CONSTRUCTION OF THE MESH-BAG-LINE SYSTEM FOR CULTURING NORTHERN

QUAHOG

IN SOFT-BOTTOM AREAS

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Issued by the Georgia Sea Grant College Program The University of Georgia, Athens, Georgia
Marine Extension Bulletin No. 18, August 1997

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ACKNOWLEDGMENTS

Funding for this cooperative project with the Satilla Sea Farms, Inc. was provided by the Sapelo Foundation and the University of Georgia Marine Extension Service. The table was designed by the Sages of Satilla Sea Farms. We wish to thank them for allowing us to use their design in this publication. Special thanks to Ms. A. Boyette and C. Ingram for production of graphics and Mr. F. Lyda and Drs. F. O'Beirn and J. Crenshaw, Jr. for reviewing the manuscript.

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The Georgia salt marshes offer an ideal environment for northern quahog, *Mercenaria mercenaria*, culture. Along the 100-mile Georgia coastline are 1/3 of the U.S. east coast's salt marshes. The majority of Georgia's pristine barrier islands are protected from urban and industrial development because most islands are owned and managed by Federal and State agencies or private foundations. Consequently, water quality near the ocean is generally good and should remain so for years to come. Ample areas approved for shellfish culture in these environs coupled with rapid natural growth rates of quahogs in Georgia make clam aquaculture an excellent potential fishery for Georgia watermen.

Previously developed methods for clam culture in Georgia have involved either off-bottom tray or bottom-cage culture of clams. Both methods are costly and require sandy, sandy/mud, or shell bottoms to support the trays or for partial burial of the cages into sediments. Unfortunately, neither method is feasible for the soft mud-bottom habitats which predominate throughout most of the marshes in coastal Georgia. Thus, a new method is required for culturing clams in Georgia's soft-bottom areas. The mesh-bag-line system presented herein is a simplified version of one developed by personnel of the Harbor Branch Oceanographic Institute, Florida. The development of this mesh-bag-line system for clam culture was carried out jointly by The University of Georgia Marine Extension Service and the Satilla Sea Farms in a project funded by the Sapelo Foundation.

Materials

For each mesh-bag-line system (Fig. 1), the following items are needed:

- 5 mesh bags
- 1 longline
- 2 line PVC anchors
- 10 crossties
- 10 PVC crossbars

The longline and crossties are constructed of 1/4-in. diameter twisted polypropylene rope. The crossbars and anchors are made of 3/4-in. diameter PVC (schedule 20; 200 PSI) pipe. Mesh bags (3/16 in., 3/8 in., and 5/8 in. mesh sizes) are available from ADPI Enterprises, Inc. All bags are 3 ft. X 1.5 ft. in size.

A work table designed by Satilla Sea Farms personnel is shown in Figs. 2 and 3. The table serves as a template for the construction of crossbars, which includes cutting the longitudinal slit in the lengths of the pipes and cutting the pipes to standard length for bag closure. Flanging one end of crossbars, grinding the sharp edges of the crossbars, and folding the 2-in. flap on both ends of the mesh bag also are performed on the table.

Crossbar Construction

Cutting the 20-ft. lengths of pipe is the first step in the crossbar construction process. Four pipes can be laid in the cutting tray at one time (Fig. 4). Secure them and then cut all four with a circular saw fitted with a plywood blade (6 teeth/in.). Be sure to use safety goggles to prevent eye injury and a mask to avoid breathing PVC dust. These precautions are necessary at all times when cutting or grinding materials or operating any power tool. It is best to lay the end of the pipe that is opposite the coupling end against the table's tray stop. Cut the 20-ft. pieces at the 110-in. mark at the open end of the table. Place the 130-in-long pieces in the tray and cut the coupling ends off by laying pipe in the tray with the coupling extending through the open end of the tray. Cut off the coupling ends (20 inches) at this point. Be sure the pipes are weighted securely. Set these coupling ends aside for later use as line anchors. Next, lay one pipe at a time in the splitting trough (Fig. 5) and push/pull the pipe through the saw blade. This operation requires two people. Be sure the saw blade is set at the correct height so as to split the pipe on one side only. Both the saw and the pipe must be held securely (Figs. 6 and 7). Place the bag folder (Fig. 6) over the pipe in the trough and run the pipe through two cable clamps for 3/4-in. diameter pipe (Fig. 7) to secure the pipe from jumping and to keep it from jamming the saw blade.

After the long sections have been split, place them in the cutting tray and cut four pipes at a time using the saw guides (Fig. 8). Remember to hold pipes securely in the tray and wear safety goggles and a mask. This table design produces 22-in. sections of pipe.

Once the pipes (now called crossbars) have been split and sectioned, the sharp edges must be smoothed. This is done with an industrial-grade grinder secured (disk-side up) by a stainless-steel pipe clamp on the work table (Fig. 9). The best grinding surface is a 7-in. diameter masonry/tile disk 1/8-in. thick. Place one end of the crossbar against the grinder with the split against the grinding surface (Figs. 10 and 11). Apply pressure until the pipe has been angled to a point (Fig. 11). The edges of the split also must be smoothed by running the crossbar in both directions along the grinder disk (Fig. 11). Practice will perfect this technique. The corners of the angled section and the split (Fig. 11) also must be smoothed. Rounding the corners and split will prevent the bag from being cut by the crossbar while securing the bag ends. Hearing protection is recommended.

OPTION: Although the split can be smoothed with an industrial-size grinder, a smaller hand-held grinder does a better job (Fig. 12).

Line Construction

The longline anchors are made by cutting two 2-ft. lengths of pipe and drilling a 7/16-in. through-hole near the end of each. The coupling end of the 20-ft. sections of pipe works well for this. Two-ft. anchors work well in soft-bottom areas, but longer anchors (3 to 4 ft.) are required in sandy-bottom areas where water current speed is greater. A 51-ft. length of rope is cut using an electric rope cutter/burner (Fig. 13). Each end of the rope is melted to prevent unraveling. The end of the rope is then run through the holes in the line anchors (Fig. 14). Overlap approximately 6 in. at each end of the 51-ft. rope and secure with four or five 1/2-in. stainless-steel hog rings spaced about 1 1/2 in. apart (Fig. 15).

Bag Assembly

For each bag on the line, two lengths (36 in. each) of polypropylene rope are cut and melted on the ends. These are called crossties. Each end of the crosstie is knotted (slip knot) and hog ringed (Fig. 16). Then the bag is folded by placing one end into the bag folder on the table (Fig. 17). The bag folder is pushed down, which forms a crease approximately 2 in. from each end of the bag (Fig. 18). Reverse the bag and repeat, making sure that the new fold is in the same direction as the fold on the opposite end (Fig. 19). Place a crosstie within each fold (Fig. 19). To close the bag securely, a crossbar is pulled down the bag over each folded end containing the rope (Fig. 20).

OPTION: To keep the crosstie from pulling out of the fold of the bag and crossbar during harvesting, it is recommended that two cable ties be used on both ends of the bag to secure the bag assembly to the crosstie (Fig. 21).

Bag Attachment and Stocking

Bags are stocked with clams by pulling one of the crossbars partially off the bag, opening one corner of the bag, and pouring in the clams (Fig. 22). The crossbar is then replaced. Individual bags (five per line) are attached to the rope by threading the knots of each crosstie through the longline (Fig. 23). Separate strands of the longline's rope by twisting in the direction opposite the rope's spiral. Then secure the crosstie by running the crosstie's knotted end through the hole in the rope's twist. Five bags are placed on each line with 1.5-ft. spaces between individual bags (Fig. 24). Place bags such that the folded lips are facing the same way - either up or down. Bagline systems deployed in the field should be checked visually every two weeks to ensure that bags are not buried with silt and sand.

OPTION: When deploying bags in areas with sandy sediments, bags may become heavy as they fill with sediment. When cleaning and filling, these bags may pull the crosstie knots through the longline. To prevent this from occurring, one can hog ring the knots of the crosstie to the longline (Fig. 25). This makes it a permanent part of the longline system.

STOCKING DENSITIES

Initial (shell length) stocking size of seed clams should be at least 1/4 in. (6 mm). The seed are planted in 3/16-in. mesh bags. A more preferable stocking size is 1/2-in. seed planted in 3/8-in. mesh bags. Initial stocking densities should be 6,000 clams per bag. The seed are thinned in approximately six weeks. Thereafter, the clams need to be thinned at intervals of about two months depending upon growth. The first time the numbers are reduced to 3,000, the second time to 1,500, the third time to 750, and finally to 500 clams per bag for growth to market size. By starting with high initial densities and thinning every six-to-eight weeks, mariculturists can reduce the materials and initial costs and use their time more efficiently by starting with fewer bags and checking more often to remove predators.

STOCKING BY VOLUME

To estimate accurately the number of clams to be stocked, count out 500 clams. Pour a known volume of water into a calibrated container that is capable of holding the chosen volume of water and the 500 clams. Add the clams to the water and note the total volume. Subtract the original volume of water (Fig. 26). Do this procedure 3 times (500 additional clams per time) and average the volume measurements to reduce the chance of error (overstocking/under-stocking). To get 500 clams without counting more, start with the original volume of water and add clams until you get your desired total volume again. This is the average of the 3 volume measurements noted above. To stock 3,000 clams, this procedure is repeated 6 times and to stock 6,000 clams, 12 times, etc. Repeat this entire procedure for clams of differing sizes, because the same number of clams will give you a different volume if they are larger or smaller.

PLACEMENT OF BAG SYSTEM IN FIELD

After a complete five-bag line is constructed and stocked, the whole system can be stacked easily for transport. Duct tape can be used to hold one anchor and the folded longline together, per side, to prevent the stacked bags from separating and tangling while being transported (Fig. 27). The line can be moved directly to its field grow-out site or stacked in a boat or truck bed for transport. To set out the system, remove the tape and pull the longline tight. Then lay it down on the bottom parallel to the current (at or near the mean low-water mark). The two line anchors are then pushed into the sediment to secure the line (Fig. 28).

Leave a little slack in the line to ensure that all bags lie flat on the bottom. Ideally, a layer of silt should settle over the bags to prevent fouling. Bags should then be shuffled to distribute the clams equally within the bag. This step is important because it reduces the negative impacts caused by clams clumping within the bag. Bags should be placed so that the folded lips are facing down in the sediment. This bag positioning is important because (when bags are handled,) the crosstie tends to pull out of the crossbar, if the lip is upright.

HARVESTING BAGS WITH PUMPS

Routine maintenance and final harvest of seed clams are more easily accomplished with the use of a small 3.8 hp centrifugal pump and hose system. The pump (Fig. 29) is mounted on a piece of 3/4-in. plyboard and secured with straps. Attached to the pump inflow is a 2-in. schedule 80 PVC pipe bent three times at right angles (depending on boat hull configuration) (Fig. 29). It is important that an adequate length of inflow pipe clear the hull's freeboard and remain submerged (at least 6 inches) during pump operation. The boat should be anchored at both bow and stern to prevent it from moving into shallow waters during pump operation. Attached to the pumps outflow is a section of threaded 2-in. schedule 80 PVC pipe bent twice at 45° angles. It is important that this section of pipe also clears the freeboard, since abrasion could wear a hole in the flexible hose if it contacts the hull during pump operation.

Depending on the planting site, 50 to 150 feet of flexible 2-in. outflow hose is recommended. This hose is purchased in 25-ft. sections which are screwed together to form the desired length. One man can hold and manipulate the flexible hose to flush accumulated sediment from the clam bags. It is recommended that the mesh-bag lines placed highest on the tidal flat and upstream from the current be washed out first as accumulated sediment will wash downhill and downstream filling lower bags during the routine cleaning. When harvesting the clams, clean all bags on an individual longline system and stack the entire line (or individual bags, if preferred) in the boat hull after flushing has been completed.

PREDATORS/PARASITES

Cliona

Cliona is a small yellow parasitic sponge which will bore into clamshells. Placing clams so they can burrow into the sediment or so that bags will fill with sediment will help prevent the sponge from settling on the clams. Cliona will not kill the clam, but extensive boring causes the clam shell to become structurally weak. Consequently, the clam may be more susceptible to crab predation and slower growth. Also, Cliona boring makes the shell unsightly to the consumer. Fouling of the clams by Cliona may occur if bags and clams are not covered with sediment. If Cliona settling does occur, it can be killed by flipping the bags periodically (every 3 months) and ensuring that clams are covered with silt.

Blue Crabs

Blue crabs are one of the most harmful predators of clams in the southeast and can kill clams as large as 1 1/2 inches in shell length. To prevent loss of clams to blue crabs, bags should be checked every three months. The crabs can be removed or killed in the bag by crushing the crabs with a tool or by hand. Unfortunately, some of the best locations for clam grow-out are areas close to oyster beds. Since these areas are also where crabs are abundant, the fight with blue crabs is an ongoing process which must be taken into account in the aquaculturist's plans.

Mud Crabs

Mud crabs are also predators of clams. These crabs, like most species of crab, can crush and eat clams up to 1/3 the length of the crab's shell. This means that even small mud crabs can do a great deal of damage to a bag of small seed clams. Damage control of mud crabs is much the same as with blue crabs. Bags must be checked periodically and thoroughly since these small brown mud crabs are harder to see than blue crabs.

Oyster Drills

Oyster drills are small snails that drill through the shell of clams. These snails can kill small clams up to about 1/2-in. in shell length. The oyster drills are not a danger to larger clams.

BAG FOULING

The mesh bags may become fouled by bottom-dwelling organisms if not properly positioned in the field so that a layer of silt covers the bags. Marine algae, bryozoans, or hydroids may attach to the plastic or to clams that are exposed. The main fouling organisms are sea squirts (Tunicates). These animals may cover the bag completely, restricting water movement, and consequently restricting the availability of food in the bag. Sea squirts are filter feeders that compete for the same food as the clams. To clear bags of fouling organisms, return them to the dock; remove the clams from the bags and then pressure wash or scrap the bags and let them air dry. Clams may last several days out of water if the weather is not too hot or cold, but most fouling organisms cannot survive more than a few hours out of water. Bags also may be rolled over in the field. The fouling organisms will be pushed down into the mud where they will suffocate and the clams can right themselves within the bags. Remember, after turning the bags, the folded lips will be face-up and care must be taken when handling or moving the bags on the next site visit.

LIST OF TOOLS REQUIRED

- 7-in. circular saw
- industrial grade grinder
- rope burner/cutter
- 1/3-hp power drill (7/16-in. bit)
- hog ring pliers (1/2-in. stainless-steel hog rings)
- pressure washers (1500+ PSI)
- 4 1/2-in. grinder/sander (optional)
- 3.8-hp gasoline engine pump

EAST COAST U.S. CLAM SEED SUPPLIERS

Aquacultural Research Cooperation
P.O. Box 2028
Chapin Beach Road
Dennis, MA 02638
800-334-1380

Bagwell Enterprises
Smith Beach Road
Eastville, VA 23347
804-678-5806

Bay Farms
586 Dock Road
West Creek, NJ 08087
609-294-0235

Bears Creek Shellfish
506 W. Spring Street
Swansboro, NC 28584
910-326-2088

Biosphere
1199 S. Green Street
Tuckerton, NJ 08087
609-296-0945

Blueprints
P.O. Box 8
W. Sayville, NY 11796
516-589-0123

Carolina Cultured Shellfish
P.O. Box 3576
Morehead City, NC 28557
919-728-1411

Chincoteague Shellfish Farm, Inc.
P.O. Box 576
Chincoteague, VA 23336
804-336-1985

Low Country Seafood
P.O. Box 262
McClellanville, SC 29458
803-887-3389

Mook Sea Farm's, Inc.
HC 64, Box 041
Damariscotta, ME 04543
207-563-1456

SeaPerfect Clam Farms
2107 Folly Road
Charleston, SC 29422
803-762-0022

CAUTION

The Georgia Department of Natural Resources (GA DNR) bans the importation of any bivalve seed into the State of Georgia in an attempt to reduce the threat of accidental introduction of various pathogens (diseases, e.g., the oyster disease *Perkinsus marinus*, "Dermo", and/or *Haplosporidium nelsoni*, "MSX") into Georgia shellfish populations. Importation of quahogs may be allowed with special permission by the GA DNR. The importer must arrange to have each shipment of hatchery seed inspected and certified by a shellfish pathologist as disease-free. Each shipment of seed, even from the same hatchery and stock, must be checked for diseases. Most commercial hatcheries routinely provide this service at an added cost to the purchaser.

Contact the GA DNR for current procedures:

Shellfish Program Manager
Georgia Department of Natural Resources
1 Conservation Way, Brunswick, GA 31522
912-264-7218

MATERIAL SUPPLIERS

ADPI Enterprises, Inc.
3621 "B" Street
Philadelphia, PA 19134
800-621-0275

- 3/16, 3/8 and 5/8 in. mesh bags

Memphis Net & Twine Co.
2481 Matthews Avenue
P.O. Box 8331
Memphis, TN 38108
800-238-6380

- hog ring pliers
- 1/2-in. stainless steel hog rings
- rope cutter
- twisted polypropylene rope

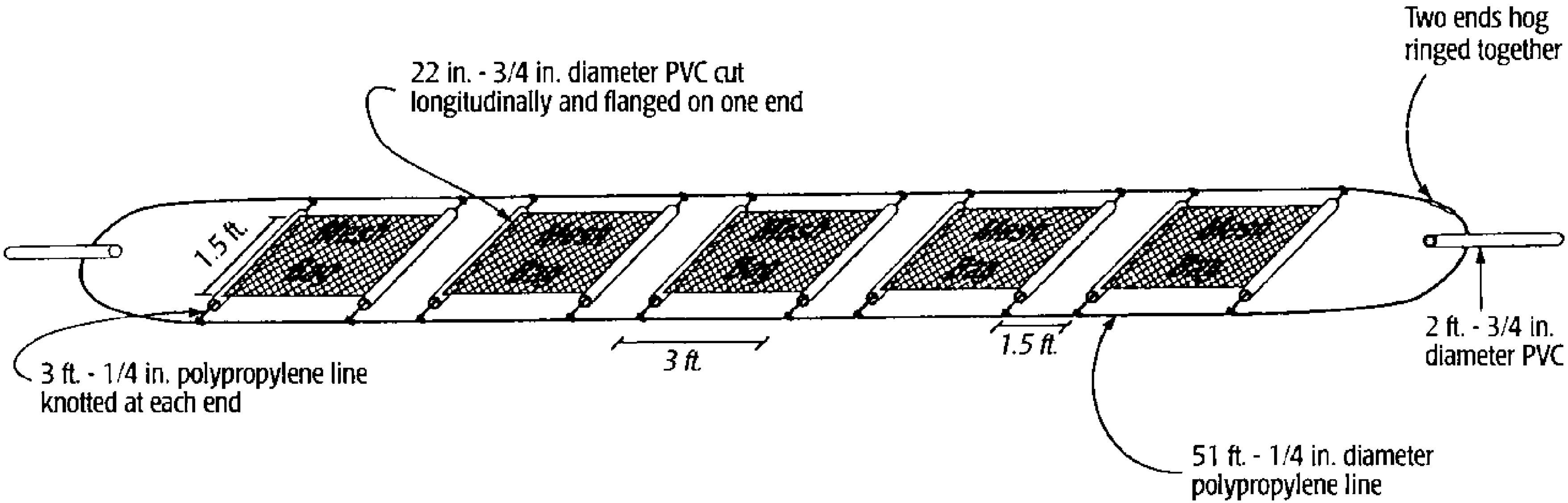


FIGURE 1 Schematic of the mesh bag line system for culturing northern quahogs in soft-bottom areas

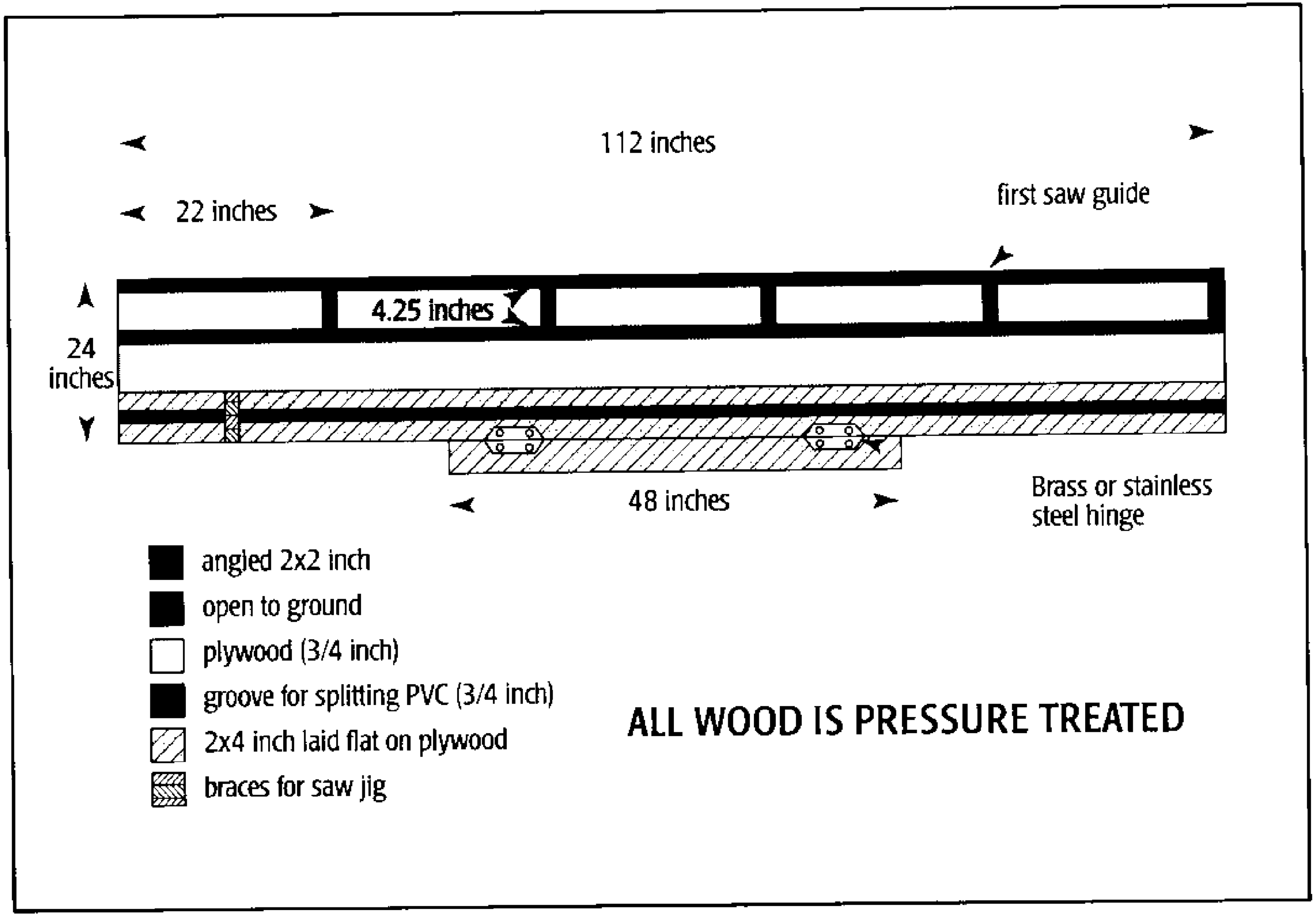
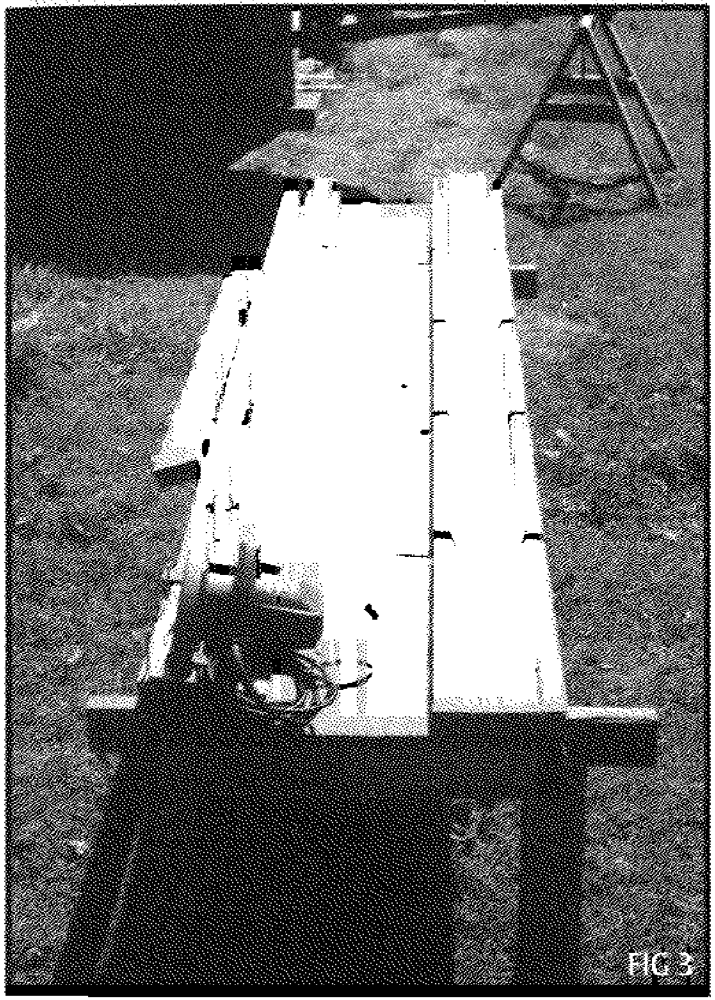


FIGURE 2 Schematic of the work table used to construct the mesh-bag-line system



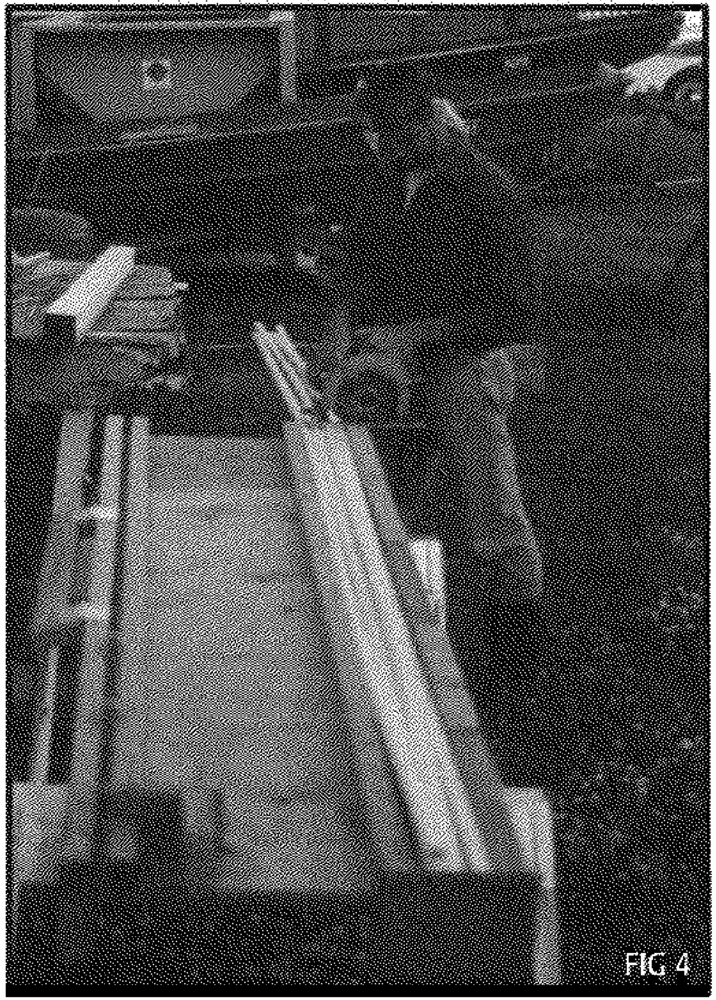


FIGURE 3 Photograph of the work table

FIGURE 4 Photograph of four 3/4-in. PVC pipes secured in the cutting tray and ready to be cut with a circular saw

FIGURE 5 A 10-foot section of pipe positioned in splitting trough

FIGURE 6 Photograph of bag folder board on top of pipe which prevents the pipe from jumping out of trough

FIGURE 7 Close-up of saw and pipe being split. Note the two PVC cable clamps holding and guiding the pipe for the saw.

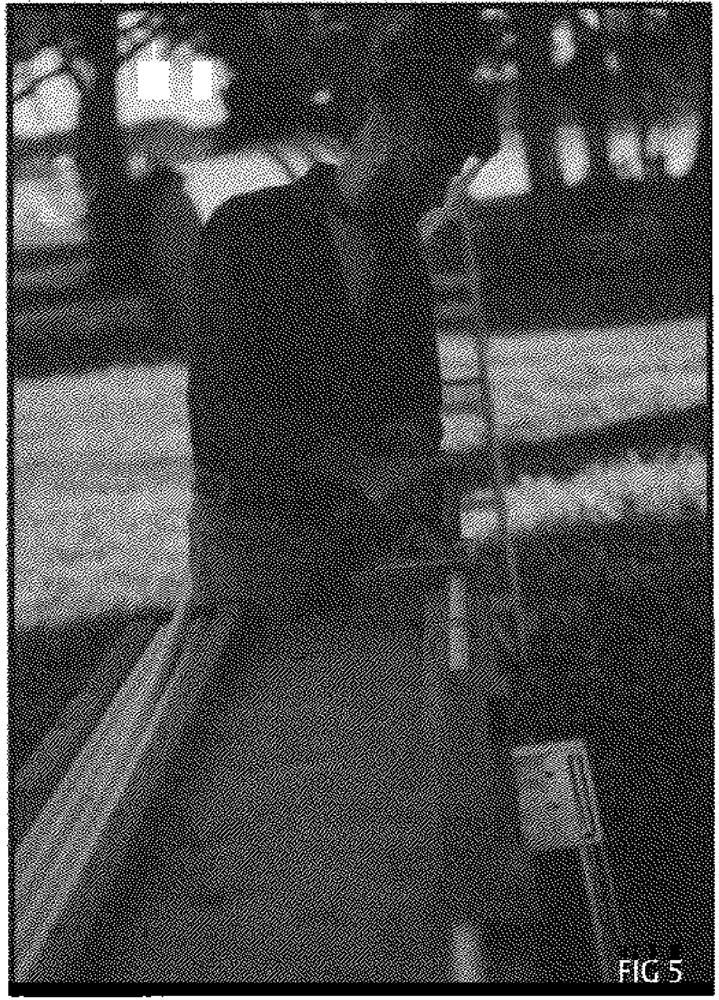
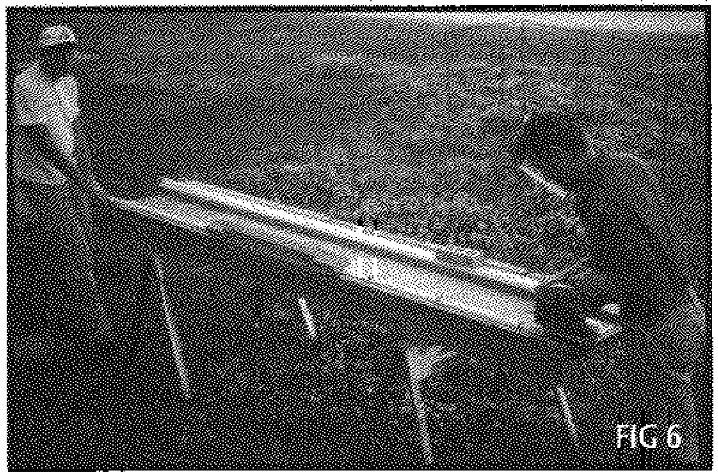


FIG 5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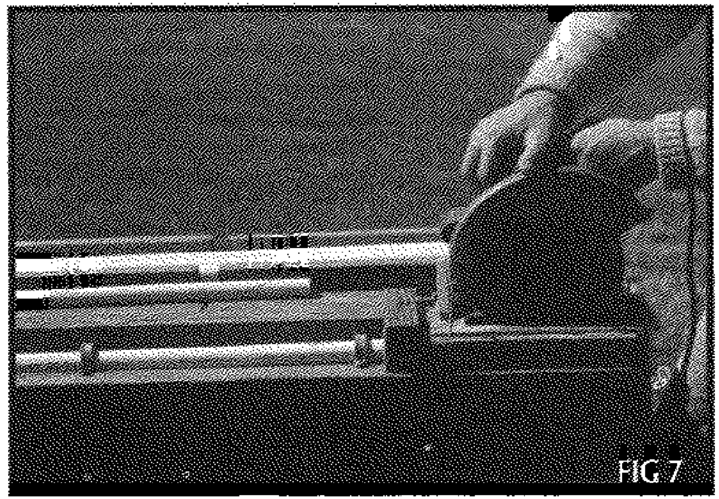
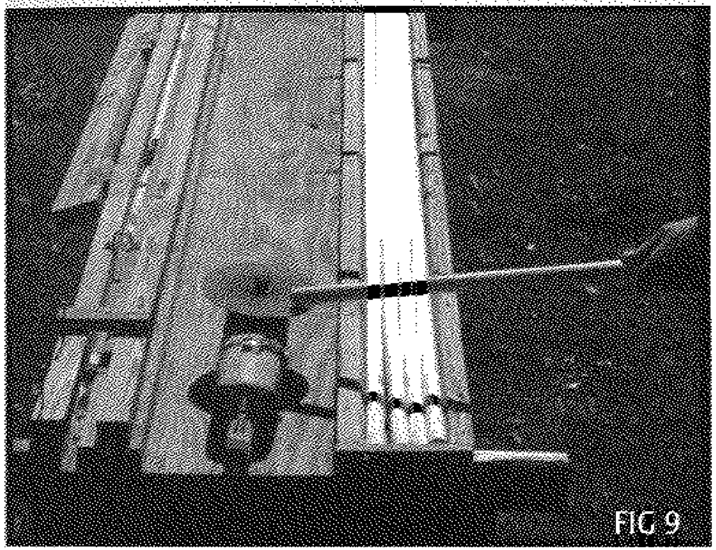


FIG 7



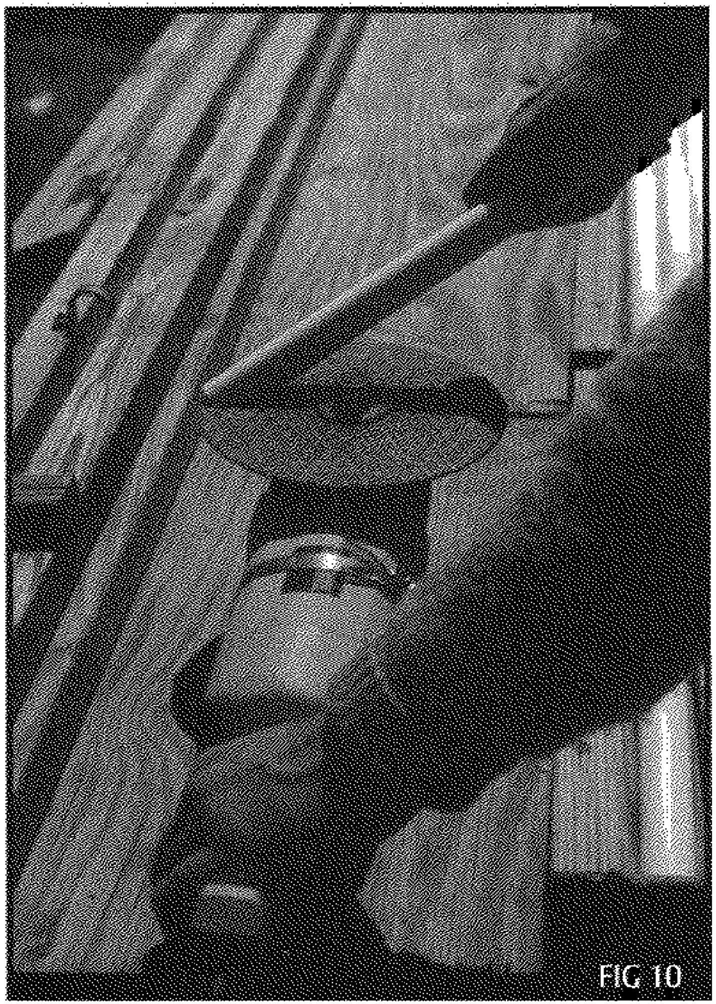


FIGURE 8 Photograph of four split pipes being cut to form crossbars

FIGURE 9 Photograph of grinder mounted by ring clamp on the working table

FIGURE 10 Photograph of crossbar being ground to a point

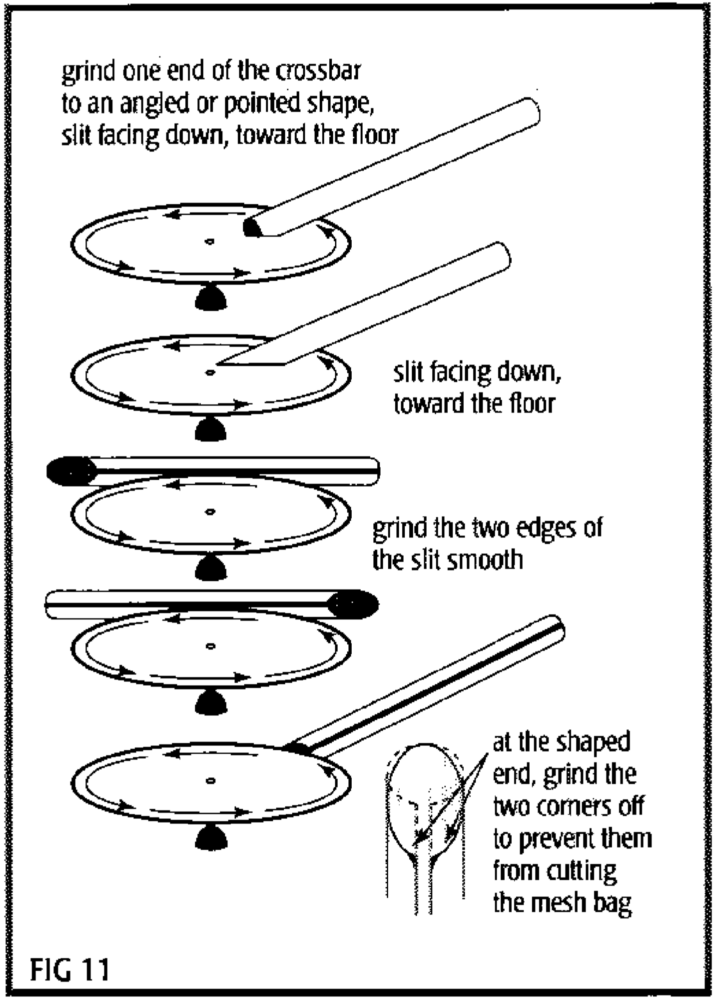


FIG 11

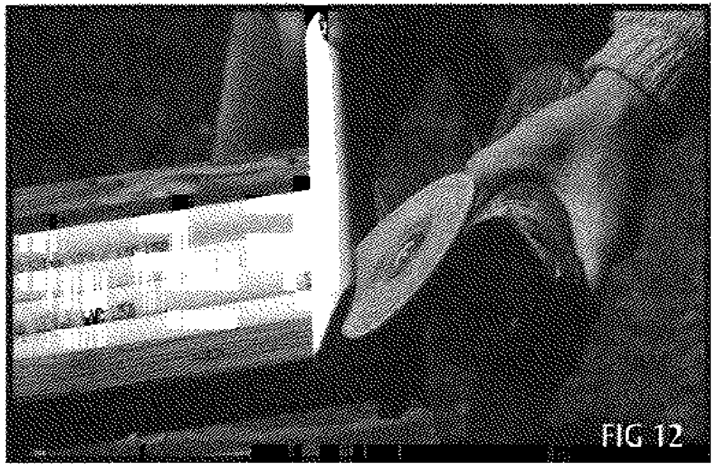


FIG 12

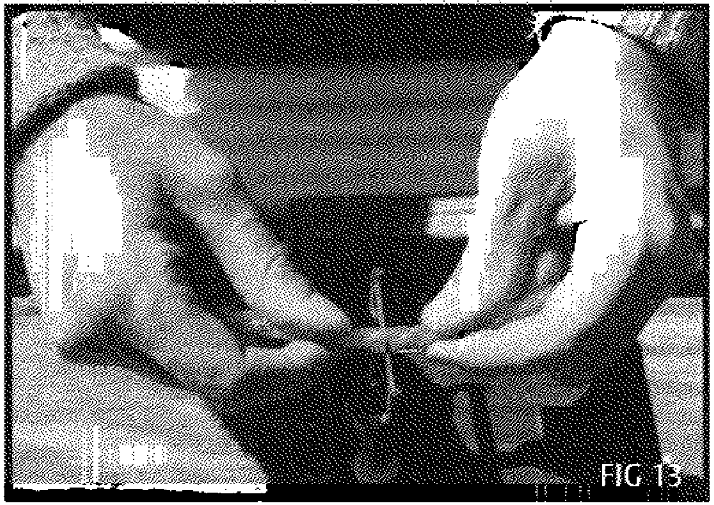
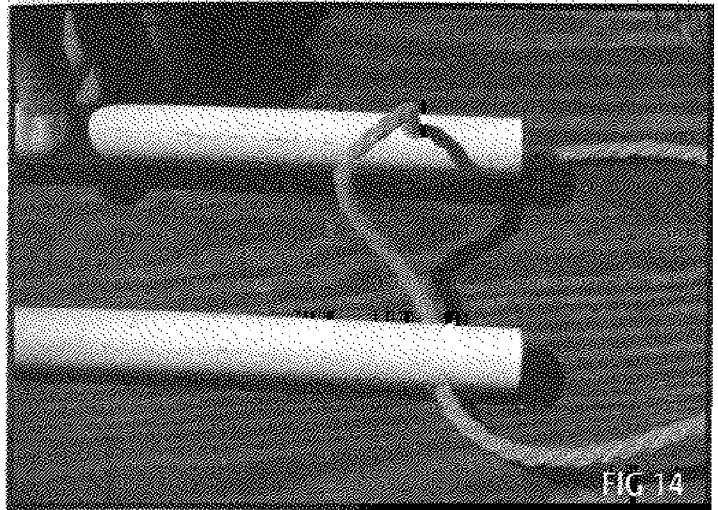


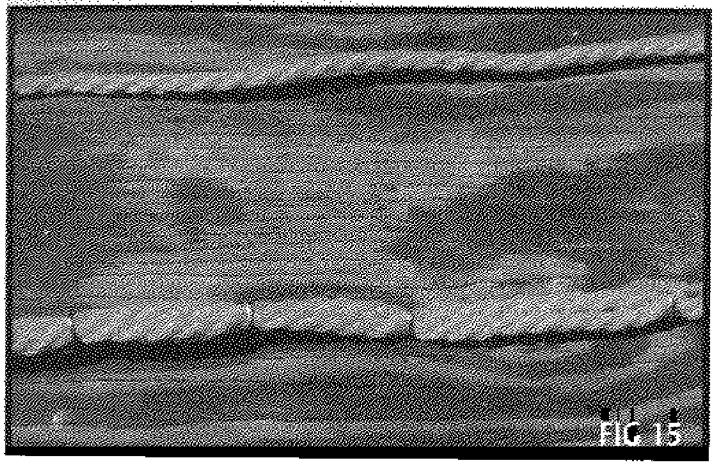
FIG 13

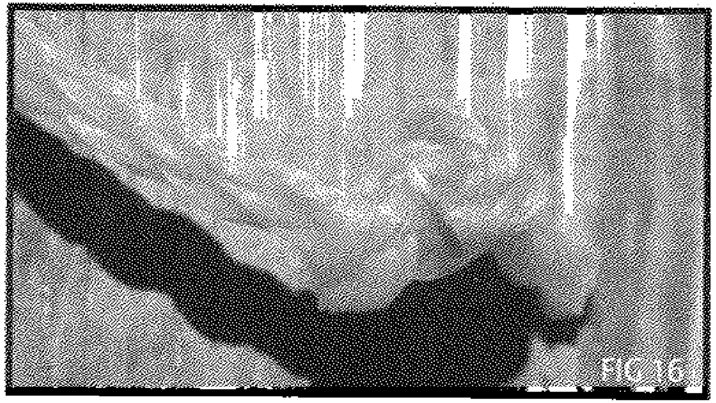
FIGURE 11 Schematic of crossbar construction

FIGURE 12 Smoothing the split in a crossbar with a small grinder

FIGURE 13 Cutting and melting the ends of the rope with an electric rope cutter







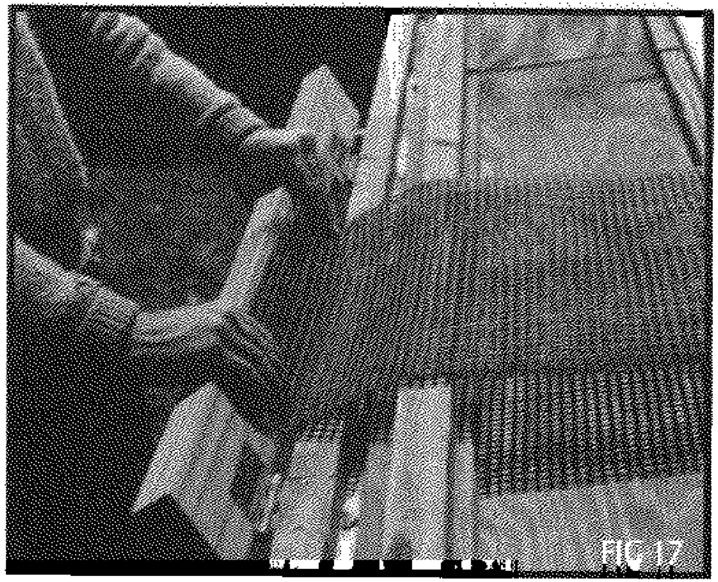


FIGURE 14 Photograph of one end of the rope passing through the holes in the two anchor pipes

FIGURE 15 Photograph of the two ends of the longline being attached together with hog rings

FIGURE 16 Photograph of the knotted end of the crosstie with a hog ring securing the knot from unraveling

FIGURE 17 Photograph of 2 inches of one end of the mesh bag being placed in the folding apparatus on the work table

FIGURE 18 Photograph of forming the fold in the mesh bag

FIGURE 19 Schematic of the folds in the mesh bag, position of the crossties, and the crossbar attachment

FIG 18

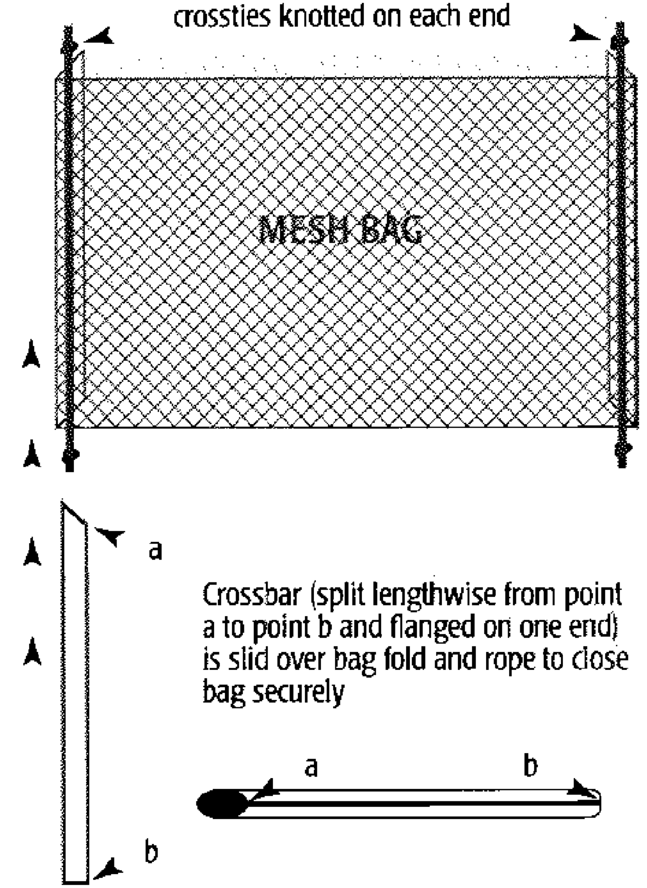
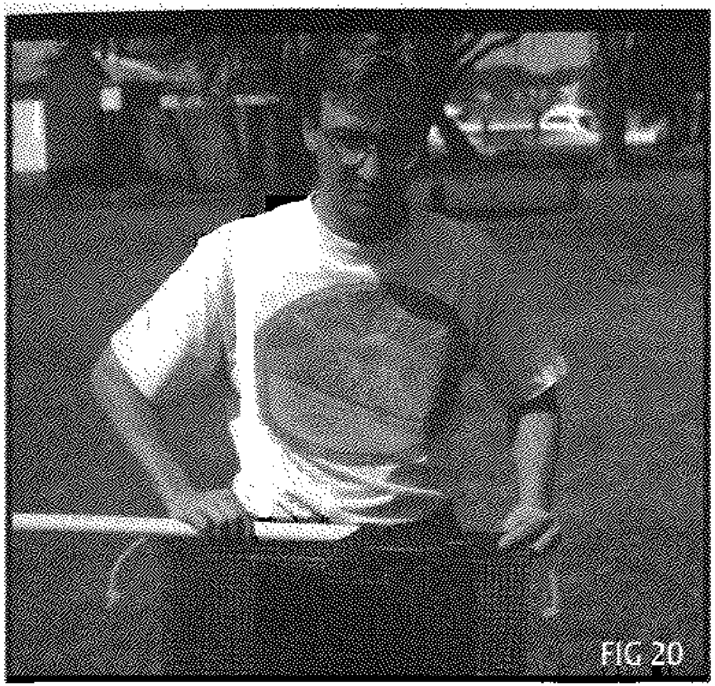


FIG 19



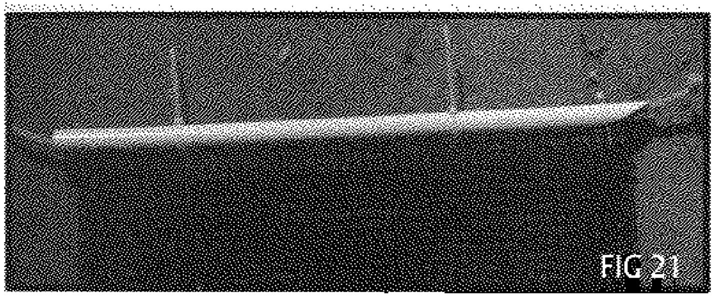


FIGURE 20 Photograph showing how the crossbar slides over the crosstie and mesh-bag fold

FIGURE 21 Photograph of two cable ties used to secure the crosstie, crossbar, and mesh bag to the longline

FIGURE 22 Photograph of the mesh-bag unit with clams

FIGURE 23 Photograph of crosstie knot inserted through the strands of the longline

FIGURE 24 Photograph showing spacing between mesh bags on the longline

FIGURE 25 Photograph of hog ring holding the crosstie to the longline

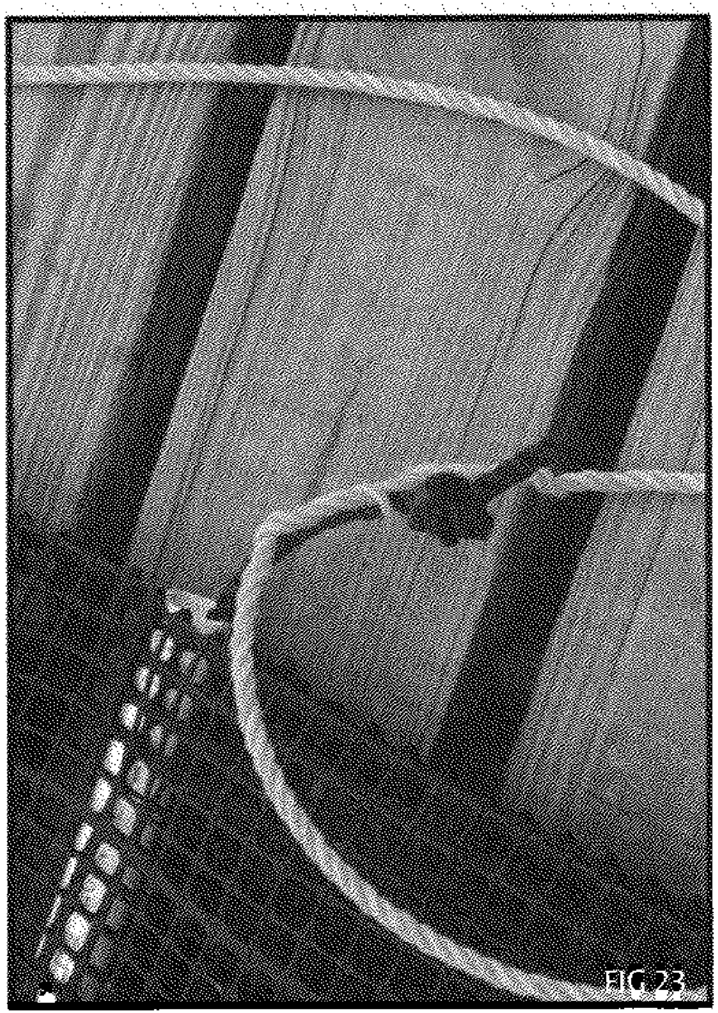
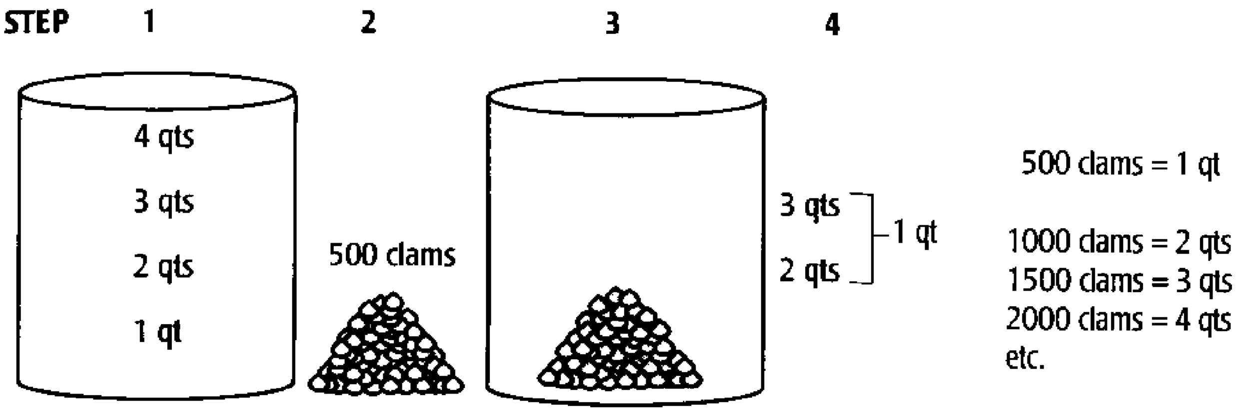


FIG 23

FIG 24

FIG 25



1. Start with a graduated one-gallon container and add 2 quarts of salt water.
2. Count out 500 clams.
3. Add the clams to the 2 quarts of water and note final volume of the water.
4. The final volume minus the initial volume equals the volume of the 500 clams (In this example, the volume of 500 clams is one quart).
5. Repeat the procedure three times (with two additional counts of 500 clams) to minimize mistakes.
6. Average the three volume estimates.
7. Once the average volume of a known number of clams is determined, rapid counting of clams can be undertaken by filling the container to 2 quarts and adding clams until the predetermined volume level is achieved.

FIGURE 26 Instructions on determining the volume of quahogs required to stock a mesh bag

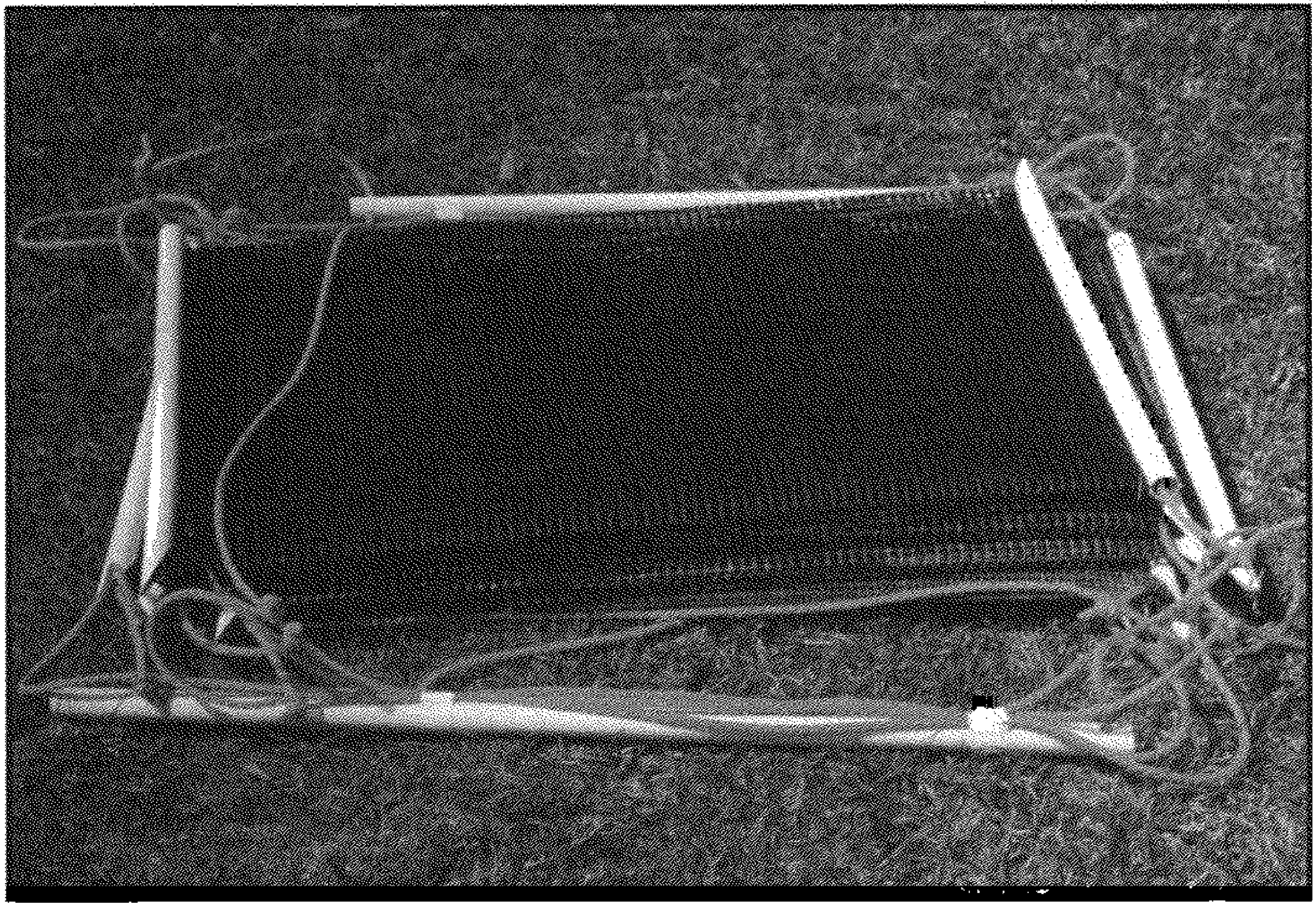


FIGURE 27 A complete longline with five bags stacked and taped to keep them from tangling

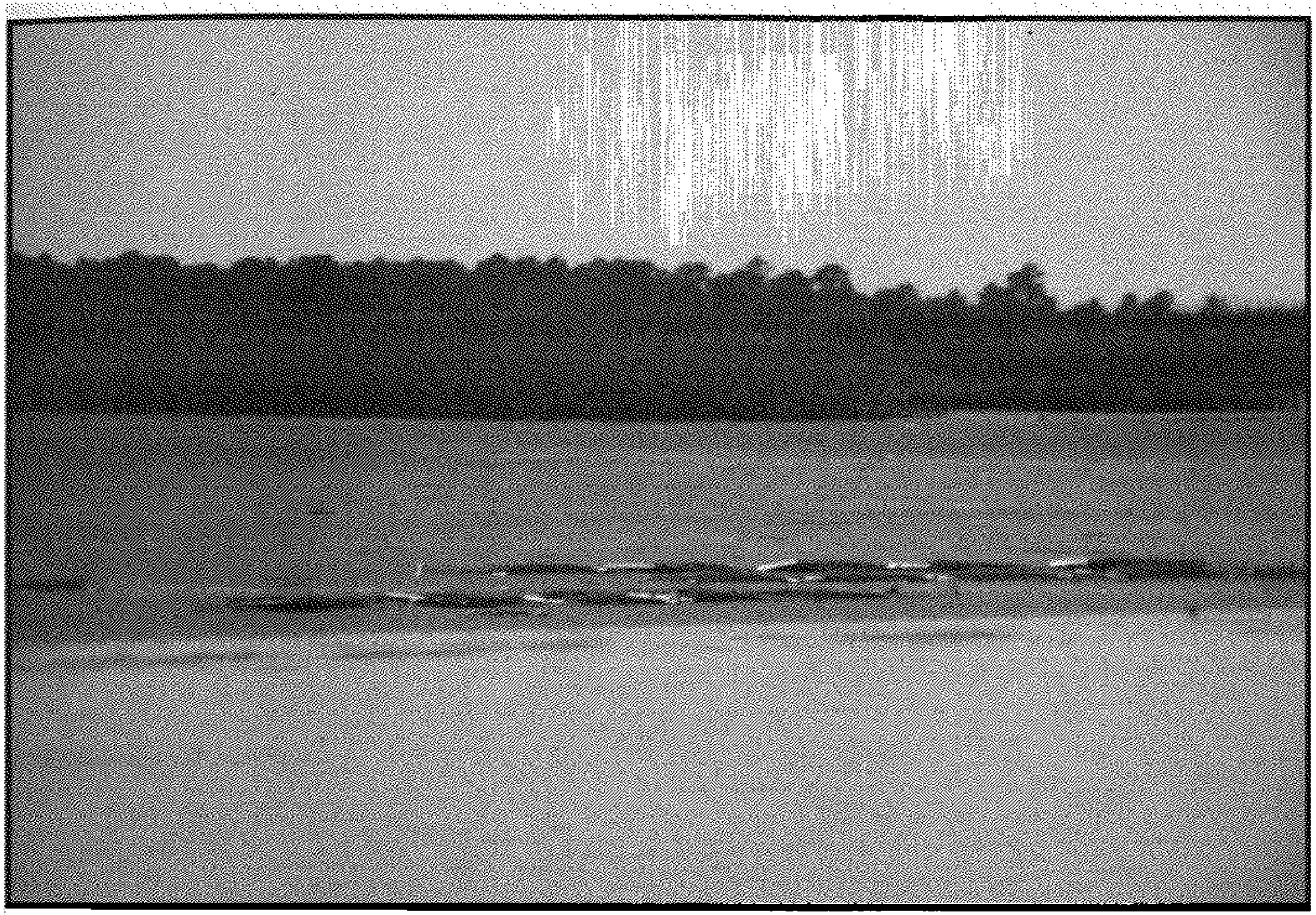


FIGURE 28 The deployment of the mesh-bag-line system in the field

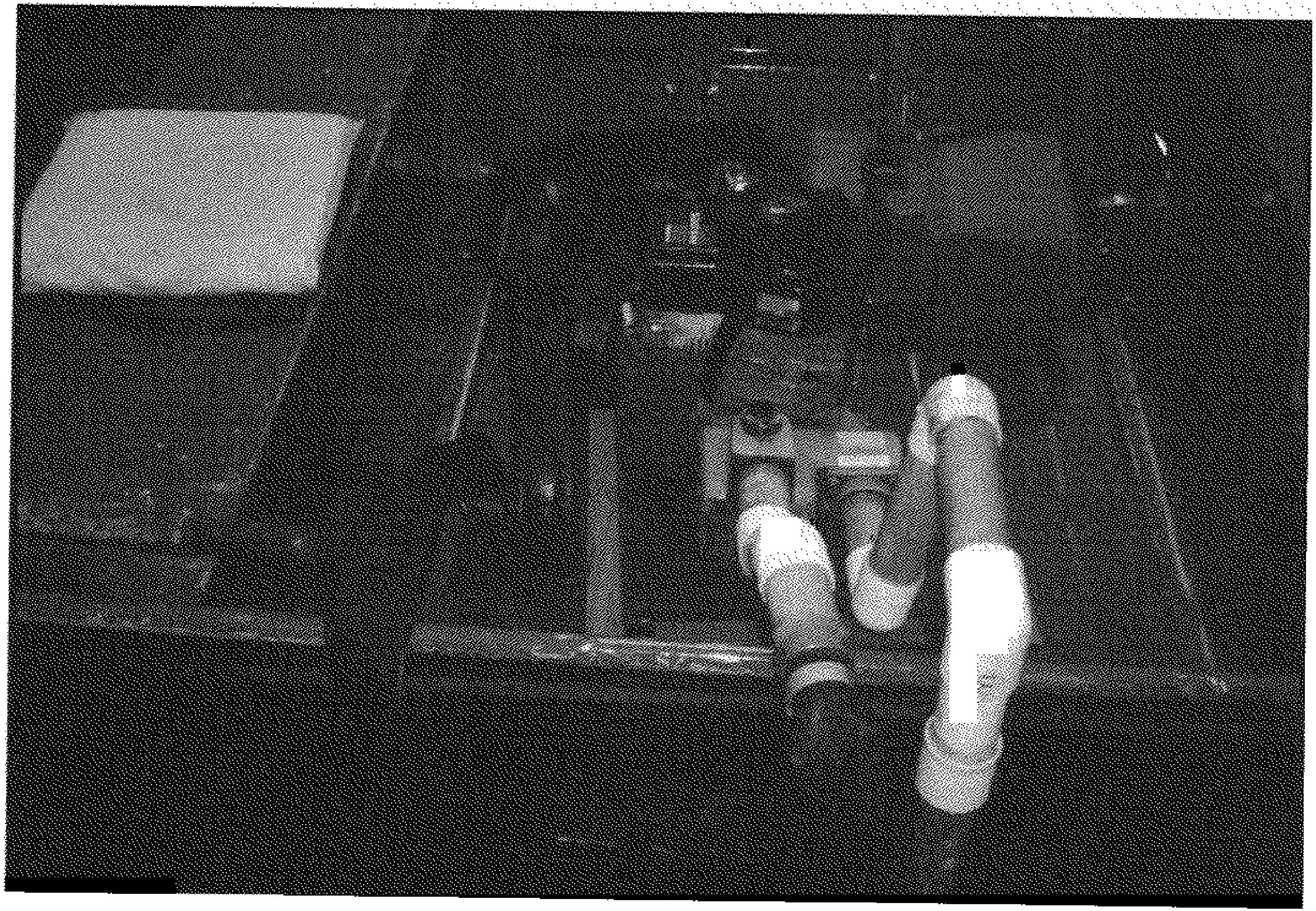


FIGURE 29 The pump setup for harvesting or cleaning bags