator

The purpose of this regulator is to admit controlled amounts of saline water to each effect, delivering more feed water to the first effect and successively decreasing amounts to the following effects. Glass capillaries are used for this purpose, attached to the saline water feeder tubes and to a feed regulating manifold. The common conduit from the manifold terminates in the saline water tank, placed a few feet above the top edge of the solar still. All capillaries should be of the same diameter, approximately 0.05 to 0.075 cm. Their lengths should be graduated. The shortest capillary is connected to the first effect. Successive effects are fed through capillaries which increase in length by 10% for each effect. The capillary of the 10th effect is twice as long as that of the first effect. The 11th frame, which is the final condenser (exposed to the air) has a short capillary to provide more feed water, for cooling. The amount of feeding is adjusted by varying the water level in the tank.

(5) Brine collection

Excess brine flows down to the bottom of the still and is channeled away by a Mylar collecting pan, ending in a tubular outlet.

(6) Distilled water collection

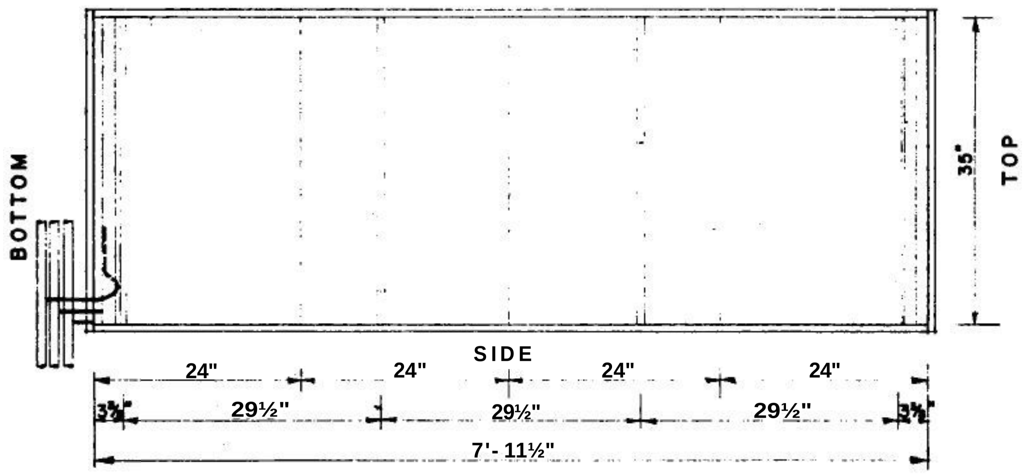
The distilled water flows through the side outlets into a collecting pan, or funnel and is piped away to a storage tank.

(7) Assembly and insulating cover

The completed frames and window frames are assembled and bolted together. It is essential that vapor leakage should be eliminated as completely as possible, by cementing the frames together into a compact unit. Vapor leaks generally occur on the top of the still, but they can be diminished by covering the top with a tightly fitting Mylar hood or cover. The wood frames are reasonably good heat insulators, but further improvement can be obtained by covering the still on the sides and on top with Fiberglas insulation, mounted between water impermeable plastic film layers, which are heat-sealed, to prevent entrance of water,

8. Operation of the multiple effect still

The still should be placed in vertical position, preferably in the shade, or facing North. The feed water tank should be filled with a few gallons of salt water, mixed with a wetting agent or suitable detergent. The still is fed until brine flows from the bottom of the still. Under these conditions, no liquid should flow from the fresh water channels. The still is placed then into the tilted position, while feeding continues - in the shade. No liquid should flow from the fresh water channel, and the still should not leak, except for the flow through the still. After this preliminary "priming" the still is ready for operation.



PLAN
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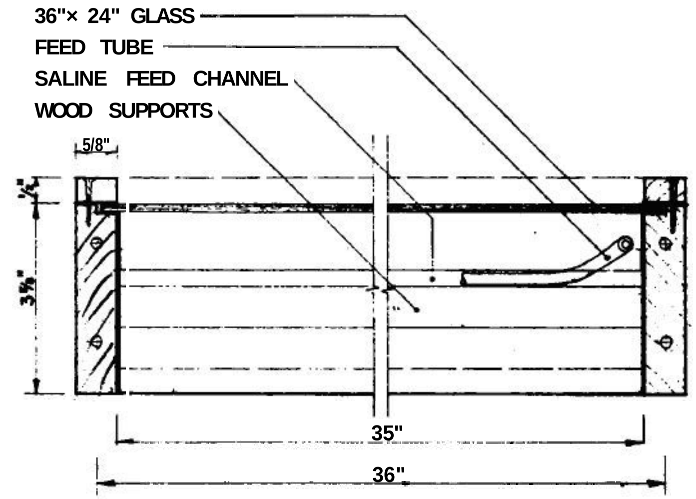
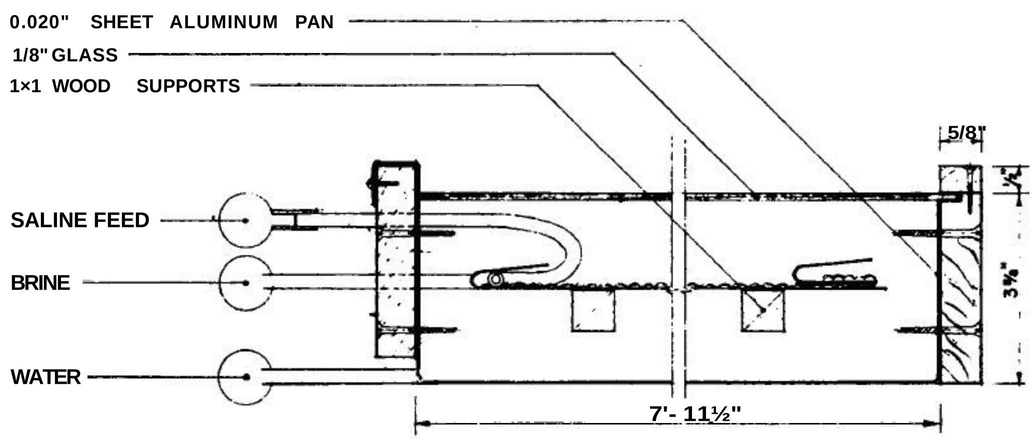
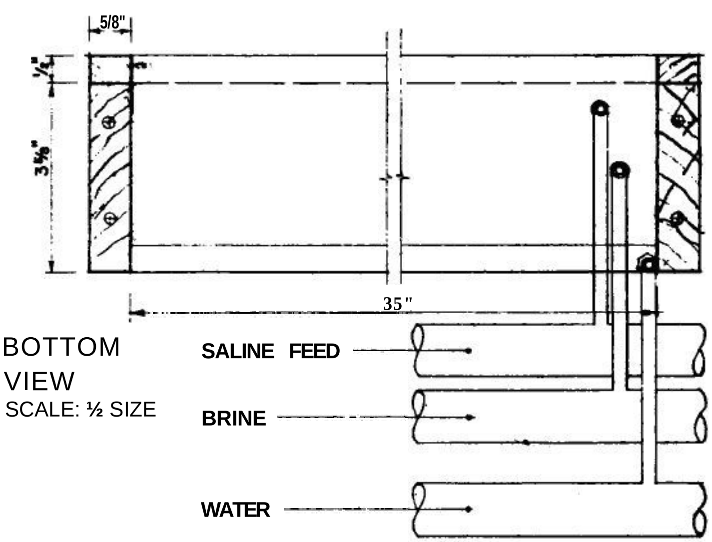


TOP VIEW
SCALE: ½ SIZE



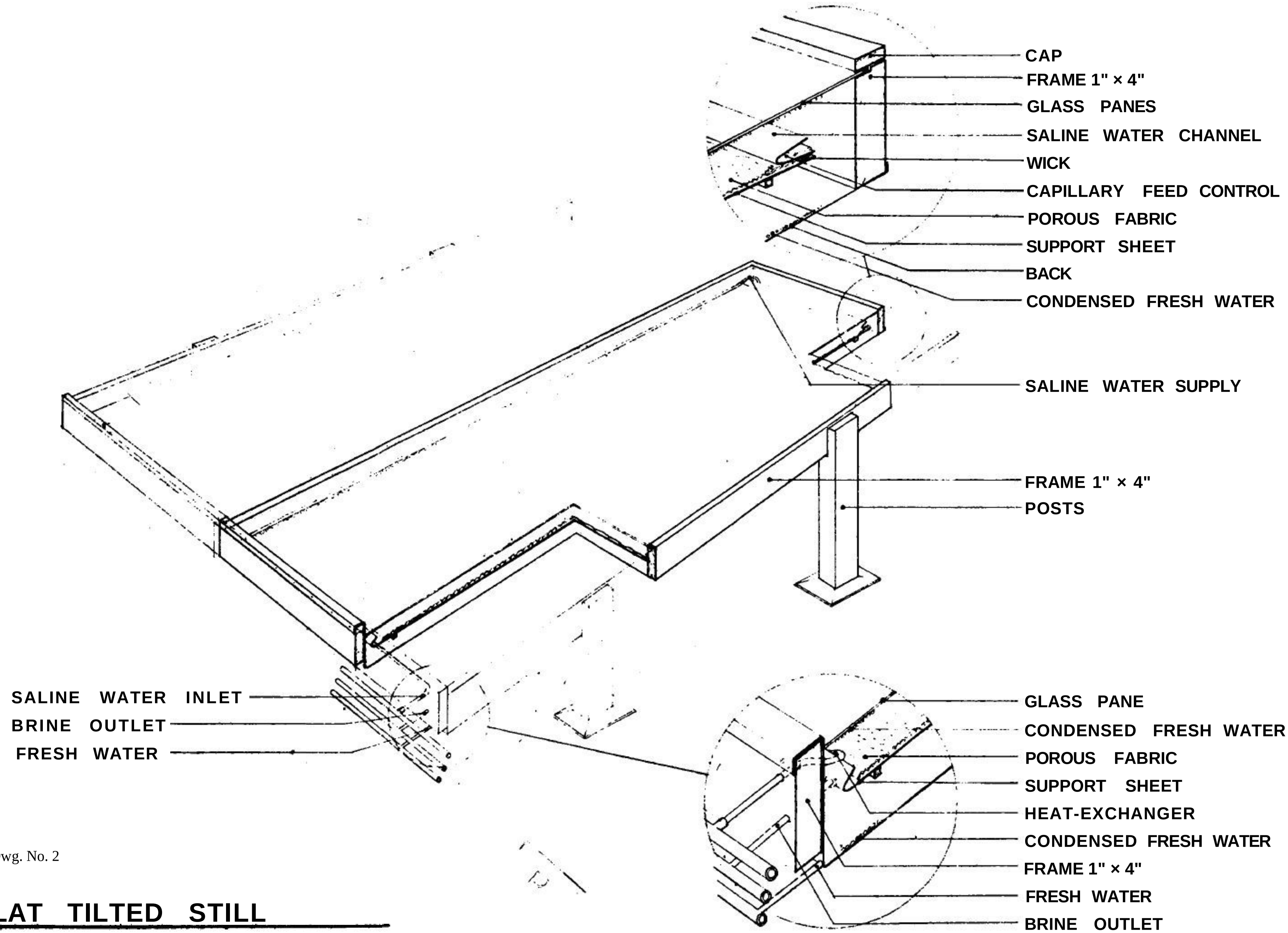
SIDE VIEW
SCALE: ½ SIZE



BOTTOM VIEW
SCALE: ½ SIZE

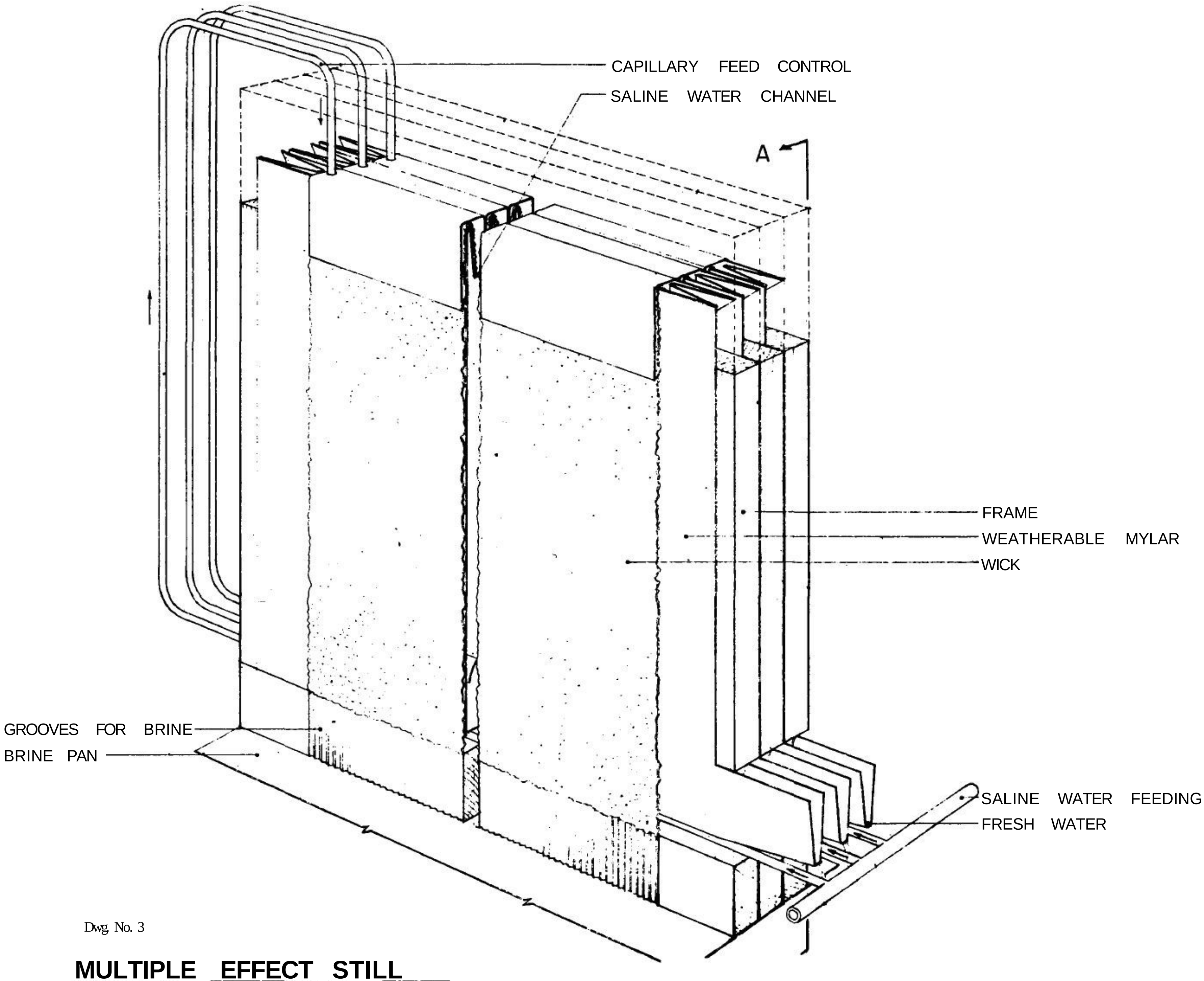
Dwg. No. 1

FLAT TILTED STILL



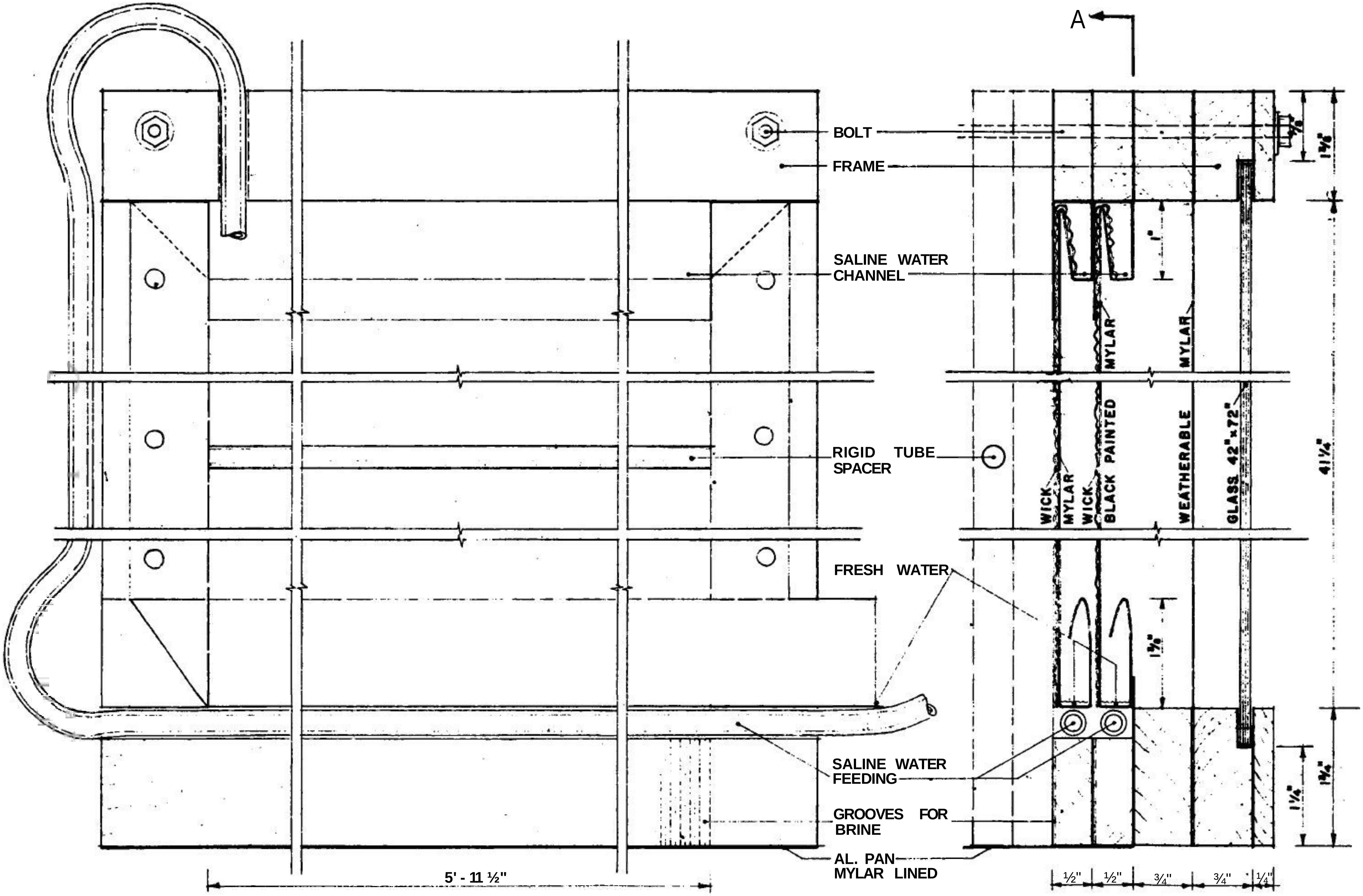
Dwg. No. 2

FLAT TILTED STILL



Dwg. No. 3

MULTIPLE EFFECT STILL



FRONT VIEW
SCALE : FULL SIZE

SECTION
SCALE: FULL SIZE

Dwg.No. 4

MULTIPLE EFFECT STILL

USCOMM-DC-62,497