Installation of a Solar Distillation Plant on Ile de la Gonave, Haiti Internal Report No. I.67

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May 1970

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INSTALLATION OF A SOLAR DISTILLATION PLANT

ON ILE DE LA GONAVE, HAITI

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Introduction

This report is subsequent to Technical Report No. T.58 and itemizes the actual installation of the glass and concrete solar still specified in that paper. The main subject covered in this paper will be the installation of the solar distillation plant without auxiliaries. The latter are dealt with elsewhere.

The format of this report will follow closely that of T.58 for ease of reference and to illustrate point by point the problems encountered and their ultimate resolution.

Selection of Site

In T.58, five considerations are enumerated for the choice of a site for a solar distillation plant. These are listed here for ease of reference. In general, the site selected should be:

1. on firm, well drained, reasonably level land,
2. unobstructed from the sun during most of the day,
3. as square in area as possible to reduce heat losses from the edges, with one edge running nearly in an east-west direction,
4. reasonably close to the saline water source, but not so close as to be covered with spray on windy days,
5. not excessively exposed or windy.

In addition to these, a sixth might be added, namely that the site selected should be acceptable to the community that the solar still is going to serve. This acceptability is not an item one can gauge accurately and easily because it is involved with the whole cultural norms and patterns of the community. An indication of the importance of this latter consideration was revealed by a look at the possible repercussions inherent in the original site selection for the Haiti still in Source Philippe.

Before the arrival of the project engineer, a site had been tentatively selected for the installation of the solar still adjacent to the existing brackish water well. This was intended to permit the use of the well water or nearby sea water as feed to the still. Also involved in this choice of site was the fact that nearby flat land would permit expansion of the facilities by a factor of four. Subsequent to arrival at the village by the project engineer, an inspection of the proposed site and the surrounding terrain was undertaken. Discussions with the villagers and those in authority suggested that a better site might be selected. The reasons given, relating to the sixth criterion mentioned above, are outlined below.

At the originally proposed site, near the well, stands one of the best shade trees in the village. It is not a large tree; however, its use as a gathering place gives it a significant role in the everyday life of the community. If a solar distillation plant were to be built at this site, the usefulness of the tree as a meeting place would have to be terminated for two very good reasons. Either it would have to be cut down to avoid shading effects on the still, or else its close proximity to the still would make access to the tree, by scores of people every day, an unacceptable hazard for the glass cover.

Cutting directly across this original site was the major trail for driving cattle to the well. The herders felt that it would be difficult to change the habits of their animals from running down the hillside, over the proposed still site, to the well. As examples of the ineffectiveness of local fencing to block animals from their customary trails, the enclosures around the hillside rain catchment and the school yard were noted. Well installed barbed wire fencing was continually being knocked over or broken through by animals where it cut across an old trail.

The original well, from which the village took its name, plays an important part in the lives of the villagers and the farmers for miles around. The people of the village bathe and wash their clothes at this site. They, like the outlying farmers, also water their livestock here during the dry months. It was noted that, at high tide, the water in this well was definitely saltier than at low, indicating the influence of the sea on the composition of the well water and that, during these periods of increased salt concentration, no animals would drink the water. The implications of this were that if large quantities of water, in addition to that already taken out for the livestock, were used for operating the solar still, there would be increased infiltration of sea water into the source, thus possibly rendering the well unuseable for the animals. Subsequent installation and operation of a temporary pump in this well revealed that increased contamination by the sea water was indeed a problem.

A site was selected for the installation of the solar still on a piece of gently sloping land a few hundred yards from the original well. This site satisfied the villagers and the technical requirements enumerated above. This locale was completely unobstructed from the sun from sunrise to sunset. It was, however, located near the edge of a coastal line of mangrove bushes, some as high as 20 feet. These were systematically topped so that any winds from that direction would not be unduly obstructed before reaching the proposed windmill. As previously mentioned, the terrain sloped down, fortunately, toward the equator. Since this slope was somewhat uneven, land fill was necessary.

Preparation of the Site

One of the easily most time consuming jobs was in the site preparation, particularly where it involved land levelling. Initially, all vegetation was removed from the selected area and the ground liberally doused with sea water in an attempt to kill all vegetation. The dimensions and elevations of the distillation plant were surveyed out and land fill started in the southwest corner up to a depth of four and one half feet. Several large rocks, some weighing as much as two tons and requiring about 25 men to move, were dug out and removed from the still area. To account for the slope of the land, the ground levels for successive basins were stepped down, 1.5" between each of the first ten bays, and 4" between each of the last five. Ground levelling usually preceded the installation of formwork of successive bays by about four to six days. This allowed time for considerable traffic to pass over the filled or cut down areas so that a maximum of ground compaction could occur before the concrete walls were poured.

During this period, between levelling a basin area and installation of the curb wall formwork, the ground was once again thoroughly wetted with sea water and then treated with herbicide mixture in the following proportions: 8 lbs. Weedazol (trademark), plus 1 quart of 2-4-D, plus 35 gallons of sea water. This quantity of mixture was applied to an area of 100 square meters.

The addition of the herbicide added to the effectiveness of the sea water in eliminating plant growth. The success of both of these methods in completely destroying organic life must be questioned somewhat, since much later on, before any [illegible] fill was used between the concrete curb walls as preliminary basin fill, some forms of plant life began growing again. The action taken to destroy this vegetation was to dig out the roots, then to soak the basin with more sea water, allow it to dry out for several days and finally to cover the ground with a 2" layer of high salt content beach sand.

Preparation of the Foundations

An accurate determination of the east-west line, parallel to which the solar still foundation walls would be built, was made in the following manner:

A shadow method was used in which a pivot stake was firmly placed in the ground. When the sun rose, a second stake was set at a given distance along the path between the pivot stake and the point of sunrise. Likewise, at sunset, a third stake was placed at the same given distance from the pivot on the line joining pivot stake and point of sunset. The straight line between the second and third stakes was the required east-west line.

The ground on which the concrete foundation walls were built was quite firm. The stability of the ground for supporting the concrete walls was questioned; however, several factors led to believing that it was adequately solid. The continuity of other concrete installations in the vicinity, such as the large rain storage reservoir, the guest houses, the school and canteen floors, all showed no cracks due to ground movement or settling. There was no real bed rock that could be easily found. The ground was not loosely packed and it required working with a pick before shovelling. After the ground at the site was levelled, it was tamped and watered and then subjected to considerable human traffic to return it to its former solidity.

The basin areas were generally laid out with lines delineating the course of the concrete walls. To allow for an adequate rate of distillate withdrawal as well as to allow for the flow of brine within the basin, each wall was made to descend uniformly over its length a vertical distance of one foot. This permitted a level difference of one inch between successive ponds within each basin.

The formwork for the concrete walls was changed several times before settling on a very workable and efficient system. For the first (upper) curb wall, 3/4" plywood lengths, 2 feet high, were backed with 12 to 16 foot lengths of 2" x 4" and positioned in a line down the entire proposed wall length at a height of one inch above the ground. This one inch gap would allow some concrete to flow out under the formwork so that a broader footing would result. Great difficulty was encountered in laying out a straight form. However, with strategic interior and exterior bracing, especially to counteract the inevitable bulging of the plywood, a fairly straight course was established. The warping of the 2 x 4's supplied for backing the plywood was the main reason a straight form was difficult to build.

After pouring the concrete for this first wall, it was decided to construct future formwork as unit pieces, each 8 feet long with short pieces of 2 x 4 nailed to the back of the plywood sections for supporting bracing materials. This would also allow for ease of moving the forms from bay to bay. After pouring the second wall, this formwork was discarded, again due to extreme difficulty in aligning and the slowness in removal and relocating.

The third method hit upon solved most problems. This involved using plywood backed by plywood, alternately spacing the plywood sheets to give rigidity and straightness. Each wall of the formwork was now 1-1/2" thick over its entire length and most of its height. This form, illustrated in Figure 1, proved highly successful. It could be removed from one concrete wall, one side at a time, and set up and aligned in a new position ready to pour concrete within one and a half hours. To help speed installation, a set of standard form spacers, wire and steel rod braces were used. Using this particular formwork and allowing time for gutter forming, described below, one complete wall could be cast each day.

Casting the Curb Walls

The concrete used for the wall construction was a 1:2:4 cement:sand:gravel mixture. The optimum method of pouring the concrete, laying the course of concrete blocks and forming the gutters was, like the formwork installation, determined by experimentation. The upper curb wall was simply a concrete pour so no real difficulties were encountered in the course of its construction. The second and successive walls were installed using concrete blocks and guttering. The following gives the chronology of procedures used while settling on the best method.

Wall number 2 was laid in two sections. First the concrete was poured to just below the level of the gutters and after it had hardened somewhat, a layer of sufficiently stiff mortar (1:2:0 mixture) was poured around a special guttering form. This form consisted of two 20-inch long pieces of wood used for moulding the mortar into the shape of the gutters. These were attached to a guide frame which rode along the upper edge of the concrete formwork. A space was left in this frame to allow for positioning of the concrete blocks. Figure 2 shows this special guttering form in operation. While the mortar was being moulded into shape, the concrete blocks were sealed in position. Reinforcing steel was secured in place as outlined in T.58.

The guttering of wall 2 was very rough and, by the time a good method of laying a smoother gutter system was decided upon, the necessary wall formwork, used as a guiding surface, had been removed and re-positioned for wall number 3. Thus a skeleton formwork had to be re-set to complete the second wall gutter surfacing.

In constructing the third wall, three teams of workers were used to establish the feasibility of completing a whole wall in one day. After the forms were aligned and reinforcing steel positioned, the first team poured and tamped the concrete up to a level just below the guttering. After approximately one half hour, a second group laid the mortar and concrete blocks as was done for wall 2. However, due to the tie wires between the two wall forms, it was necessary to chip some concrete blocks as can be seen in Figure 3. Also, because of these wires, the guttering form was less effective since it had to be picked out of the mortar, lifted over the wires and set down in the mortar on the other side of each wire. As a result, this team fell way behind. The third team followed, pouring and forming the fine finish on the gutters, using another specially contoured wood and metal-backed mould (see Figure 4). This final surfacing on the gutters consisted of a 1:2:0 mortar mix with SIKA compound mixed in for water proofing.

The only subsequent alteration in this method of wall construction was to allow a greater time lag between the first and second teams of workers. This delay allowed the concrete to set longer and become more stable, so that just ahead of team number 2 the cross tie wires could be cut and all concrete blocks laid whole.

This general procedure proved successful on all remaining walls. If concrete pouring was started early enough in the morning, the forms, having been left in position until the fine guttering surfacing was completed, could be removed and re-positioned late in the afternoon, ready for the next day's work on the following wall.

Smooth surfacing of all exposed concrete areas with a waterproof plaster layer was accomplished from 3 to 15 days after the formwork had been removed. All surfaces had to be layed before this waterproof layer was applied. Concrete and plaster surfaces were kept wet for at least two weeks. Figure 5 shows various degrees of finish on several walls.

Very few problems were encountered in keeping to the dimensions outlined in the construction drawings. Frequent checks were made to ensure that the glass covering would fit properly.

The end walls were cast in four units, in groups of eight and seven at each end (see Figure 5).

Preparation of the Basin

The area between the curb walls was covered with a layer of beach sand up to a depth of four inches below the proposed level of the butyl rubber liner. The length of each basin was then split up into a number of six-foot sections. A large wooden frame (see Figure 6), some 7 feet in length, was built with appropriately sloping guides such that the sand in each of these six-foot sections could be levelled. This first layer of beach sand was well tamped and on top of this went a two-inch layer of dried coffee husks to act as insulation. This layer was levelled using the same wood frame with the levelling boards raised two inches. A second two-inch layer of beach sand was placed on top of the insulation, and again the area was wall tamped. A series of two-inch high weirs were built from the sand, at the end of each six-foot section.

These weirs were installed to keep a uniform, shallow depth of water in a series of ponds down the length of each basin.

Installation of Basin Liner

The butyl rubber sheet was installed in the basins in the following manner: All the concrete surfaces required for adhesive application were brushed and wiped clean. Then the butyl rubber sheet was unrolled in the basin and the edges folded over onto the main sheet to avoid dirt contamination. Butyl adhesive was applied to both the concrete and the butyl rubber at the proposed areas of adhesion. When the adhesive was tacky to the touch, but not adhering to the skin, the two surfaces were joined and pressed together until a good bond was effected. The drying time usually varied from 10 to 30 minutes. Much difficulty was encountered in this process. First of all, the folding of the rubber sheet at points were it mounted and descended each retaining weir caused restrictions in the limited space of the distillate gutter. These folds were difficult to glue down and a free flowing channel was thus hard to obtain. Secondly, the rubber had a tendency to pull away from the concrete and repeated attempts at rejoining the surfaces by applying hard pressure to the joint were only partially effective.

At the time, it was felt that increased temperature had an adverse effect on the adhesive setting, so butyl rubber installation was restricted to the cooler early morning and late afternoon hours. It has subsequently been learned from the supplier of the rubber that increased temperature has a positive hastening effect on the glue setting so that the time between application of the glue and adhesion of the two surfaces can be shortened. However, it was specifically pointed out that humidity is a serious problem. High humidity decreases the adhesive drying and curing rate.

Several days were allowed between butyl rubber adhesion and glass placement to permit any serious adhesion problems a chance to show up. Even then, some of the most serious unsticking appeared after the glass was in place a few days. To correct this, some of the glass had to be removed and the rubber tacked in place on the concrete wall with concrete nails every few feet as required. Care had to be taken that the rubber was under no tension when tacked up because tearing from the nail hole could very easily occur.

The first problem mentioned, that of distillate gutter blocking by rubber folds, was never completely solved. In an attempt to eliminate the folds, a 4½-inch wide strip was cut from the butyl sheet along its entire length and this strip glued into the distillate gutter, overlapping each side of the gutter. The main sheet was then glued into position in the basin, one edge overlapping the gutter liner to effect a good seal. This method might have proven successful but for two very good reasons. One was that it was never possible to cut a perfectly straight edged 4½-inch strip out. One of its edges was always uneven, such that, when the basin liner and gutter liner were positioned, gaps appeared between them. This might have been avoided by purchasing a wider butyl rubber strip to allow greater overlapping; however, such hindsight was useless under the circumstances. The other objection was that, even if the two rubber strips were slightly overlapped (above water level to avoid liquid leaks), this joint would have to be positioned on or near the narrow lip between the gutter and the basin. Due to the rubber curvature at this point, its elasticity would inevitably cause points of unsticking, resulting in the rubber rising to where it might contact the glass cover. No available means of pressure application could prevent some small strips of rubber from coming unstuck.

The overall solution that permitted the least amount of adhesive application and unsticking problems was to revert to the original continuous piece of butyl rubber for both gutter and basin. Repeated efforts to minimize the size of the gutter folds did not give an entirely satisfactory result; however, a free flowing channel was obtained. Some minor blockages occurred holding back small ponds of distillate up to one inch deep; however, these did not affect the still production as, once they filled up, the distillate flowed on over the restriction and continued down the gutter.

Corner laps with the butyl sheeting were easily handled by folding and then adhering rubber to rubber. At the brine outlet pipe, care had to be exercised. A smooth one-inch diameter hole was cut in the butyl sheet and the rubber stretched to allow this opening to pass over the two-inch brine pipe. This hole in the rubber had to have perfectly rounded corners since any sharp incision would initiate tearing when the sheet was stretched. Before stretching the butyl sheet over the pipe, both the pipe and the underside of the rubber were covered with adhesive in an attempt to make a water tight seal. Often, however, leaks occurred at this contact and a one-foot square butyl patch was adhered both to the main basin liner and to the inside of the outlet pipe.

A completely installed continuous butyl rubber basin liner is shown in Figure 7. Note the series of gradually descending ponds formed by the weirs. Special note: It was later demonstrated by a representative of the butyl rubber supplier that, prior to applying adhesive, the rubber surface should be roughened with a wire brush and wiped clean with a solvent. The brushing was not essential. However, the solvent cleaning was definitely recommended. On the concrete surface, which might or might not be highly porous and full of small indentations, it was recommended to give the surface a preliminary adhesive coating and allow it to dry for some hours so that a less porous surface resulted. Once adhesive was applied to the rubber and a second coat to the concrete, it was suggested to go over the covered surfaces again, dabbing the adhesive with the end of the brush to break any bubbles of adhesive liquid remaining. This would eliminate any large concentrations of adhesive which might later cause blistering or unsticking.

Finishing Curb Walls

Due to delays in obtaining the butyl rubber adhesive at the site, painting the white epoxy strips on the concrete was carried out prior to laying the basin liner. The inside north wall of the concrete curb was painted white to give a reflecting surface for sunlight down to the butyl liner. Most of this latter painting was done with a good outdoor concrete paint, as the epoxy paint was insufficient to complete this task.

Laying Transparent Cover

The single strength (18 ounce) glass used for this purpose proved exceptionally good from both handling and workability points of view. As mentioned in Technical Report T.58, a special form was set up to join glass panes in a workshop in order to minimize the number of joints undertaken in the field. This method was soon discarded after it was discovered that an equally good joint could be had much quicker if all glass panes were laid and joined in situ. This latter method involved, first of all, washing the glass clean with a detergent and then rinsing. This was done to remove all dust and fingerprints accumulated when shipping conditions necessitated re-packing the glass for transport to the work site. The clean glass was carried by its edges to avoid further surface smudges. It was placed in position on the concrete walls with 1/16 to 3/32-inch gaps between the panes. This spacing was decreased under that noted in Report T.58 for the following reasons. If too large a gap were permitted, the silicone sealant bead would drop through into the basin. To avoid this, a backstop of wood covered with moistened plastic sheeting was placed behind the wider gaps. This was found unsatisfactory since silicone sealant adhered somewhat to the plastic. The backstop had to remain in position for an unsuitably long time to allow the silicone sealant sufficient curing so that it would not stick to the plastic. Also, the limited space and awkwardness of working under the glass made this operation too difficult. Thus, recourse was taken to the narrower spacings and this ultimately proved very satisfactory. Adequate, full depth bonds could be made and the simplicity of the operation permitted three men to lay one complete basin cover in one and a half hours, including cleaning, positioning and joining the glass panes. Figure 8 shows the simple method of installing the glass cover.

Glass Protectors and Precautions During Severe Storms

To protect the glass from breaking under suction pressures induced by high winds, two features were built into the system. Firstly, the basin width was kept to an economic minimum and, as a result, there was no large unsupported glass area for the pressure differential to have much effect. Secondly, in the event of high winds there are observation ports at either end of each bay which can be opened to equalize pressures.

The immediate still area was cleared of all matter which could be picked up by the wind and propelled against the glass surface. This, however, has limited effect in any area where human activity and plant life are prevalent. It has been suggested that a large number of locally available reed mats be prepared for tying down over the glass surfaces during severe storms.

Piping Installation for the Solar Still

Saline water feed: The overall piping is indicated in Figure XI of Report T.58. Some difficulty was encountered with the wind powered pump. A Savonius Rotor [illegible]stalled above the well and experimentation determined that the optimum position for the diaphragm pump was 7½ feet above the saline water level. This meant that there was a 10-foot pressure head for the pump to work against in addition to a 7½-foot suction. Any greater pressure head inevitably caused the diaphragm to stretch and sag on each up-stroke so that the reciprocating action of the pump rod became translated into useless work. At suctions much greater than 7½ feet, the pump became ineffective. Under these conditions, the pump never achieved its design output and saline water had to be hand pumped daily, by means of a semi-rotary pump in parallel with the diaphragm pump, up to the feed reservoir. A later modification made use of a two-stage pumping system. The first stage consisted of the Savonius Rotor operated diaphragm pump immersed in the well, pumping water a vertical distance of 10 feet to an intermediate, ground level reservoir. Initially, a hand pump was installed in this tank to move the water up into the feed reservoir. At the time of writing this report, two possible alternatives are being looked at to reduce or eliminate hand pumping operations. One is to install a second Savonius Rotor pump at the intermediate tank and the second is to replace the whole Savonius Rotor set-up with a single fan mill-piston pump arrangement.

All 1½-inch PVC piping used in the feed line has been placed in a covered concrete channel to protect it from external damage.

Brine discharge: The brine discharge is as indicated in Figure VIII of Report T.58. The brine gutter follows parallel to the rain gutter until it reaches the last bay. It then turns through 90° and tumbles over a falls into a concreted basin. It flows from here some 20 feet into the sea along a gently sloping concrete trough.

Distillate piping: The distillate take-off method has been considerably changed from that described under similar heading in T.58. Figure VIII, accompanying T.58, has the changes incorporated in it. A threaded plastic nipple was employed as originally specified and, to some of these, the butyl rubber was attached by means of a gasket and plastic nut. On the others, channel spacing did not permit the use of a nut, so the membrane liner was pierced and joined to the nipple. Rubber adhesive was used to effectively eliminate any leaks. In both instances the nipple was well embedded in the concrete end wall and sloped gently down, protruding out over the rain gutter some 1½ to 2 inches. Later observation disclosed two basins leaking around the take-off nipples. These were immediately repaired and no further leakages have since been reported.

As illustrated in Figure VIII of T.58 and in Figure 9 of this report, the distillate take-off nipples lead out over small funnels which catch the dripping water and direct it into a 2-inch ABS pipe, pierced to receive the funnel ends. This pipe lies within the rain gutter and carries the distillate directly into the daily control volume section of the fresh water collection reservoir. Distillate production is collected over each 24 hour period and measured, then discharged into the distillate storage tank (Figures XIII(a) and XIII(b) of T.58).

Incorporated into the design of the distillate take-off is a method whereby individual bays can be tested for daily production. A small secondary gutter was built within the rain gutter, as illustrated in Figure VIII of T.58. For any particular bay to be tested on a given day, a sleeve arrangement, consisting of a length of 1¼-inch ABS pipe, is placed over the protruding distillate nipple and sloped so that its lower end empties into the individual bay testing channel. Once in this channel, the distillate flows down parallel to the rain gutter and then exits via a 1¼-inch ABS pipe through the wall of the larger gutter and into a vessel for volume determination.

Rainwater trough: The rain water gutters on each curb wall empty into the larger rain gutter passing by the end walls as indicated in Figure VIII of T.58. This latter trough is sloped downwards towards the fresh water cistern and enters it through a concrete channel cut in the upper cistern wall (see Figures XIII(a) and XIII(b) of T.58).

Auxiliaries

Descriptions of further auxiliaries to the solar still are given in Internal Report No. I.66 entitled: "Some notes on the construction and costs of auxiliaries for the Haiti solar still".

Further Site Work

A barbed wire fence was installed around the periphery of the site area. This was principally to keep out wandering animals such as pigs, cows, horses and donkeys, but it also acted as a barrier to human travel through the site.

The bare ground within the confines of the fence was covered with a layer of stones to keep dust to a minimum during the dry seasons.

The still was located on an incline which extended back up for some several hundred feet. This posed a potential threat to the site during heavy rainfalls when large run-offs might inundate the still area. To eliminate this danger, a water barrier, consisting of a rock fence and gutter, was constructed just uphill from the still site to redirect any concentrations of surface water.

The distirbution area for the fresh water was adjacent to, but separate from, the actual solar still area. This area was also fenced in to minimize unnecessary traffic. To permit distribution, separate pipes discharged water from the rain and distillate water compartments of the fresh water cistern as illustrated in Figures XIII(a) and XIII(b) of T.58.

Figure 10 is a photograph of the completed solar still.

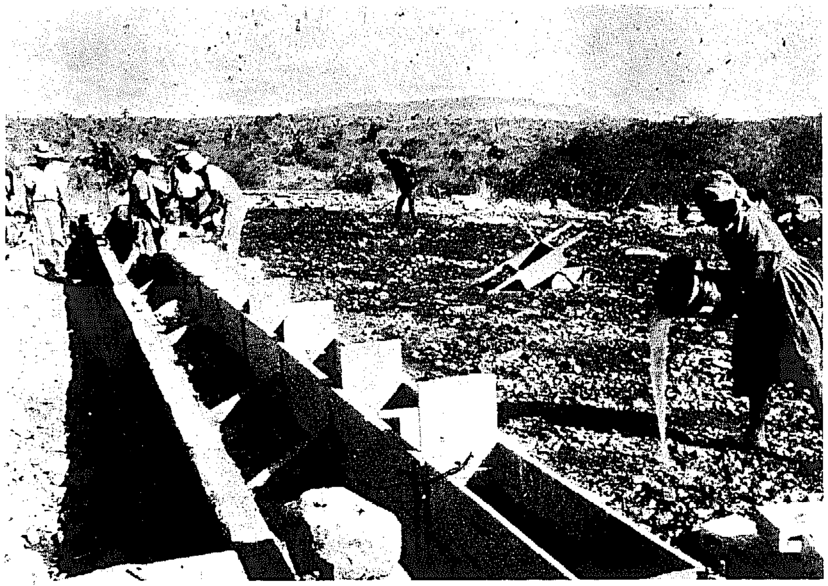


Fig 1: Form work for construction of curb walls

Fig 2: Special form used for positioning of concrete blocks and for moulding mortar and concrete into the shape of the gutters

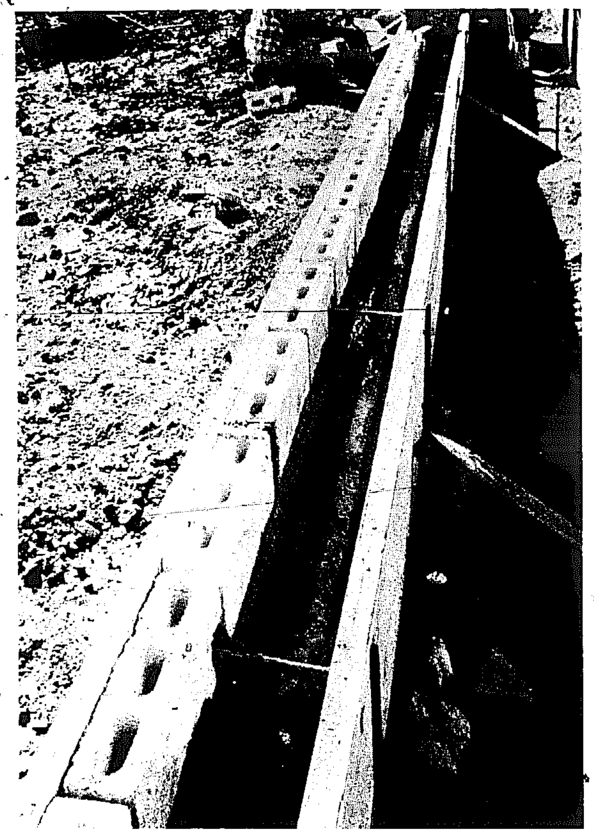


Fig 3: General view of partially completed curb wall, illustrating wood form work, rough gutters and concrete blocks. Note that at each tie wire, a bottom portion of the concrete block had to be chipped away. As noted in text, subsequent courses of concrete blocks were placed after tie wires had been removed

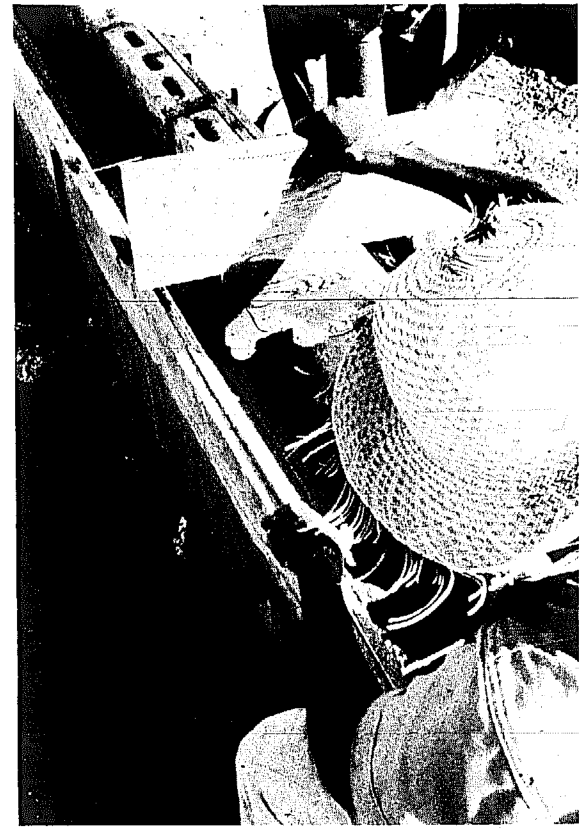


Fig 4: Specially contoured wood and metal backed mould used in forming the fine finish on the gutters

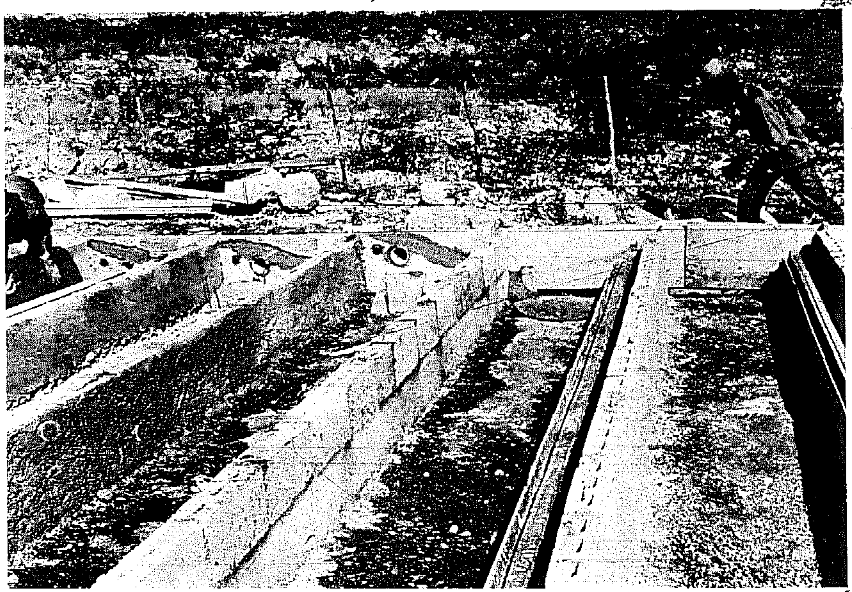


Fig 5: View showing curb walls in various stages of completion - bare concrete and blocks - rough plaster - and fine finish.

Also shown is the end wall casting.

Fig 6: Finished curb and end walls with basin fill. The wooden frame is the guide used in levelling the basin fill in each of the twelve 6 foot long ponds that form one bay

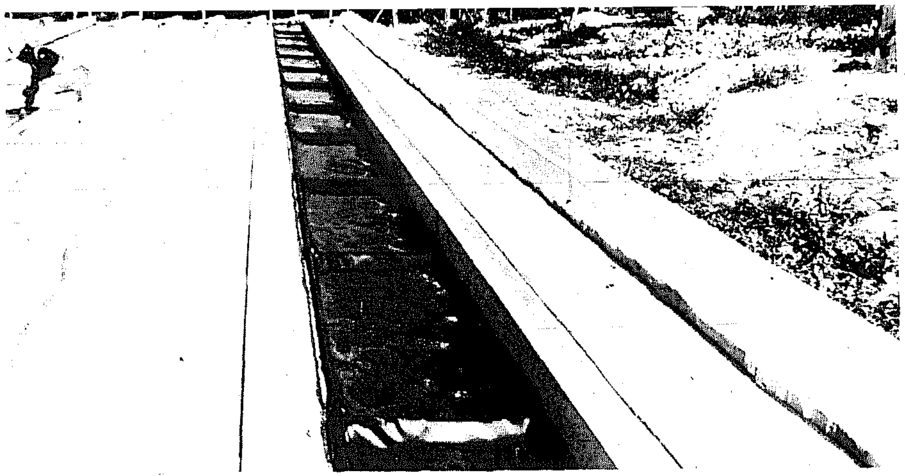


Fig 7: Butyl rubber basin installed in one of the bays. Note the series of gradually descending ponds formed by the weirs

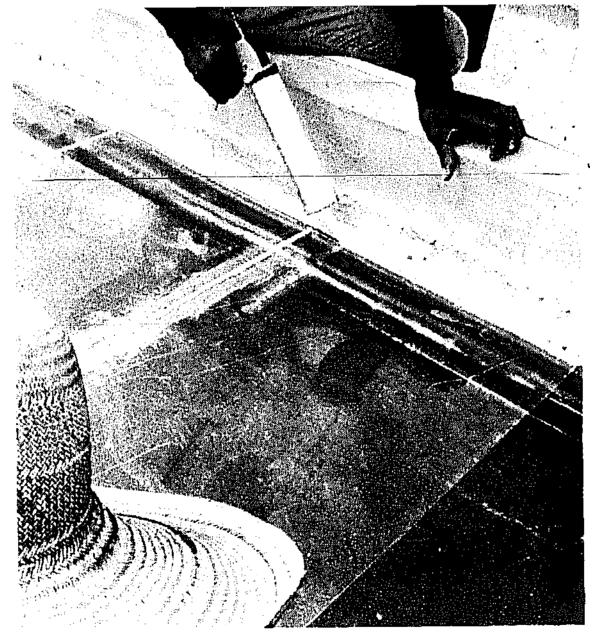
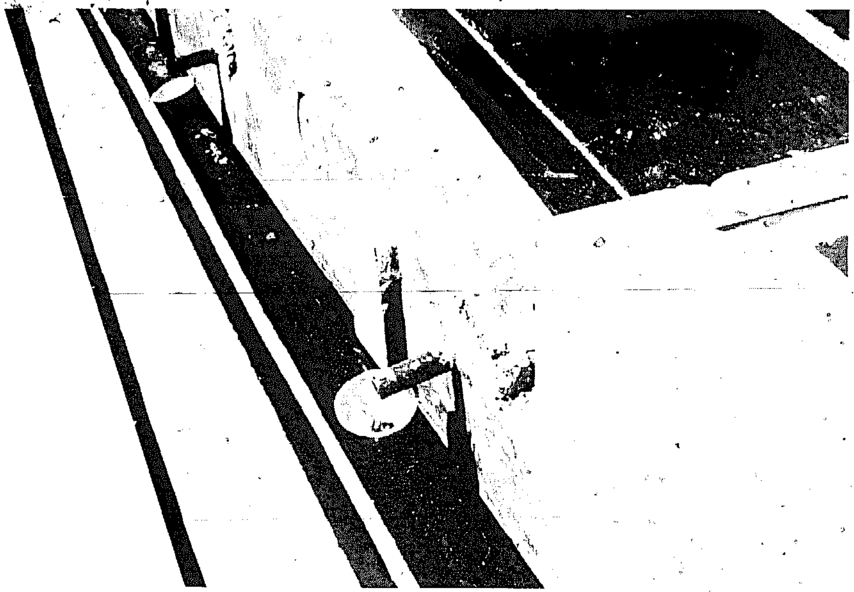


Fig 8: Glass installation. Glass panes were positioned between adjacent curb walls with 1/16 to 3/32 inch gaps between panes. Silicone sealant was then applied in a single bead along each end and in the gap separating the panes.



ate take-off end showing pipe leading
ill interior, through the end wall and
funnel. Fresh water is directed by
l into a two inch pipe pierced to
he funnel end

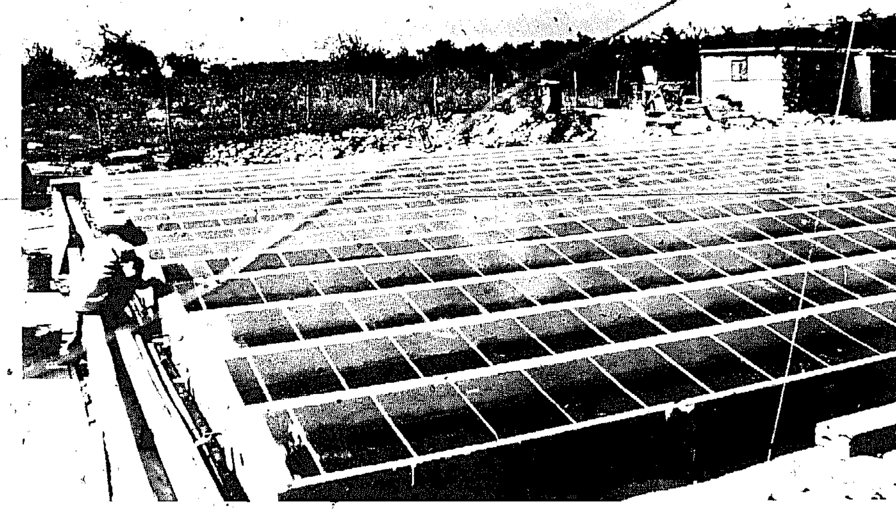


Fig 10: Overall view of completed solar still. The saline water reservoir is at the upper right hand corner