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A PROPOSED NEW DEPLOYMENT SCHEME, COMBINING DRILL-SHIP AND MASTER-BUOY CONCEPTS: THE DUMAND TOWER

by

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The master-buoy deployment scheme, as described in the Proceedings of the 1980 DUMAND Deployment Workshop[1], has the advantage of using a much less expensive ship for deployment than the Glomar Challenger, or any other drill ship. The master buoy, with its array of glide bodies, is a self-contained deployment module requiring no mechanical manipulation except to implant it in the proper position and orientation. To control its operation only electrical signals are required. Fig. 1 illustrates these concepts.

If we compare the drill-ship scheme[2] with the master buoy, we note that the drill-pipe has the advantage that many deployment modules - in this case individual canisters, each containing a single string - can be strung on it at once (thus providing the name "bagel-on-a-string"). Many canisters can be emplaced in a single lowering of the drill string. However, we note that the only use made of the drill pipe is as a mandrel on which the canisters are stacked; the capability of the ship to rotate the pipe, using it as a drill, is unused. Fig. 2 shows the drill-string deployment concept.

This comparison suggests the possibility of combining the two deployment schemes into one that does not require an expensive drill ship, but merely a ship - possibly even a barge - with the appropriate winch and cable control equipment. Possibly the ORB may be satisfactory. We outline below such a scheme; it falls into two parts.

A. Modification of the master buoy. In the master-buoy system, a single buoy, which we now call a sub-master, can be equipped with six glide bodies, and could therefore deploy directly a hexagon of six canisters, a seventh being on the axis and requiring no glide body. Six such sub-master buoys, each connected by a rotating arm to the central master buoy, can be used[1] to deploy an array of seven such hexagons, thus allowing up to 133 strings to be emplaced in a single deployment operation. Figs. 3-8, from Ref. 1, show such a system. The assembly of master and sub-master buoys can become rather cumbersome, difficult to assemble on shore and to launch into the ocean, as may be inferred from Fig. 8.

We propose a modification of the basic sub-master buoy, in which the glide bodies are replaced by rotating arms of the sort shown in Figs. 4-5. They are now used, however, for individual canisters. A swinging arm to hold a single canister weighing perhaps 1000 lb in water need not be very massive; quite possibly a single steel pipe a few inches in diameter will serve. Its sole function is to allow the canister to fall, with suitable damping, from the upright position to the ocean floor, under the influence of gravity, when the arm is unlatched. In case sufficient damping cannot be readily provided, the release could be controlled by a cable and pulley system. Figs. 9-11 illustrate the idea. It appears likely that such an emplacement system would be simpler and cheaper, as well as more accurate than the use of glide bodies.

Another major difference between this concept and the original one lies in the positioning of the sub-master buoy. In the original scheme it is suspended some distance above the bottom by a cable to an anchor; its buoyancy holds it in place. In the present scheme, it is settled permanently on the bottom and its location and orientation checked, before it is anchored and the arms are released.

B. To connect together the sub-masters - there no longer is a master - we adapt the bagel-on-a-string concept from the drill-ship method. We now picture all the sub-masters mounted serially on a drill pipe or similar tube (Fig. 12). If they are mounted on the tube on shore, we see no serious difficulty in assembly, launch, and convoying to the deployment vessel, upending the strings, and lowering to the ocean floor by cable, as described in Figs. 8a-c.

Since there is a requirement for accurate location and orientation of the sub-master, the string will have to be provided with thrusters, like those on the drill-string, to locate the individual modules on the bottom and to give them their correct orientation. As in the drill-ship, these can be recovered and used over and over.

There is no particular reason to retain the nomenclature of the buoy; the module need not be buoyant, and resembles a tower more than a buoy. It is long and thin; its stability requires some attention. It will probably need a fairly wide base, perhaps with outrigggers, that can be used as an anchor. There may or may not be a permanent central pipe. If there is the individual arms can be fastened to it before release. However, all that is needed is a centering device to maintain the tower alignment with the pipe. This can be provided by sliding collars which are recovered when the towers have been deployed and the pipe string pulled up.

Advantages of Proposed Tower Scheme.

1. It retains the features of the drill-ship deployment that are useful to DUMAND; the rigid pipe, the existing mechanisms for attaching and releasing objects from the pipe (J-slot), and thrusters to position the pipe for accurate location and orientation.

2. It dispenses with unneeded drill-ship features: ability to assemble and disassemble pipe strings in segments when raising and lowering the string; and the mechanism for rotating the drill.

3. It adopts a useful feature of the master-buoy system: the lowering

by cable instead of pipe string, thus allowing the use of less expensive ships.

4. It dispenses with the relatively expensive glide bodies, substituting less expensive, more accurate rotating arms. Glide bodies can be readily adjusted for different glide distances; DUMAND does not require that versatility.

5. As in both alternative schemes, no underwater connections or underwater vehicles are required.

Disadvantages of Proposed Scheme.

1. It needs development of a stable tower platform, perhaps with folding outriggers for stability.

2. The unit of deployment is the tower, with nine modules. It is not clear how many towers can be deployed at once. Four would seems to be a minimum requirement, since this gives a 36-string MICRO array in a single deployment operation. It is not clear what will limit the number. It may be that separate mandrels can be assembled on the surface and deployed at once, each with several towers.

References.

1. The Master Buoy Approach, by R.E.Jones, Proc. DUMAND 1980 Deployment Workshop, LaJolla, Dec. 1980, p.35. A. Roberts, ed. Hawaii DUMAND Center, Honolulu, HI., 1981.

2. Deployment and Implantment of the DUMAND Array, by A. Schlosser, ibid., p. 13.

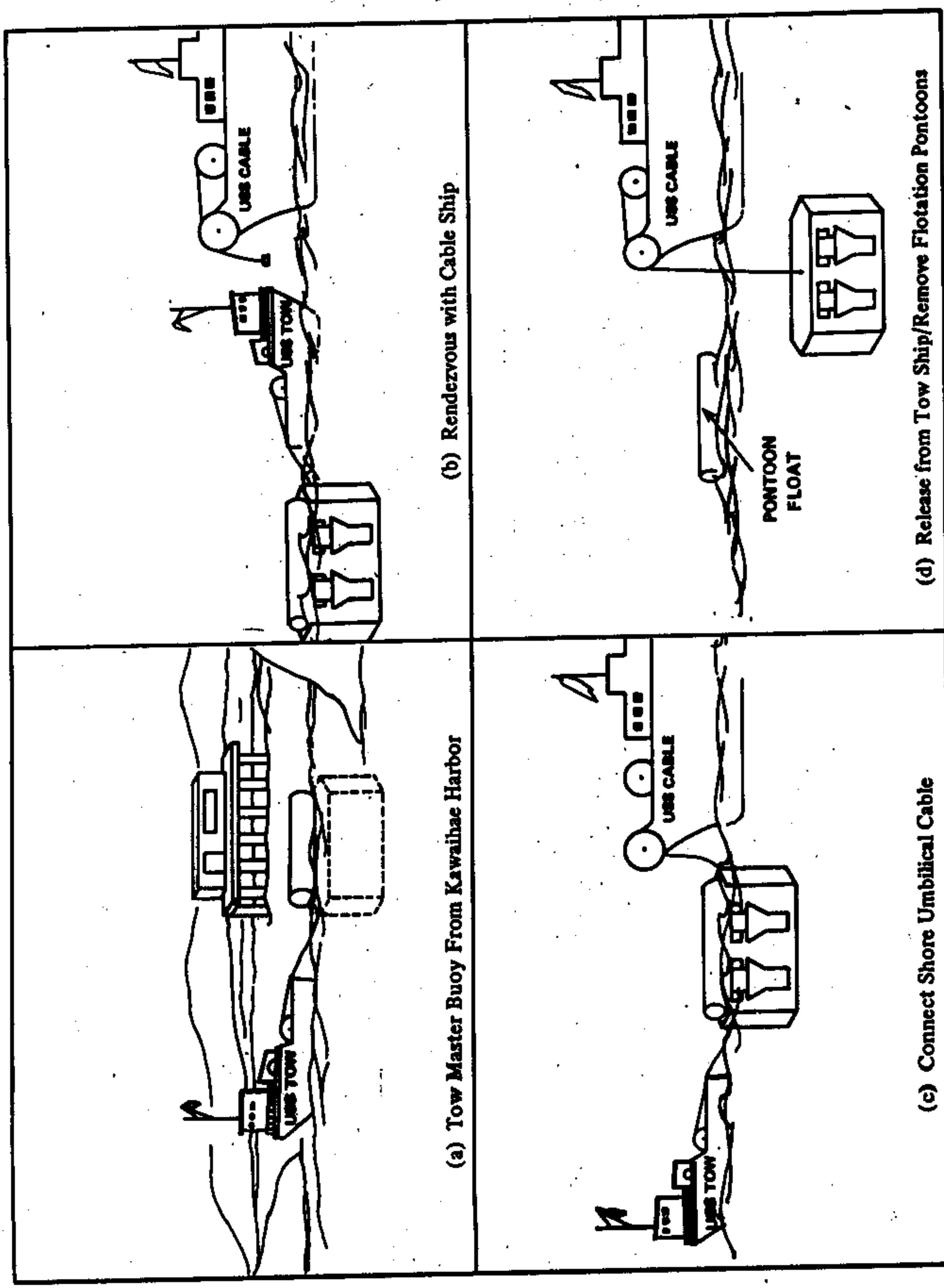


Fig.1a, b. The various stages in deployment of a single master-buoy system, equipped with glide-bodies, from shore assembly to final string release. Each glide body carries a canister containing a complete string. From Ref. 1.

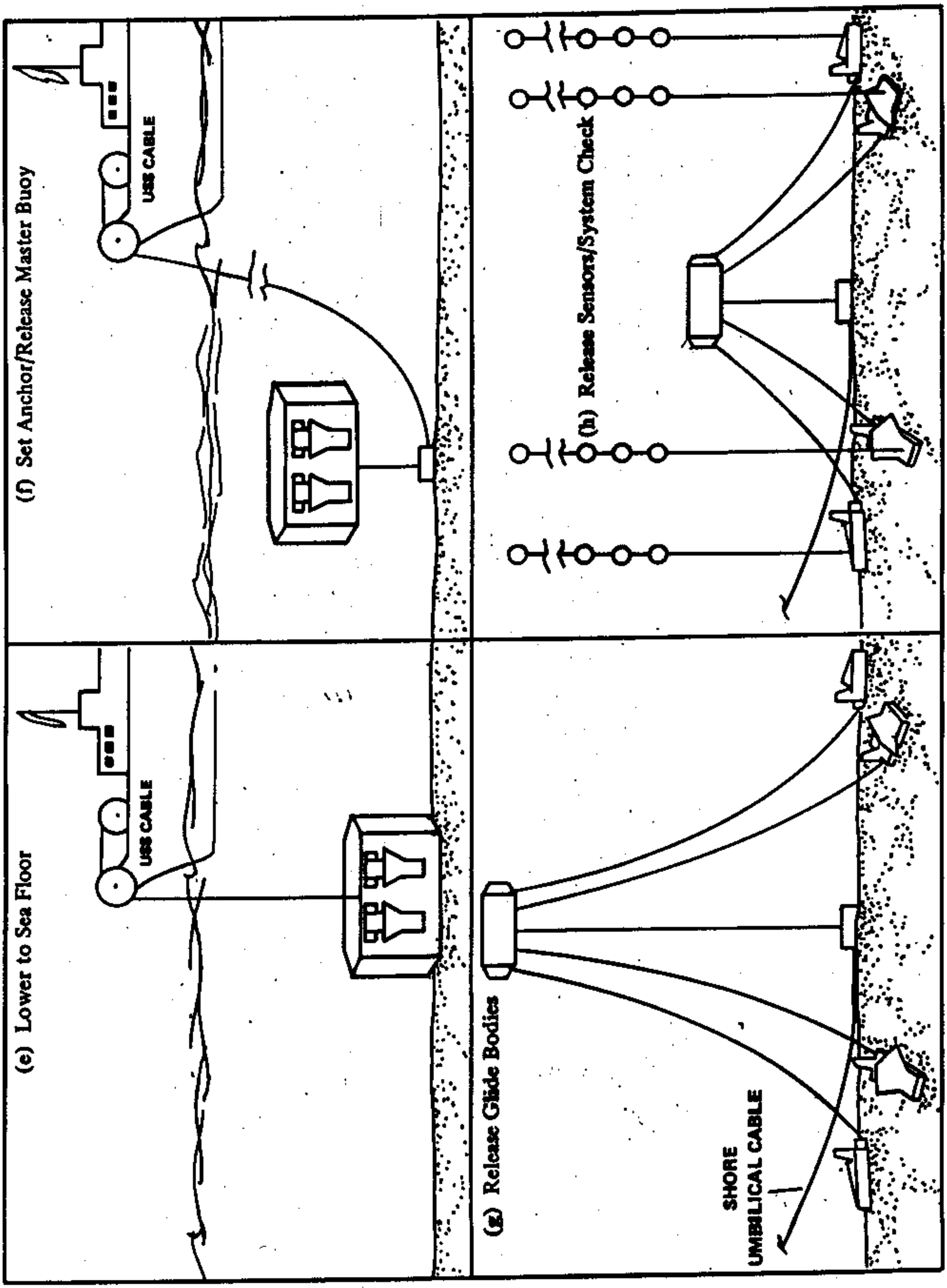

(e) Lower to Sea Floor
USS CABLE
(f) Set Anchor/Release Master Buoy
USS CABLE
(g) Release Glide Bodies
SHORE
UMBILICAL CABLE
(h) Release Sensors/System Check

Fig. 1b

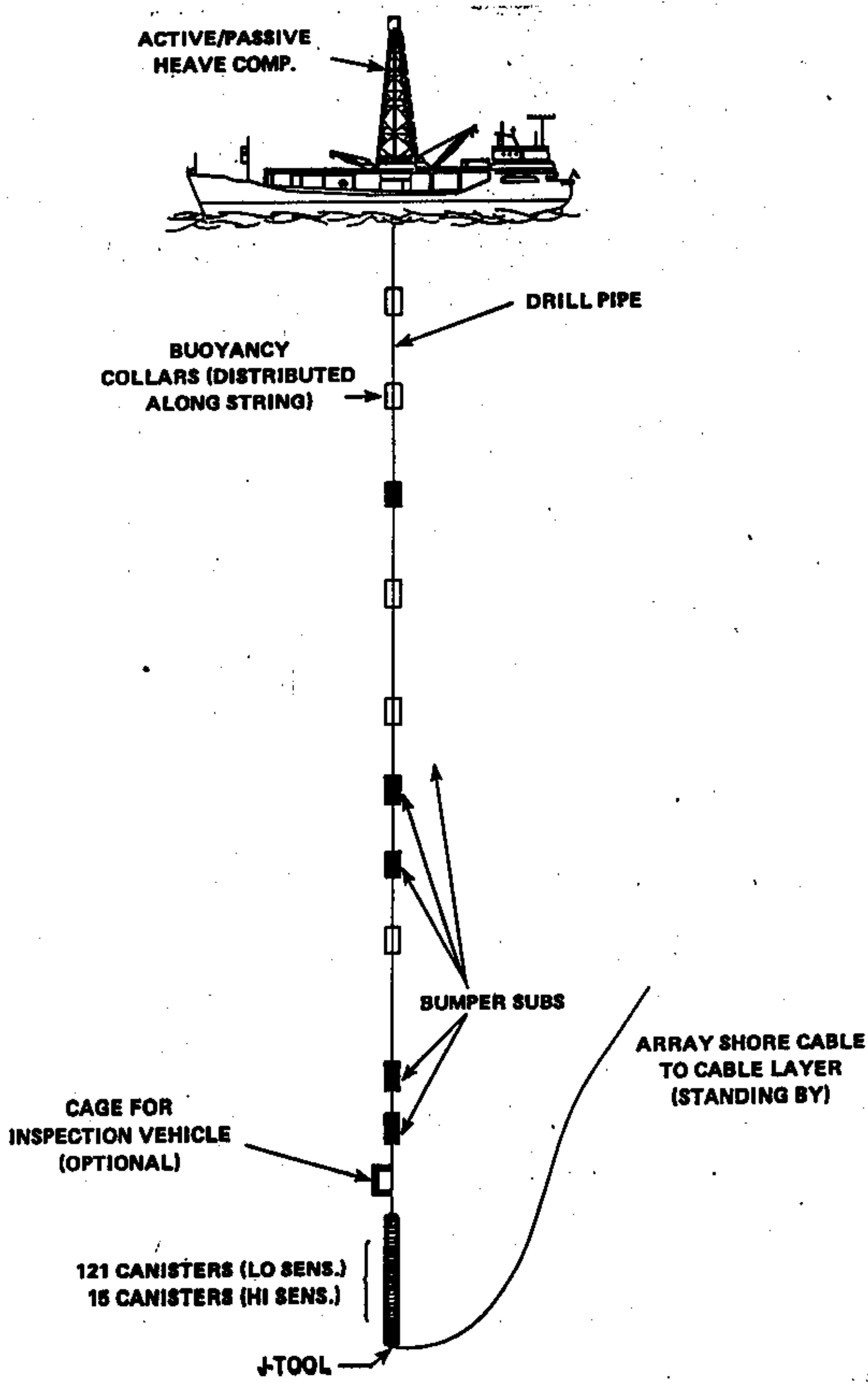


Fig. 2. Deployment of many canisters from a drill-ship, using a drill-pipe string. From Ref. 2.

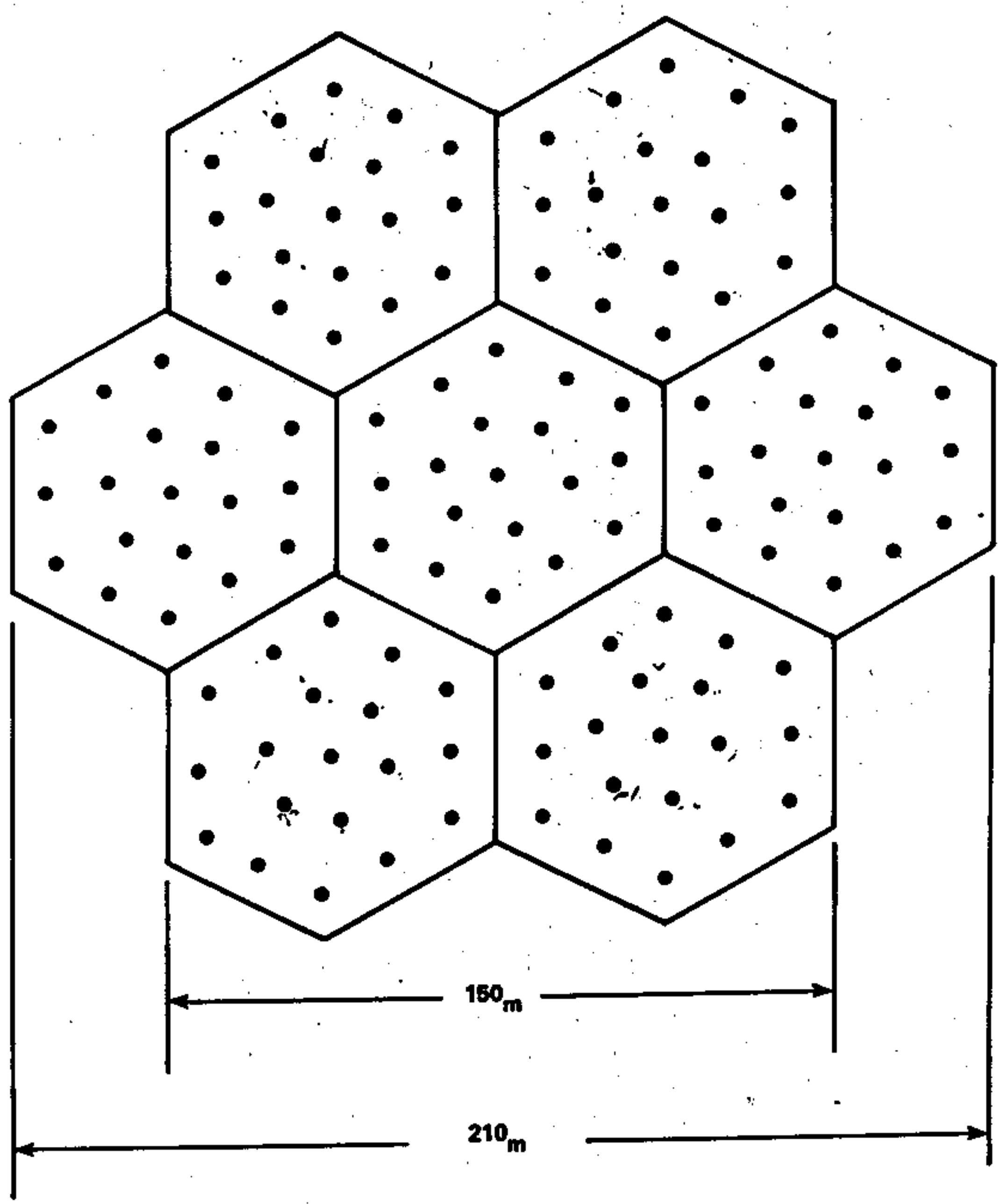


Fig. 3. A large array — the MINI - with seven hexagons, containing 19 strings each, that can be deployed by a master-buoy procedure, using seven sub-masters, as shown in Figs. 3-8, from Ref. 1.

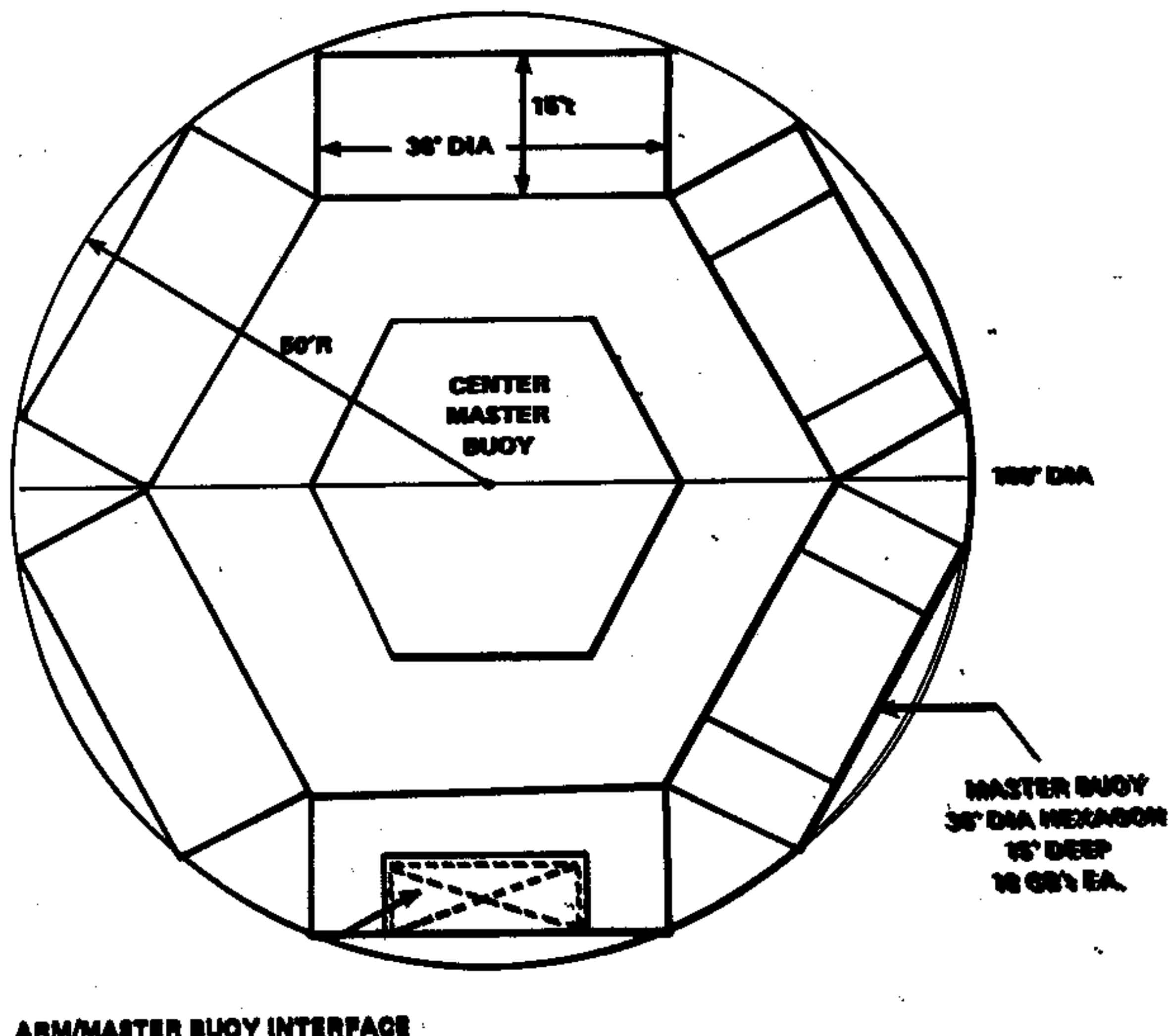


Fig. 4. An assembly of the central master-buoy and six sub-masters, mounted on a large (100-ft diameter) platform, in the folded configuration in which the array is deployed. The arms are 60m long, and are 10-ft square in cross-section to support the heavy sub-master buoys.

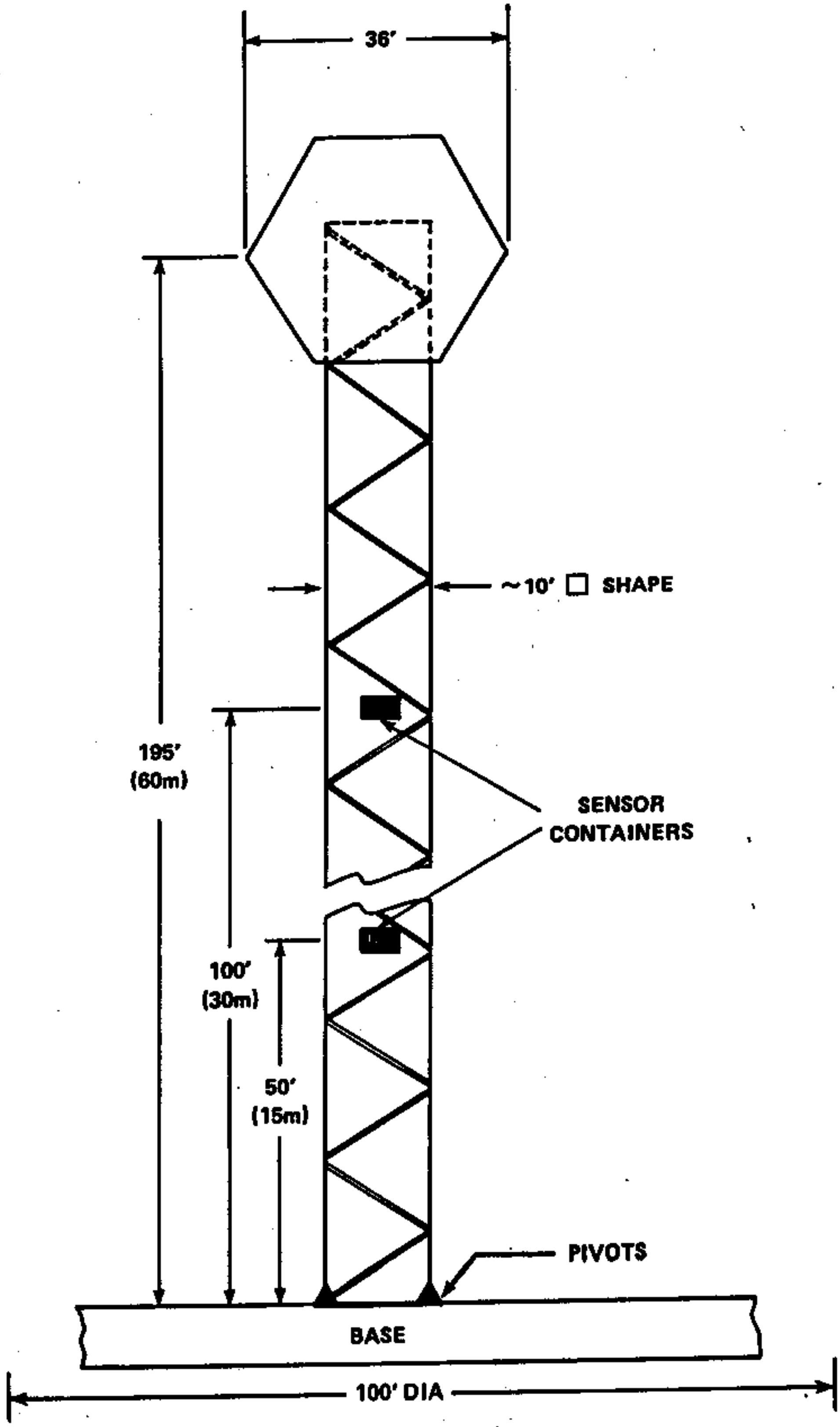


Fig. 5. A view of a single sub-master, mounted on the base-plate of the central master, before swinging down. The two additional sensors shown within the arm structure are on the outer hexagon for that sub-master, and are directly deployed after unfolding; they do not require glide bodies.

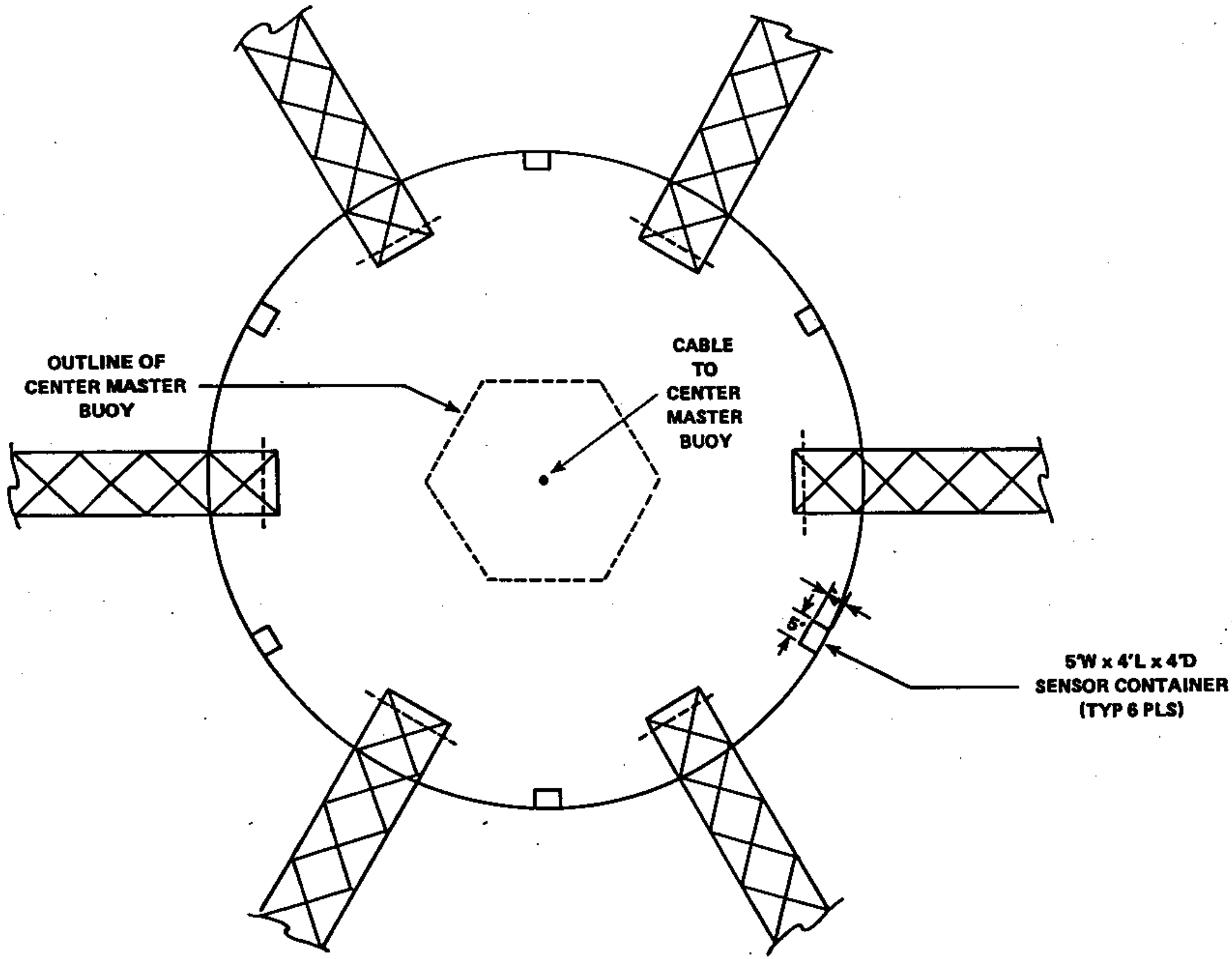


Fig. 6. The central base-plate assembly of the central master after the sub-master arms have swung down.

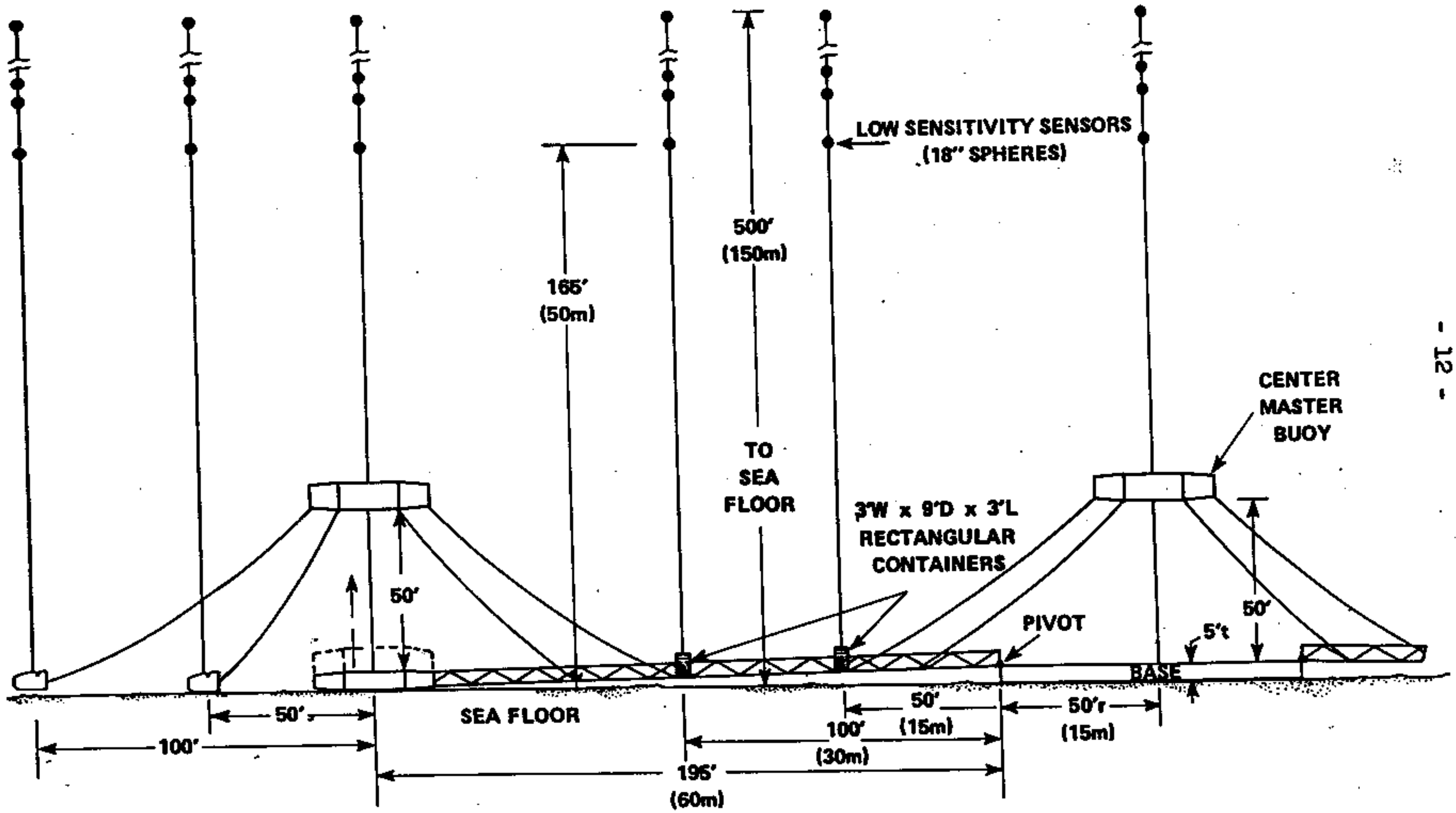
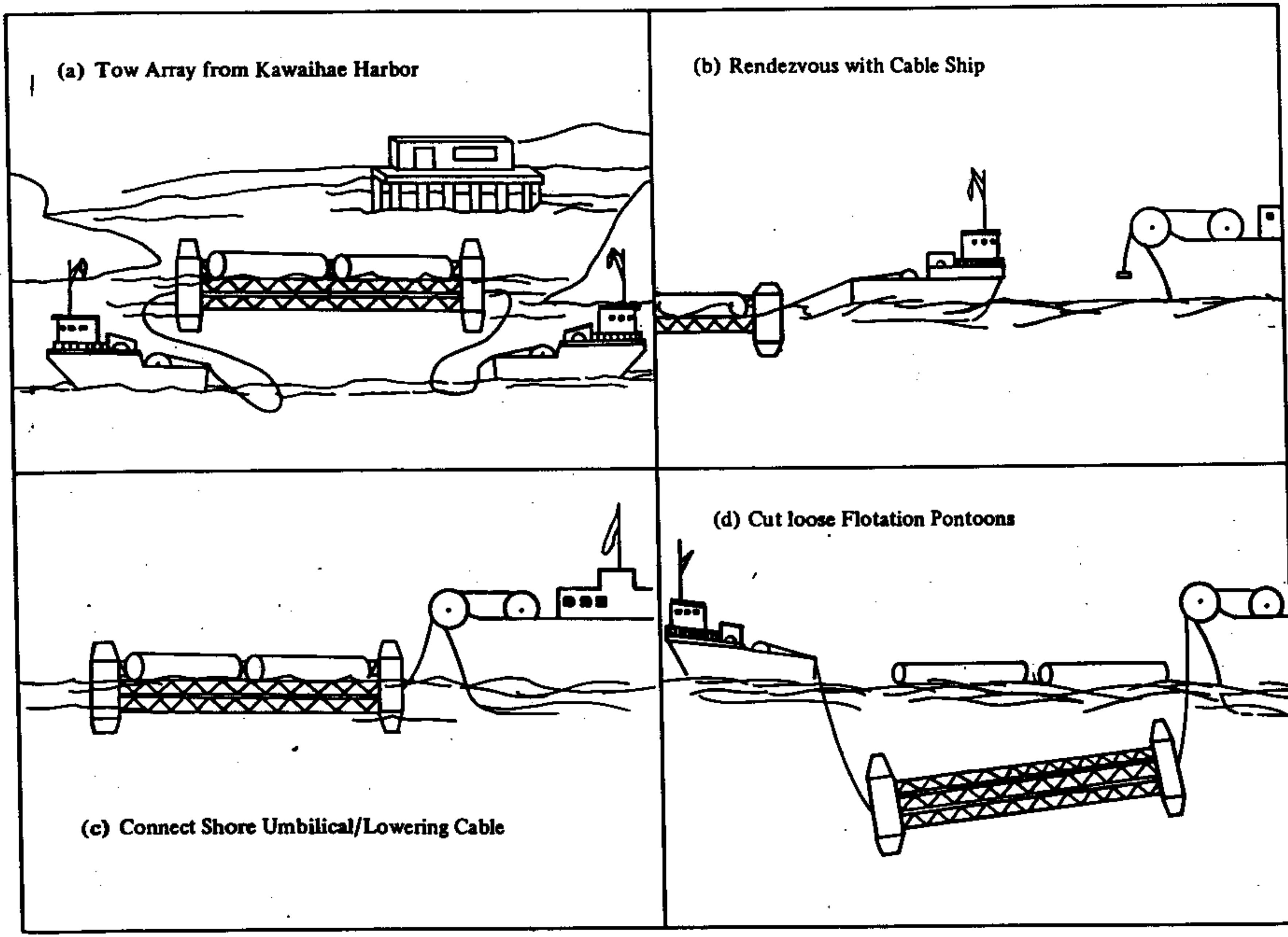


Fig. 7. The complete array after deployment and string release. The central master is shown on the right, with its sub-master buoy and the six glide bodies that have been released from it. The sub-master buoys have been released from the swinging arms, and have risen to their tethered positions, from which they have released their glide bodies.



Figs 8 a-c. The complete deployment sequence (starting after launch) from harbor to sea floor. The shore assembly and launch of the 100-ft base are not shown.

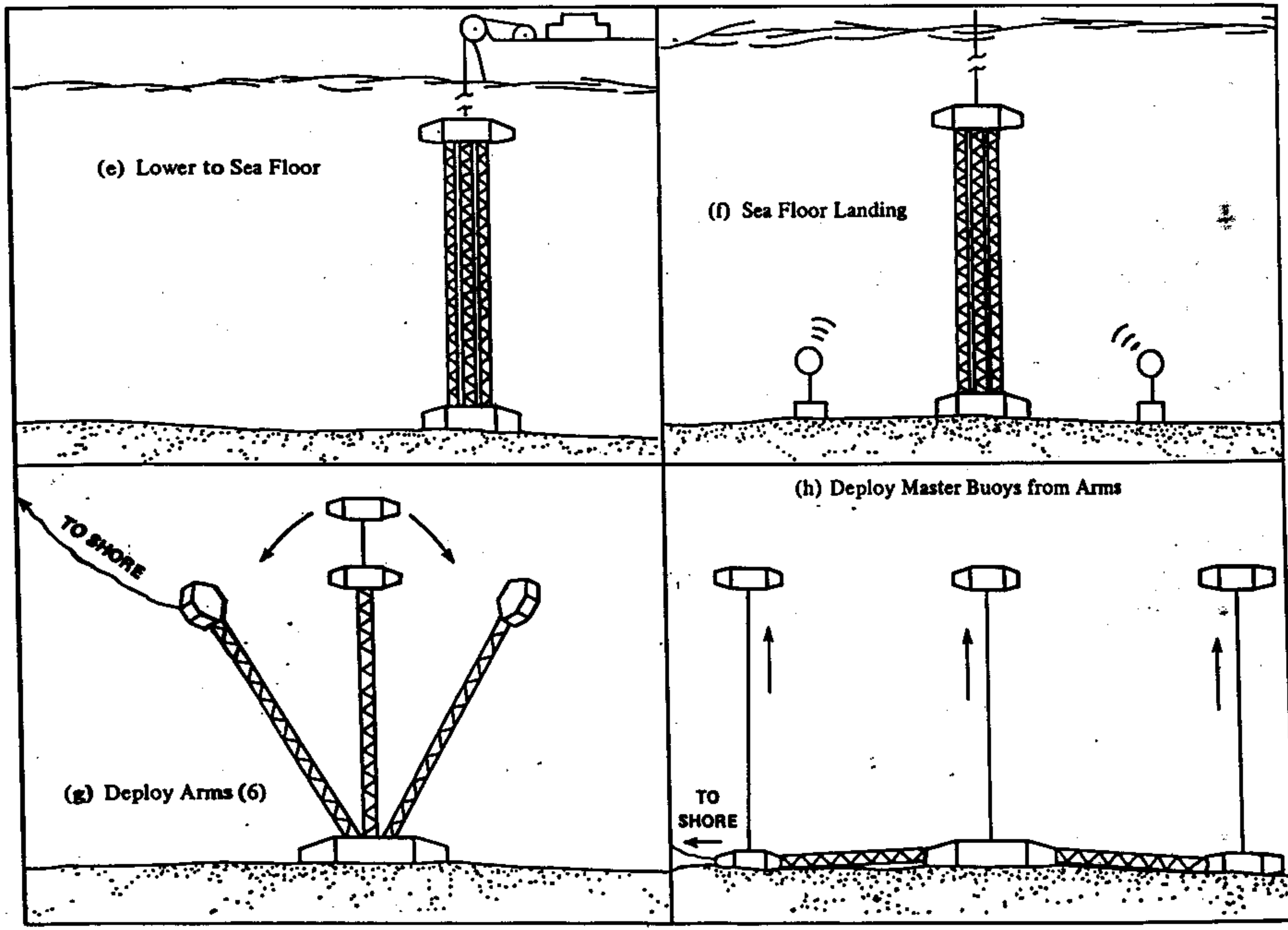

(e) Lower to Sea Floor
(f) Sea Floor Landing
TO SHORE
(g) Deploy Arms (6)
(h) Deploy Master Buoys from Arms
TO
SHORE

Fig. 8b

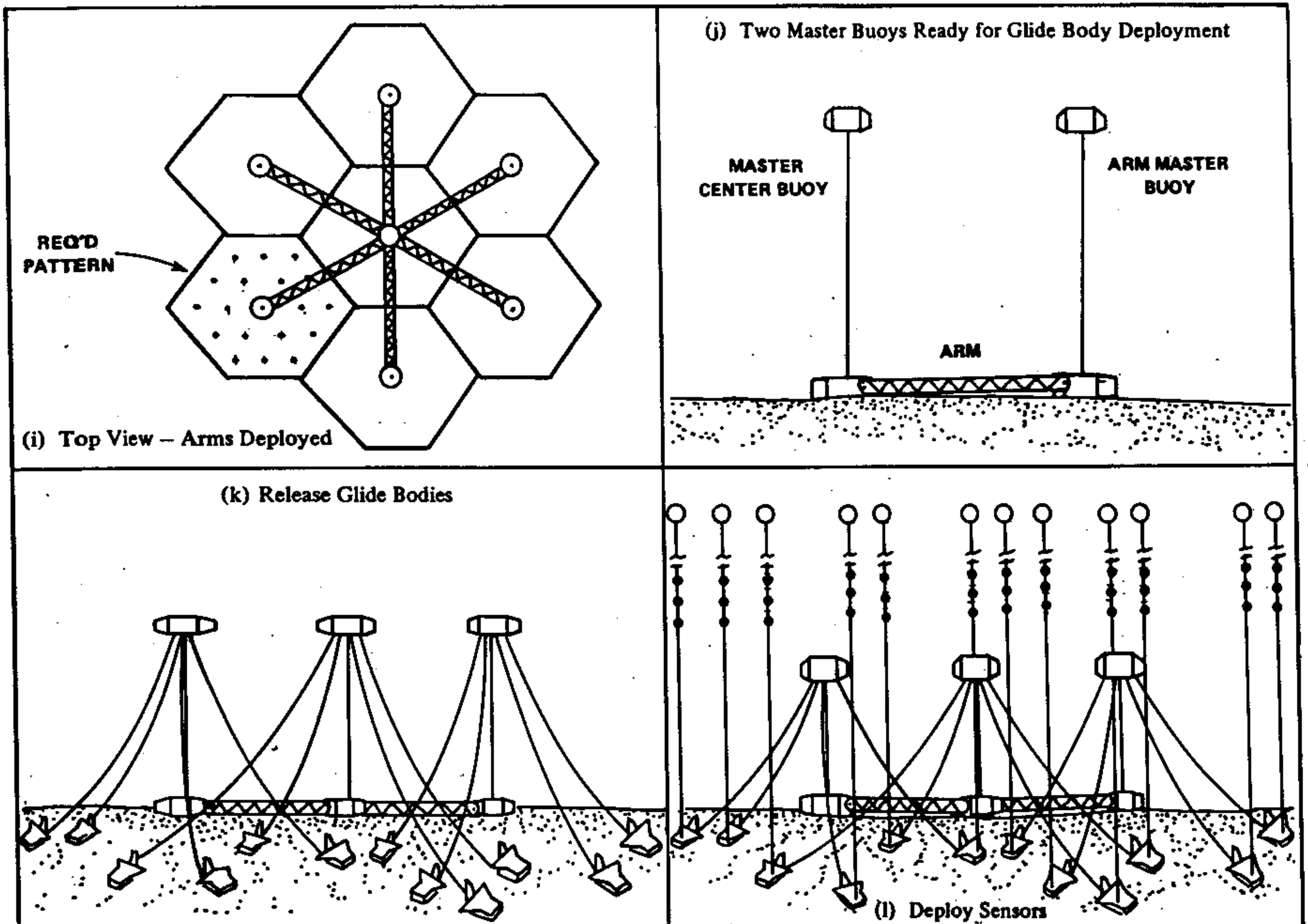

REQ'D
PATTERN
(i) Top View – Arms Deployed
(j) Two Master Buoys Ready for Glide Body Deployment
MASTER
CENTER BUOY
ARM MASTER
BUOY
ARM
(k) Release Glide Bodies
(l) Deploy Sensors

Fig. 8c

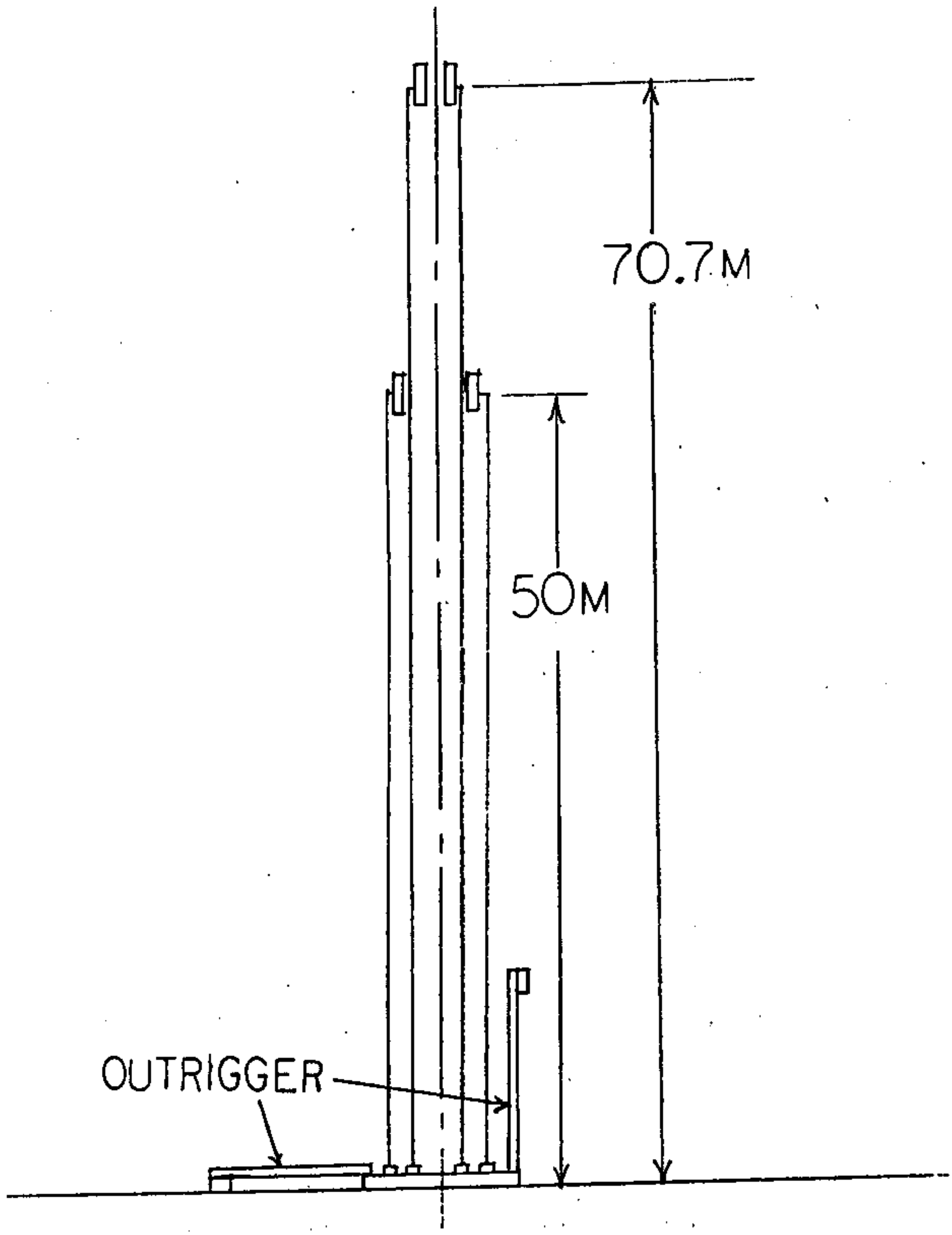


Fig. 9. Sketch of a single tower with eight canisters (only four are shown). Four are on 50m arms, four on 70.7m arms; they form two squares rotated 45° with respect to each other. When deployed, they will form a square with three canisters on each side, as shown in Fig. 11. The central canister (the ninth) is on the base of the tower (not shown). Two outrigger arms for stabilizing the tower are shown, one folded, one deployed.

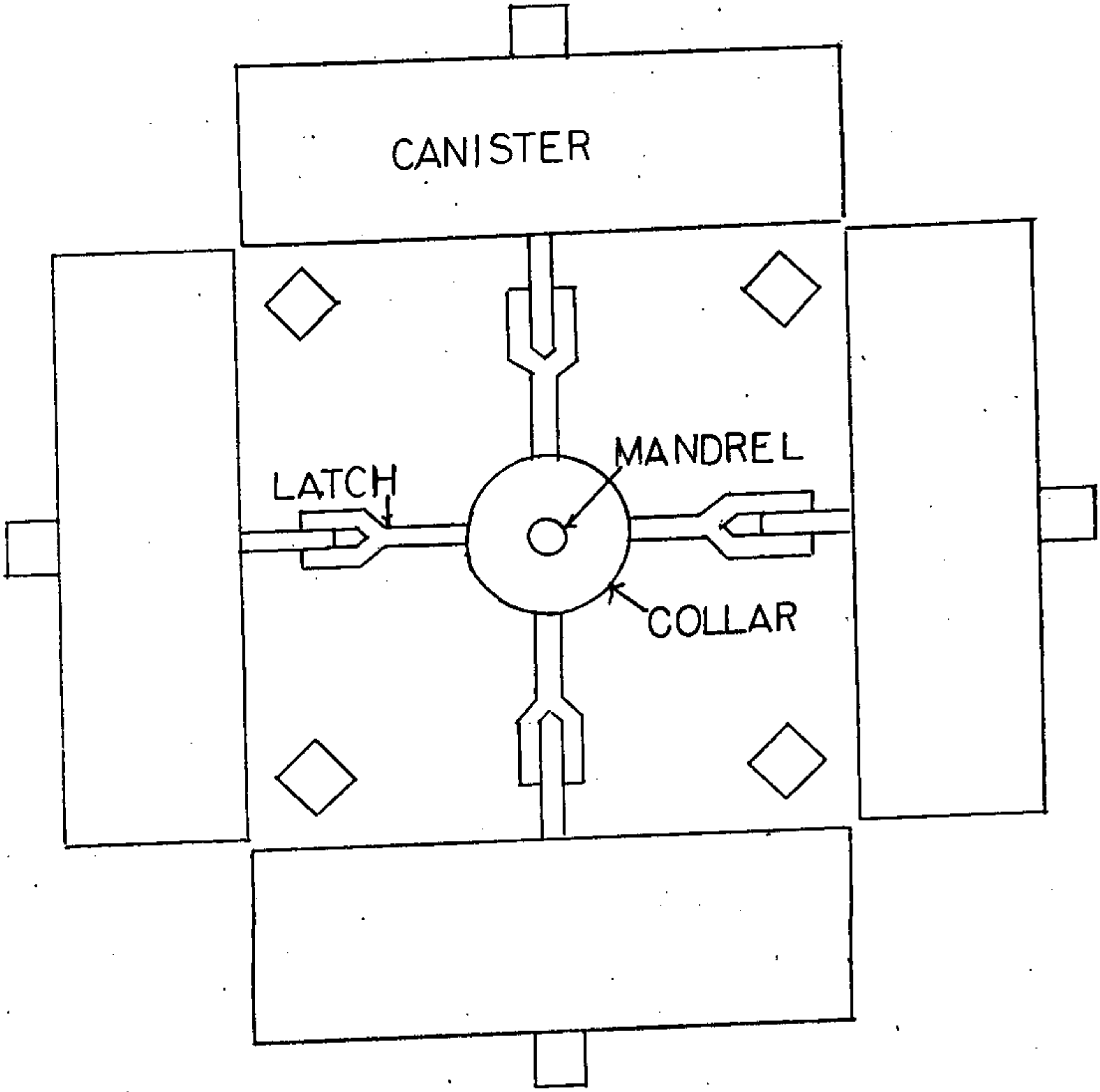


Fig. 10. Cross-section of the tower at the 50m height, showing the four canisters at this height, a possible latch arrangement, and the four longer arms in cross-section, displaced 45°. The arms are shown with square cross-sections.

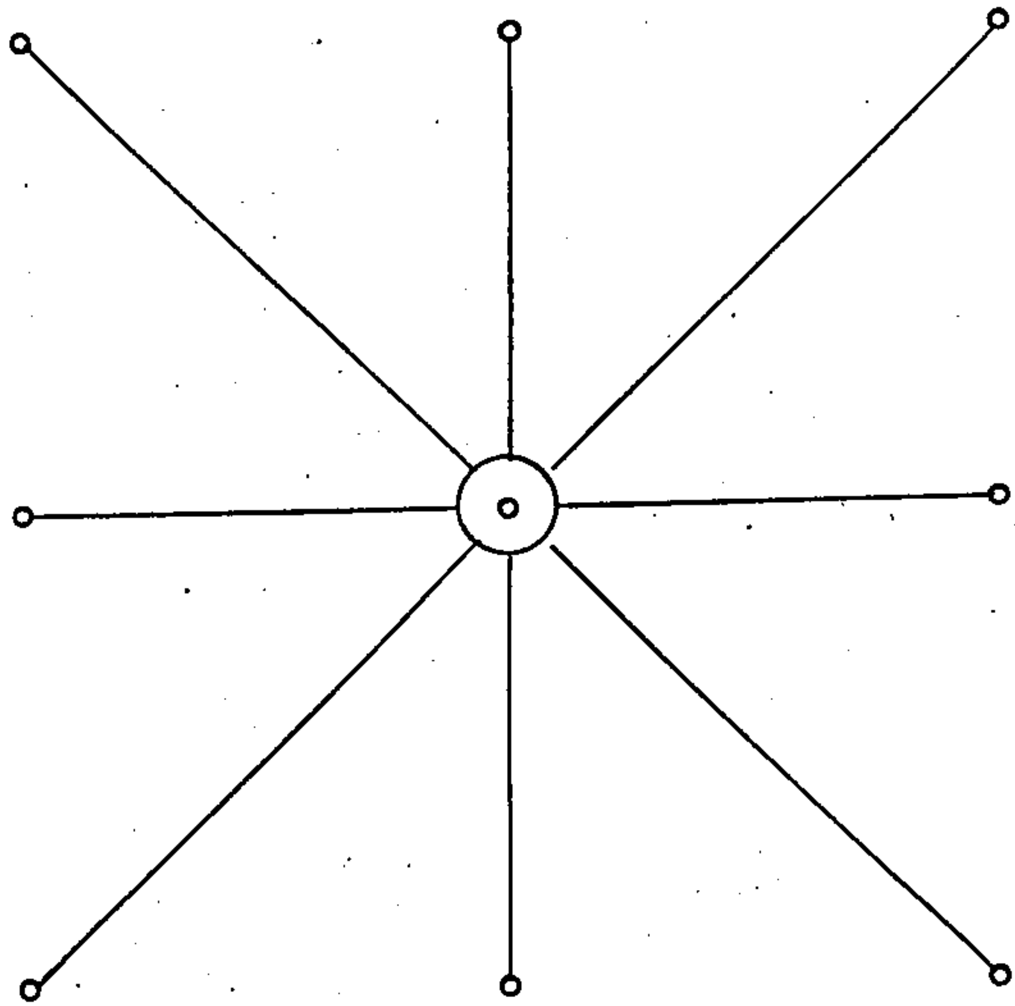


Fig. 11. Sketch of the 3x3 array produced by deploying the arms of the tower.

Fig. 12. Drill-pipe mandrel with four towers spaced 90m apart, with an overall length of 360m. It may be possible to deploy more than four towers on a single mandrel .