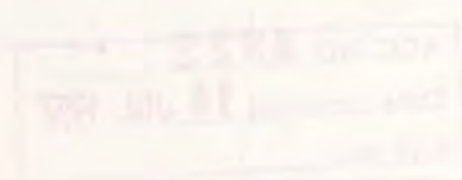


The Experiments on Turtle Excluder Devices (TEDs) for Shrimp Trawl Nets in Thailand



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Training Department
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ABSTRACT

The purpose of this paper is to determine a suitable type of Turtle Excluder Device (TED) attached to the body of a shrimp trawl to avoid inflicting harm on marine turtles. Seven types of the TEDs were tested; three brought from U.S.A. namely the Anthony Weedless, the Super Shooter and the Bent Pipe, two brought from Mexico namely the Georgia Jumper and the Mexican, and two were designed by Kasetsart University and SEAFDEC/TD, Thailand, namely the Thai-KU and Thai Turtle Free Device (TTFD), respectively. No Turtles were caught in any of the areas off Chumporn and Songkhla during a total of 120 hauls. The escape rate by weight of the Super Shooter and TTFD were found to be 2.67% and 1.80% for day-time operation and 1.91% and 1.04% during the night, this indicated that they were the most efficient TED. The fuel consumption for all TEDs showed little difference. In terms of convenience in operation, the TTFD was found to be the best and the most suitable TED for use by Thai fishermen.

1. Introduction

The U.S. shrimp import embargo, that went into effect on 1 May, 1996, stipulates a condition that the methods used in shrimp capture by harvesting countries should inflict no harm on marine turtles. One of the methods practiced during the last few years by U.S. shrimp trawlers¹⁾ is

to equip their fishing gear with a device attached to the body of the trawl. This has a grid panel which deflects marine turtles through an opening in the net. Experiments in the United States, and Mexico ²⁻⁴⁾ produced what the shrimp trawlers called a success: more or less the same quantity of shrimp in the catch but an appreciably less volume of finfish which facilitated easier sorting of the shrimp. To comply with the conditions set by the U.S. shrimp import embargo, the SEAFDEC Council asked the Training Department (TD) and the Marine Fisheries Resource Development and Management Department (MFRDMD) of SEAFDEC in cooperation with the Department of Fisheries (DOF), Thailand, to conduct a series of experiments, over a period of six months, to test the efficiency of various TEDs and of trawls equipped with the device. This study, to investigate the efficiency of a shrimp trawl with Turtle Excluder Devices ⁵⁾ is therefore an urgent task to be undertaken in order to make available all facts that will finally benefit the Thai Fishing Community and will allow fishermen to conserve the sea turtles.

2. Materials and Methods

The experiments were carried out by two research vessels namely M.V. Pramong 4 and M.V. Pramong 1 in the coastal waters off Chumphon and Songkhla provinces (see **Fig. 1**) where the depths of water ranged from 10 to 20 m during September and October of 1996, respectively.

2.1 Experimental Setup

2.1.1 Shrimp Trawl Net

Two shrimp trawl nets (two seam type, see **Fig. 2**) employed in the experiments were designed for the 250 horse power fishing vessels. The nets were approximately 39.5 m long and were complete with a 21 m long head rope and 24 m ground rope.

2.1.2 Turtle Excluder Devices (TEDs)

Fig. 3 shows the seven types of TEDs employed in the experiments which were three from U.S.A. namely the Anthony Weedless, the Super Shooter and the Bent Pipe TEDs (**Fig. 3a**), and two from Mexico namely the Georgia Jumper and the Mexican TEDs (**Fig. 3b**). The other two TEDs were the Thai-KU and the Thai Turtle Free Device (TTFD) designed by the Faculty of Engineering, Kasetsart University and the Training Department of SEAFDEC Thailand, in cooperation with DOF, respectively (**Fig. 3c**).

2.2 Experimental Procedure

The TED was attached to the cod end extension part of shrimp trawl net. Experiments were started from the early morning until late at night. For each type of TED experiment a total of 8 trawlings were carried out, these comprised (4 hauls) of each for two periods, during the day- and night-time. An extra trawling without a TED, as a control, was made before the trawling with TED was started in each of the periods. During this series of experiments, all of the TEDs were tested with an operational time for each haul of one hour. In the experiments with the TEDs, the exit part of the TEDs were covered with pieces of net as a cover net or second codend, in order to measure the amount and species of escaped fishes. The fuel consumption of the vessels with and without TEDs was also recorded. To find a suitable TED, the experiments were made in two parts, as first and second experiments.

2.2.1 First Experiment

The first experiment was carried out in the waters off Chumporn province during September of 1996. A total of 60 hauls comprising 12 hauls without TEDs and 48 hauls using six types of TED namely, the Anthony Weedless, the Super Shooter, the Bent Pipe, the Georgia Jumper, the Mexican, and the Thai-KU were made by the M.V. Pramong 4.

2.2.2 Second Experiment

The second experiment was carried out in the waters off Songkhla province during October of 1996. Using six types of TED; 5 TEDs from the first experiment namely the Super Shooter, the Bent Pipe, the Georgia Jumper, the Mexican and the Thai-KU, and the TTFD TED which replaced the Anthony Weedless TED were tested on board M.V. Pramong 1. A total of 60 hauls comprising of 12 hauls without TEDs and 48 hauls using the six types of TED.

2.3 Data Analysis

The catch data by weight in kg collected both from the codend and the cover net in each haul were analyzed for the rate of escape in percent as the following equation:

$$\text{Rate of escape} = \frac{A \times 100}{(A + B)}$$

where *A* is the catch by weight in the cover net, and *B* is the catch by weight in the codend.

The mean values of the escape rate of each type of TED were computed and compared to that of the control net (without TED). The composition by species, of the rate of escape in the cover net was also recorded. The rate of escape for shrimp was considered in comparison to that of the day and night operations.

Comparisons of the fuel consumption of the vessels between the trawling operations with TEDs and without TEDs were made.

3. Results and Discussion

The species composition by catch from 120 hauls indicated that no turtles were caught in the codend or the cover net of the shrimp trawl net.

3.1 The First Experiment

Table 1 exhibits the total catch by weight in the codend and cover net and the rate of escape in percent for each type of TED in day- and night-time operations. The results indicate that there were no differences in terms of the escape rate between the day- and night operation for all type of TEDs except that of the Bent Pipe TED. This indicated that the Bent Pipe TED is a highly efficient TED for day-time operation, but not at night. In the case of the Anthony Weedless TED, the escape rates were higher than 35.94% for both day- and night operations and showed the lowest efficiency. **Figure 4**, shows the rate of escape relative to the type of TED for day- and night-time operations. The ratio of escape between the economic species groups and the trash fish was different during day and night. In addition, three types of TEDs namely the Super Shooter, Georgia Jumper and the Thai-KU showed quite good results based on the low rate of escape, for both the day- and night-time, which were found to be lower than 11%. The escape rate of the different species/group for both periods for the Super Shooter, Georgia Jumper and the Thai-KU TEDs are shown in **Table 2** and **Figure 5**. Consideration of the escape rate for shrimp between the day and night found that no shrimp escaped through the TEDs during day-time operation

The escape rate for shrimp was considered as the index for the possibility of installing TEDs, but in tropical fisheries all catch both economic and trash fish can be sold in the market. For this reason the rate of escape for the total catch must be considered, and it can be said that among the six types of TEDs in the first experiment, the Thai-KU TED showed a high efficiency. However, in view of the structure, operation and installation of the Thai-KU TED it was found that there were some operational weight problems.

3.2 The Second Experiment

In the second experiments, five types of TED from the first experiment namely the Super Shooter, the Bent Pipe, the Georgia

Jumper, the Mexican and the Thai-KU were tested in the same manner and were compared with the TTFD. The results of the total catch by weight in the codend and cover net and the rate of escape in percent for each type of TED in day- and night- time operations are exhibited in **Table 3**. This indicates that there was not much difference in terms of escape rate for both day- and night-time operation for the Super Shooter, Thai-KU and TTFD. Two types of TEDs namely Super Shooter and TTFD were the most efficient in terms of the low rate of escape which were found to be 1.80% and 2.67% for day-time operation and 1.91% and 1.04% at night, respectively. **Figure 6** shows the rate of escape by total weight relative to type of TED for day- and night- operations. The figures also show that the main escaping fish for both day- and night-time operations were trash fish compared to economic fish in terms of the rate of escape. The escape rate of each group of species for all types of TEDs are shown in **Table 4** and **Figure 7**. The escape rate for shrimp in this experiment had the same result as was found in the first experiment that no shrimp escaped during day-time operation.

3.4 Fuel Consumption

The fuel consumption for a one hour trawling operation with different types of TED were compared to the control net operation in **Figure 8**. The figure shows there was not much difference in fuel consumption for the six types of TED and the control net. The fuel consumption for the Super Shooter and TTFD were about 23.66 and 24.31 litre per haul, respectively. In addition, the trawls installed with the Super Shooter and TTFD used less fuel than operating without a TED (control net).

4. Conclusions

The results from the first and second experiments suggested that the Super Shooter and TTFD had a quite reasonable outcome in terms of escape rate and convenience in operation. For use by fishermen, however, the TTFD seemed to be the most suitable TED based on the lowest escape rate of fish and low fuel consumption, and also for ease of

construction and installation because all materials used are available locally. Appendix 1, 2 and 3 show the diagram of the three different sizes of TTFD including the construction and installation method.

Acknowledgement

We wish to express our appreciation to Dr. Maitree Duangsawasdi, the Secretary-General and Chief of the Training Department of SEAFDEC, who made these experiments possible. We also wish to express our sincere gratitude to Mr. Udom Bhatiyasevi, Marine Fisheries Division Head of the Department of Fisheries for his valuable criticism and constructive discussion in the preparation of the experiment.

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- 2) Talavera, R. and others. 1993. Super Shooter. Manual de Materials, Cobstruccion, Instalacion Y Operacion del Dispositivo Excluidor de Tortugas Marinas Tipo. Doc. Interno/DIDT-I.N.P., Secretaria de Pesca, Mexico, 19 p.
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- 4) Talavera, R. and others. 1993. Georgia Jumper. Manual de Materiales, Cobstruccion, Instalacion y Operacion del Dispositivo Excluidor de Tortugas Marinas Tipo. Doc. Interno/DIDT-I.N.P., Secretaria de Pesca, Mexico, 18 p.
- 5) Terry Gorman. 1994. Environmentally sustainable shrimp trawling. Fishing Boat World, Vol. 20., 20-23 p.

Table 1 The results of total catch in the codend and cover net and the rate of escape for each type of TEDs in the first experiment

Type of TEDs	Day-time Operation			Night-time Operation		
	Cod End (kg)	Cover Net (kg)	Rate of Escape (%)	Cod End (kg)	Cover Net (kg)	Rate of Escape (%)
Super Shooter	32.79	2.99	8.36	25.81	1.46	5.34
Anthony Weedless	18.35	17.34	49.00	20.48	11.49	35.94
Bent Pipe	194.20	8.16	4.03	32.07	6.97	17.85
Mexican	27.83	6.90	19.88	43.30	4.68	9.57
Georgia Jumper	59.51	3.76	5.94	32.97	4.08	11.00
Thai-KU	29.42	2.57	8.02	36.87	1.04	2.75

Table 2 Escape rate of each group of species for three types of TEDs in the first experiment.

Group of Fishes	Thai-KU		Super Shooter		Georgia Jumper	
	Day	Night	Day	Night	Day	Night
Pelagic fish	3.23	1.90	1.46	0.00	0.00	1.89
Demersal fish	13.89	6.25	8.17	0.20	0.87	5.71
Cephalopod	11.64	1.43	1.94	17.72	0.00	0.00
Shrimp	0.00	10.74	0.00	1.92	0.00	7.95
Crab	11.11	0.00	42.00	6.85	56.25	0.00
Others	5.95	1.35	16.01	23.46	18.30	35.57
Trash	1.99	1.05	2.61	0.00	3.55	1.21

Table 3 The results of total catch in the codend and cover net and the rate of escape for each type of TEDs in the second experiment

Type of TEDs	Day-time Operation			Night-time Operation		
	Cod End (kg)	Cover Net (kg)	Rate of Escape (%)	Cod End (kg)	Cover Net (kg)	Rate of Escape (%)
Super Shooter	26.21	0.72	2.67	10.09	0.2	1.91
TTFD	7.40	0.14	1.8	9.52	0.1	1.04
Bent Pipe	26.21	0.58	2.17	40.72	6.36	13.52
Mexican	16.17	0.31	1.89	23.3	3.04	11.53
Georgia Jumper	11.62	0.76	6.15	101.7	0.88	0.85
Thai-KU	87.21	8.37	8.76	11.68	1.46	11.12

Table 4 Escape rate of each group of species for three types of TEDs in the second experiment.

Group of Fishes	TTFD		Super Shooter		Georgia Jumper	
	Day	Night	Day	Night	Day	Night
Pelagic fish	3.46	0.99	3.23	3.26	0.00	0.00
Demersal fish	0.72	0.49	4.24	1.59	3.62	0.08
Cephalopod	1.10	4.94	2.11	0.00	0.00	0.00
Shrimp	0.00	1.02	0.00	0.00	0.00	0.14
Crab	0.00	0.00	4.04	9.33	11.21	36.22
Others	0.00	0.00	0.00	0.00	0.00	0.00
Trash	2.63	0.37	0.38	1.55	15.10	0.19



Fig. 1. Fishing areas for shrimp trawl experiments with TEDs

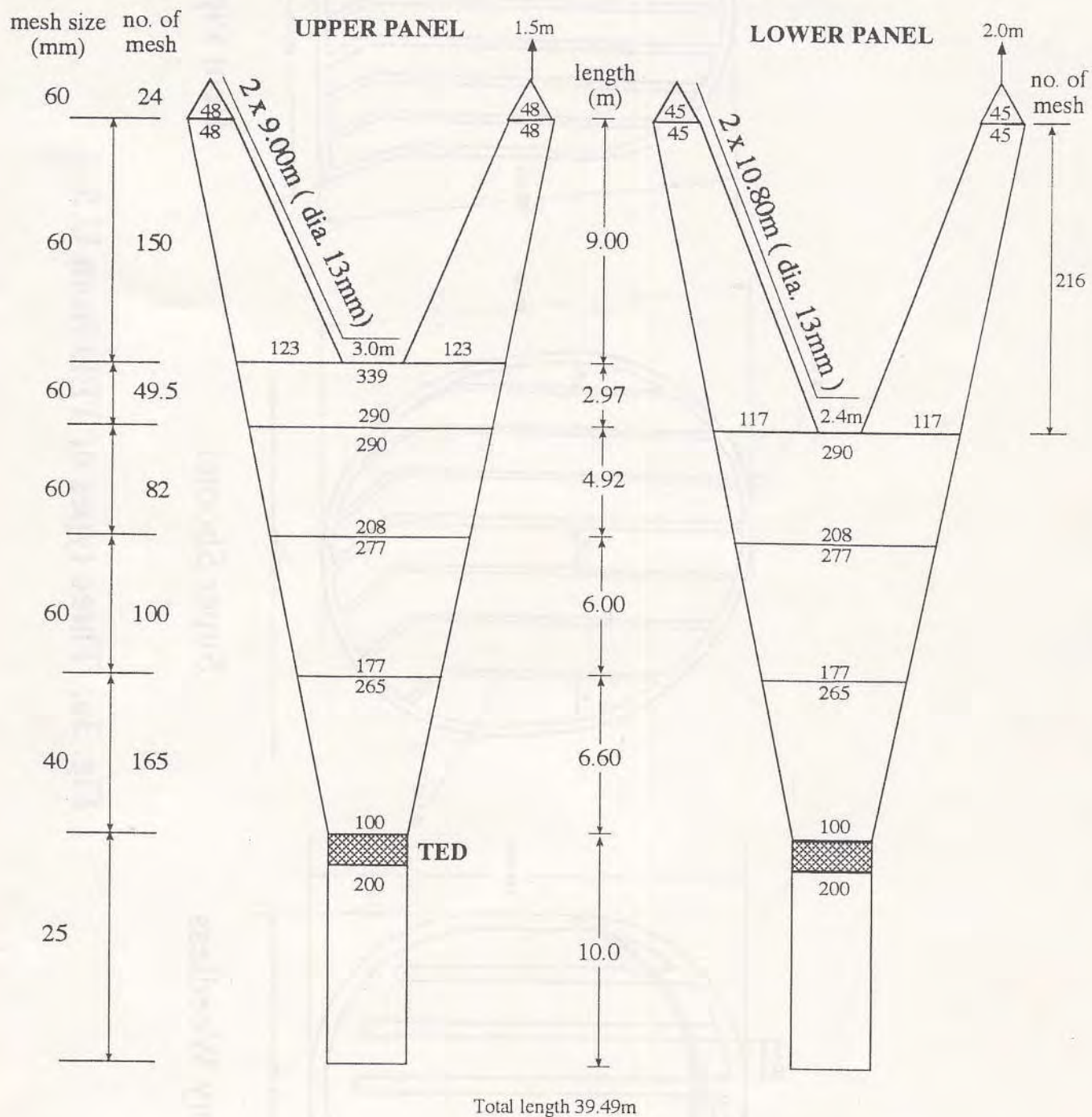


Fig. 2. The diagram of the shrimp trawl net.

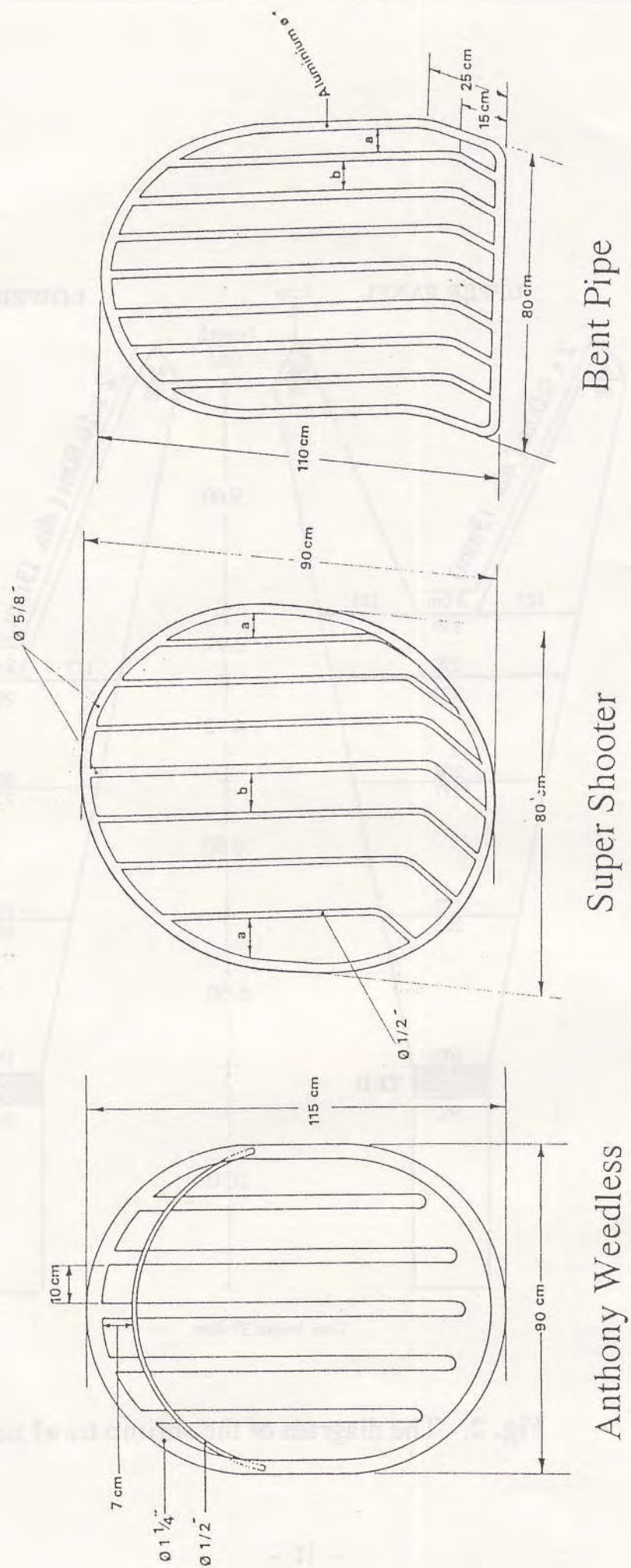
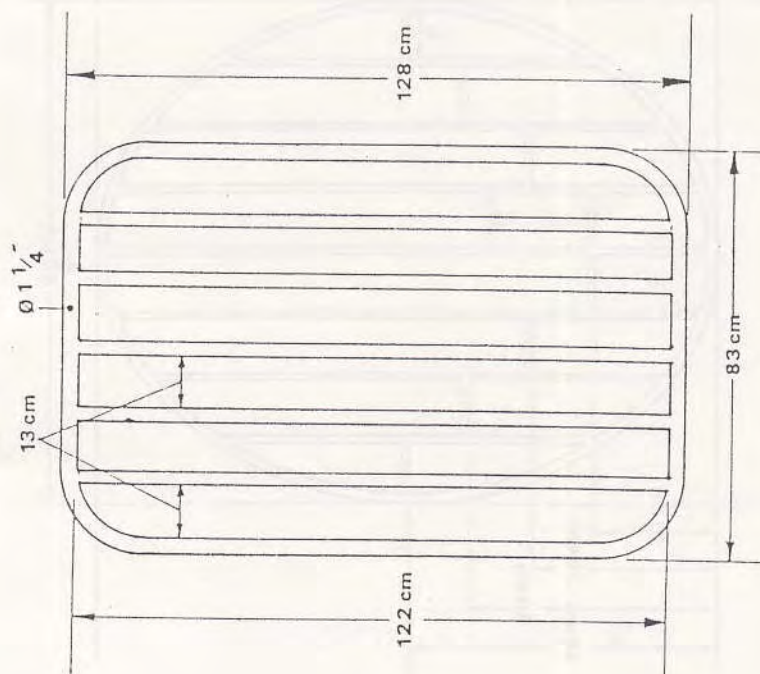
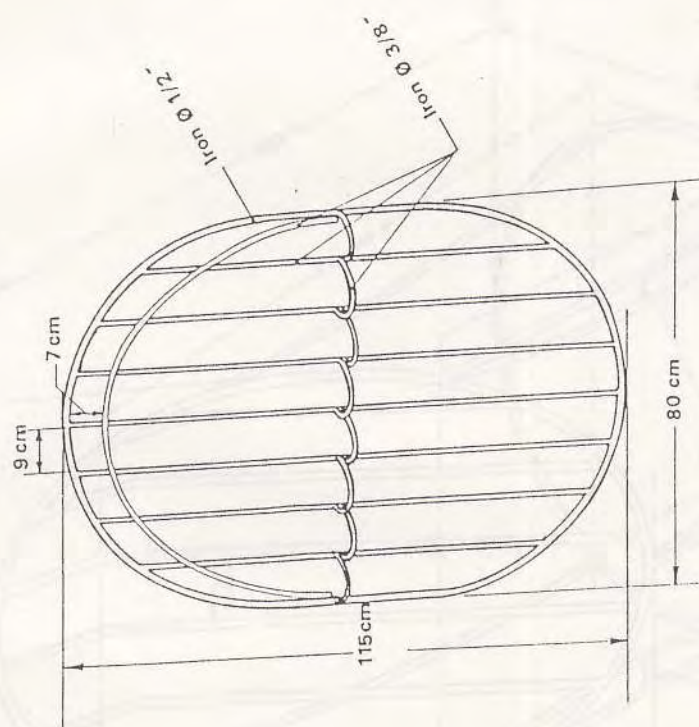


Fig. 3a. Three types of TED from U.S.A.

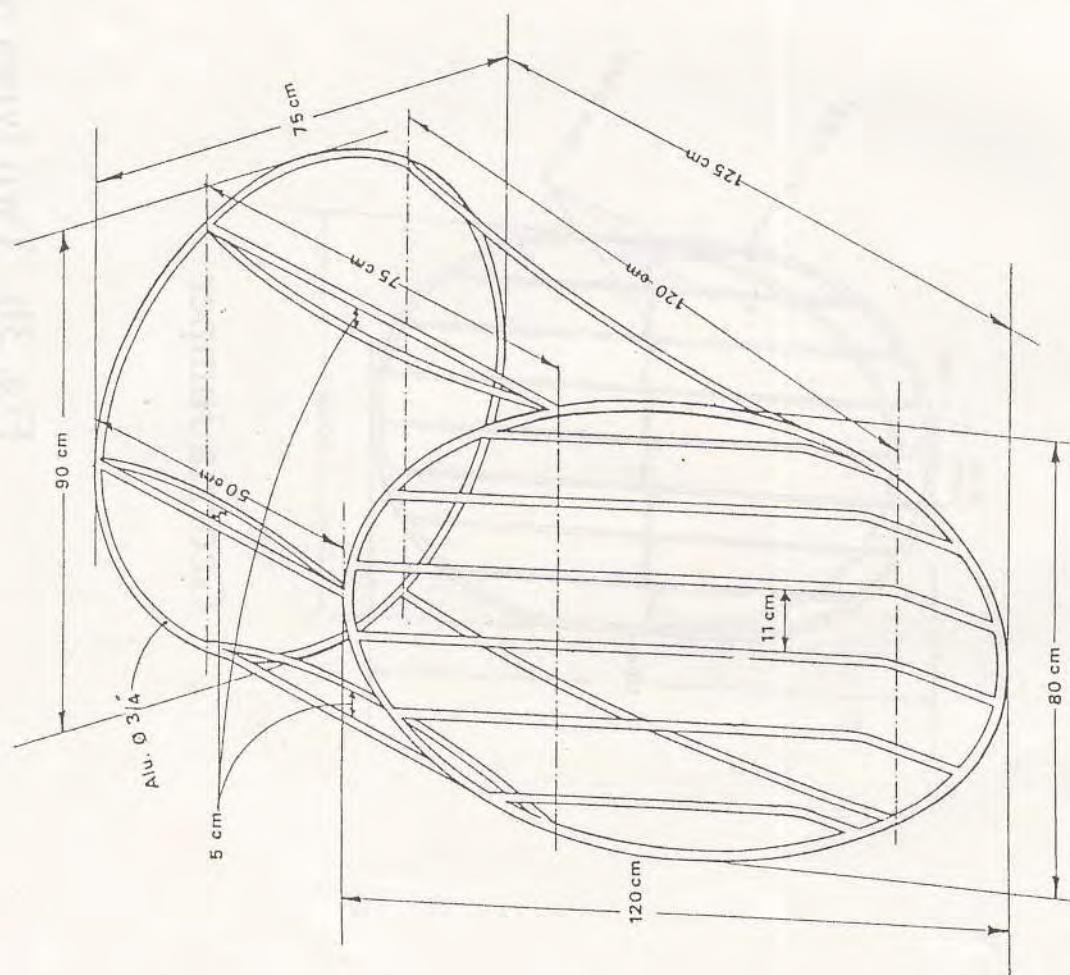


Mexican

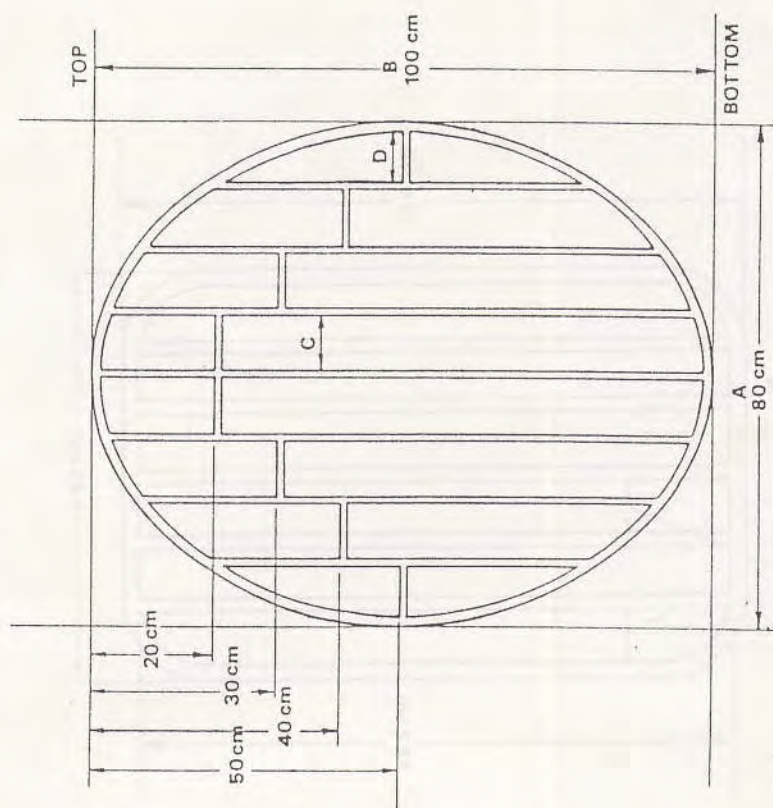


Georgia Jumper

Fig. 3b. Two types of TED from Mexican.



Thai-KU



Thai Turtle Free Device (TTFD)

Fig. 3c. Two types of TED from Thailand.

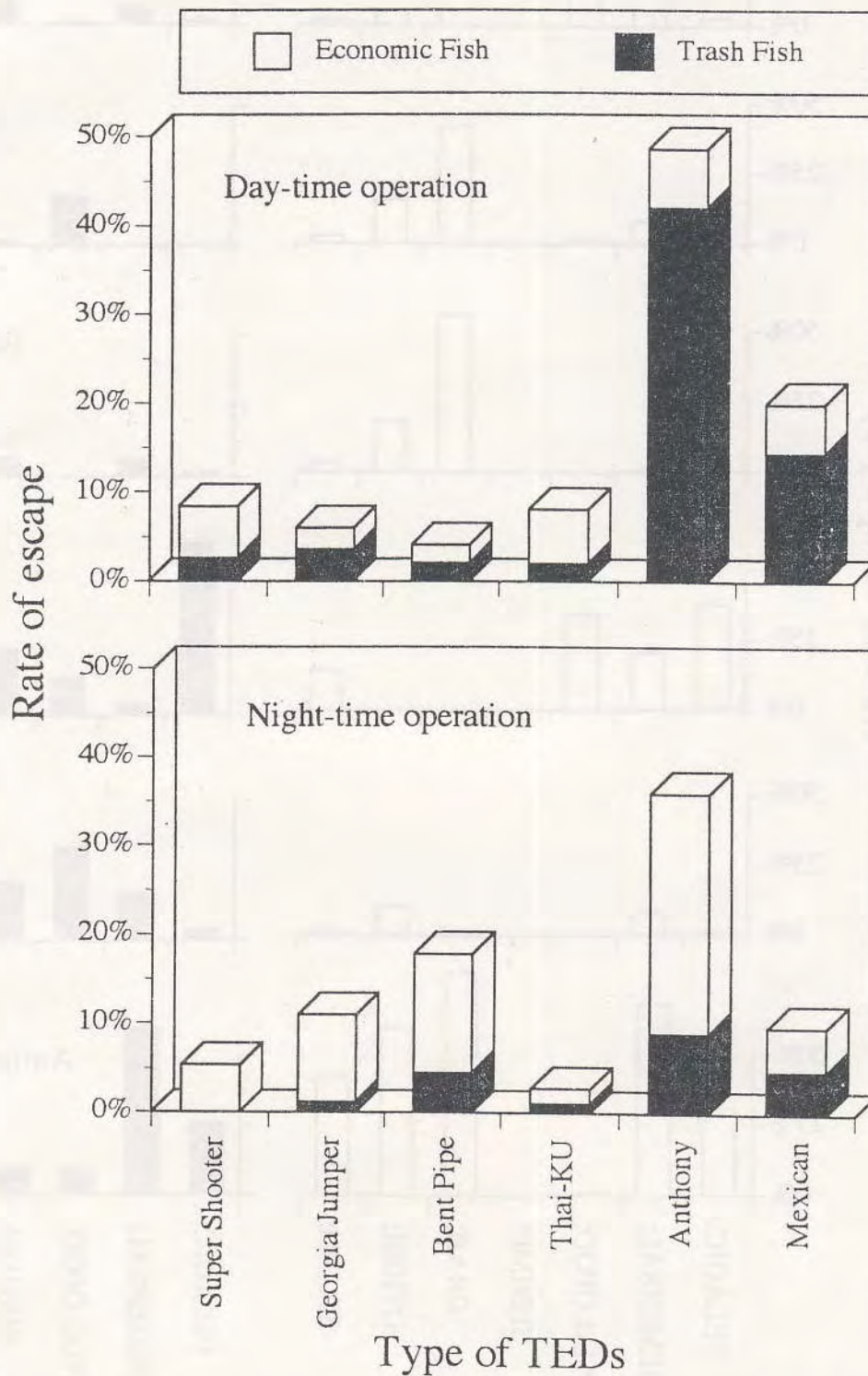


Fig. 4. The escape rate relative to type of TED used for day- and night-time operation in the first experiment

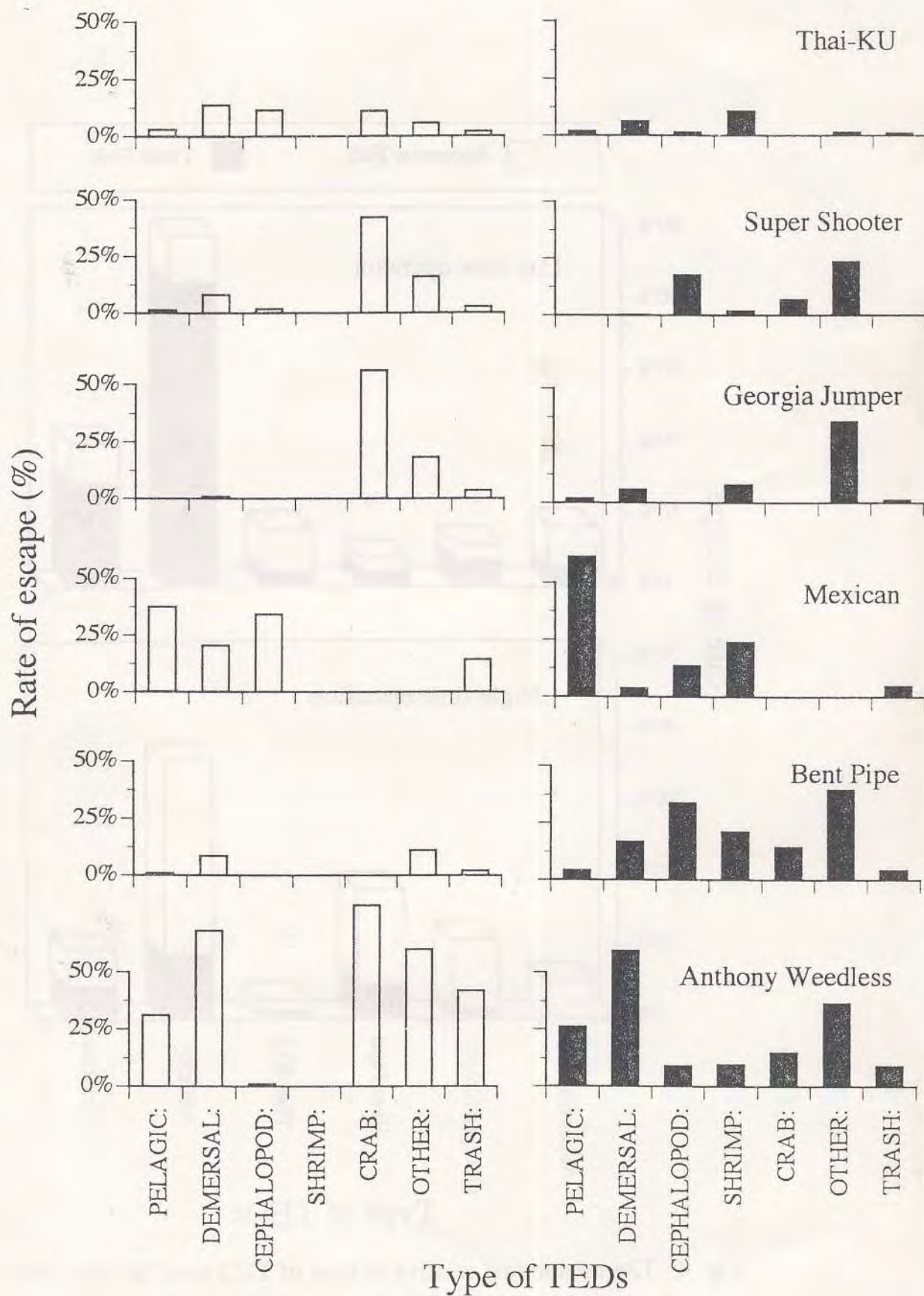




Fig. 5. Rate of escape by total weight of economic fish for different types of TED in the first experiment

 Day-time operation
 Night-time operation

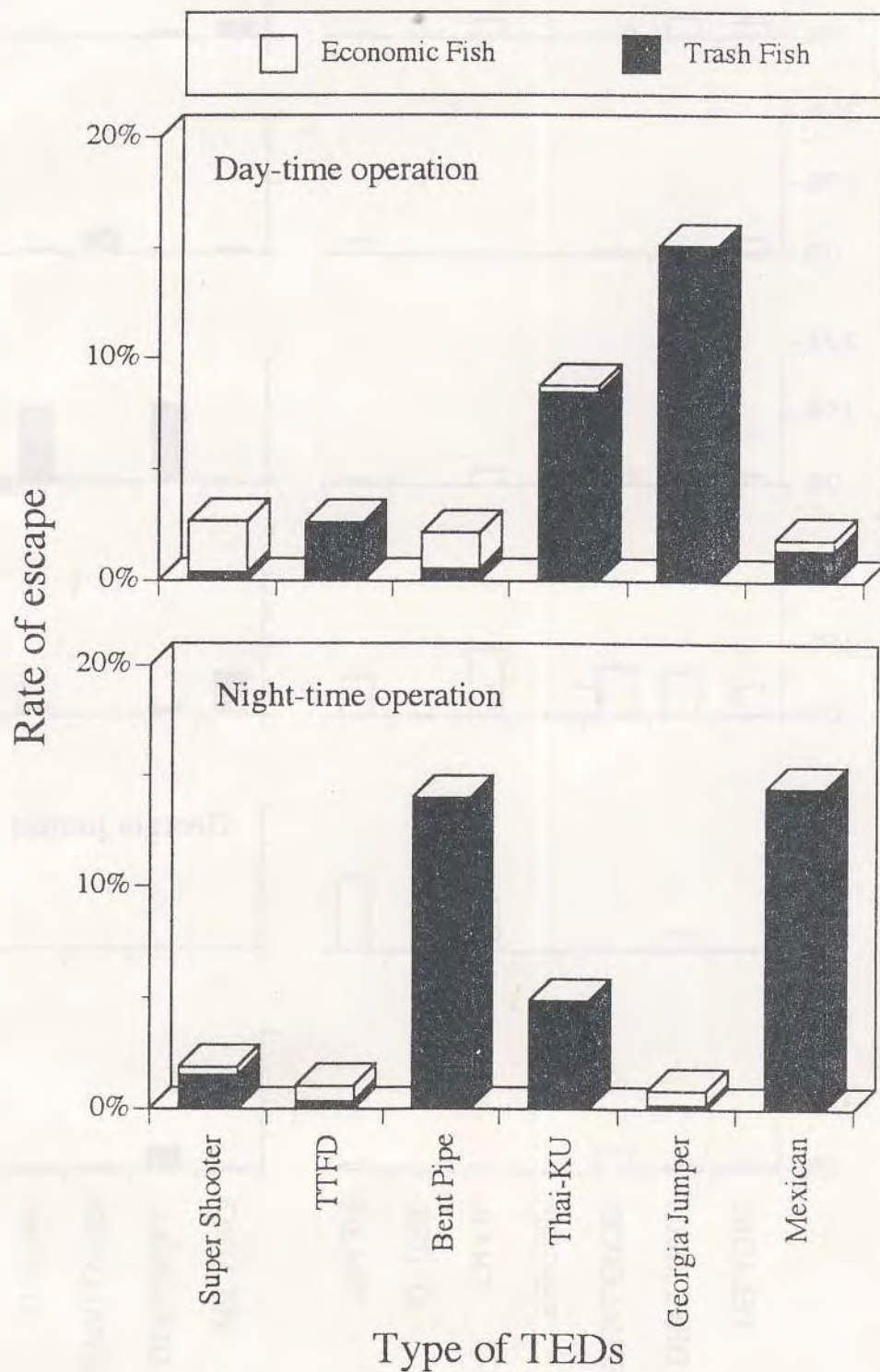


Fig. 6. The escape rate relative to type of TED used for day- and night-time operation in the second experiment

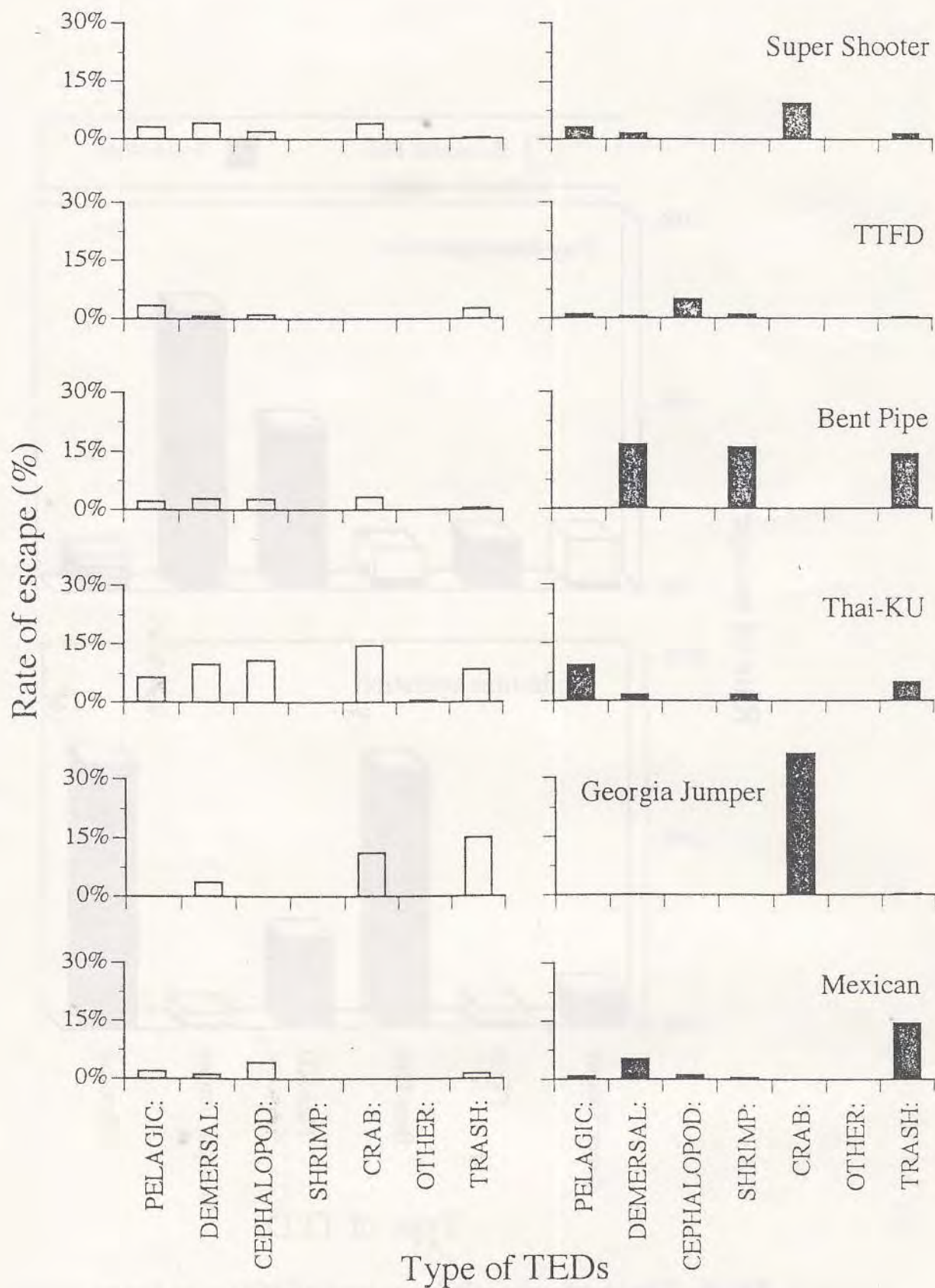




Fig. 7. Rate of escape by total weight of economic fish for different types of TED in the second experiment

 Day-time operation
 Night-time operation

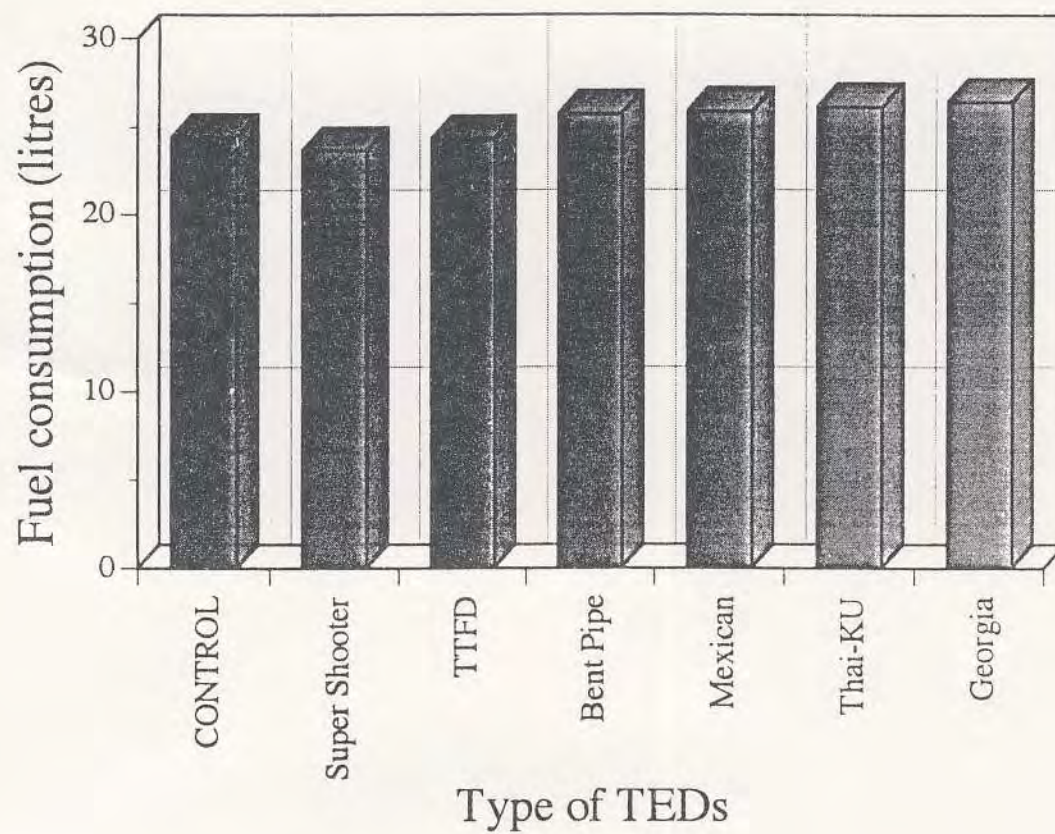


Fig. 8. Fuel consumption relative to type of TEDs

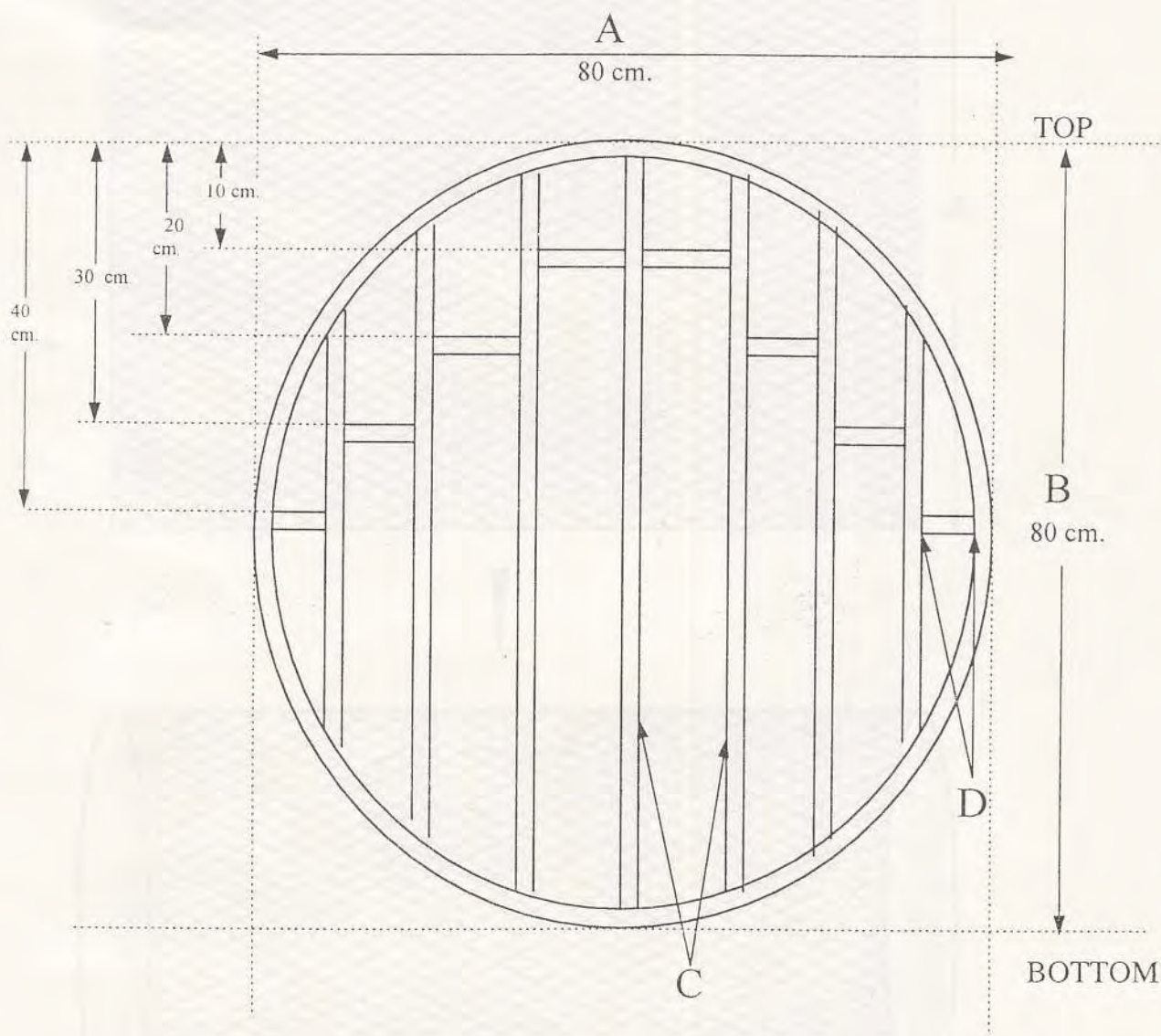
Appendix 1

Construction and Installation of Small Size TTFD

TTFD Construction and Installation (SMALL SIZE)

Construction of the Frame

Construction for a circular frame measuring 80 cm. high by 80 cm. wide. The outer ring of the frame is steel rod of 1.27 cm. diameter. The vertical grid bars are 0.95 cm. diameter metal steel rod. The spacing between deflector bars (C) is 9 cm. and between deflector bars and frame (D) is 7.5 cm.

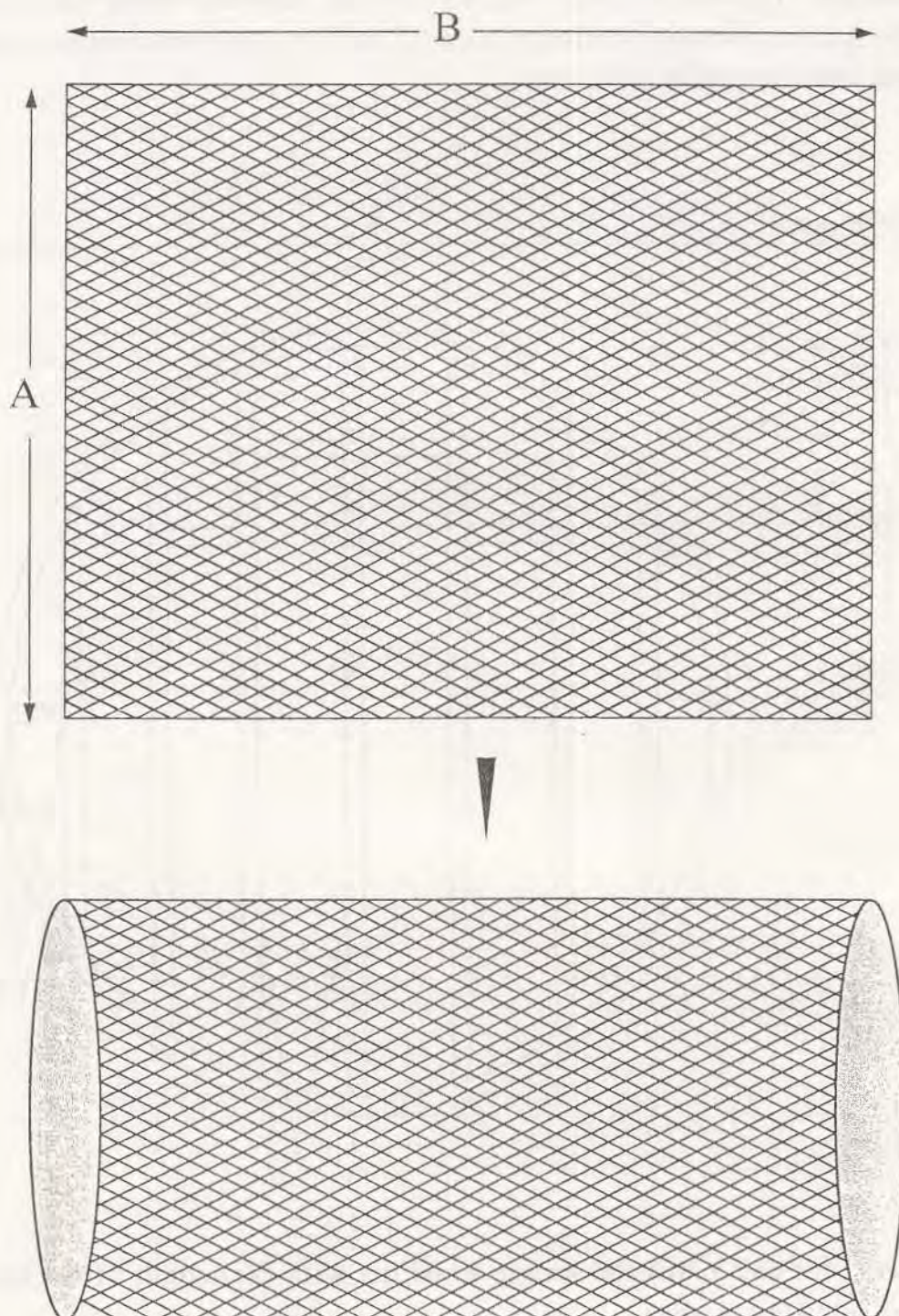


Small size (80 x 80) for shrimp trawl net with the length of the ground rope of 12-18 meters.

2. Construction of the TTFD extension

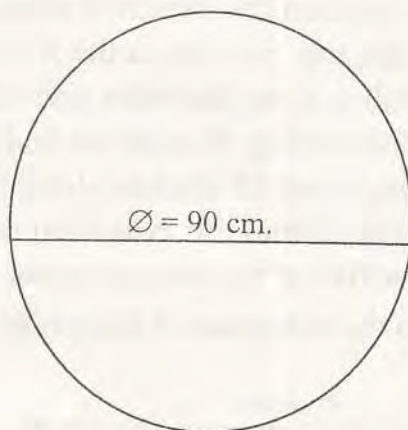
The TTFD extension is constructed from a single piece of (250d/6) polyethylene net which is 250 meshes by 90 meshes, (mesh size is 2.5 cm.)

Construction a cylinder from the piece by sewing the 90 (B) meshes sides together.



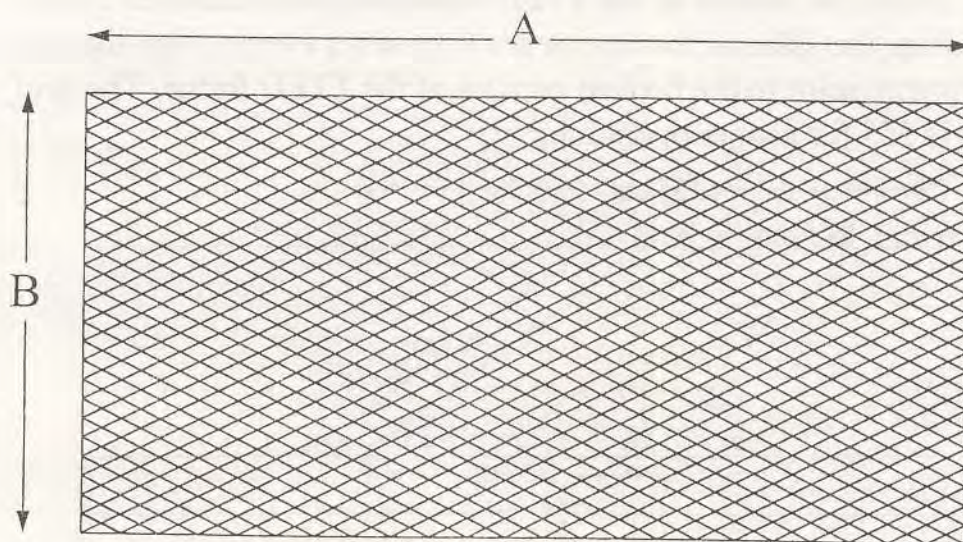
3. Construction of the metal hoops.

Two metal hoops 90 cm. in diameter.



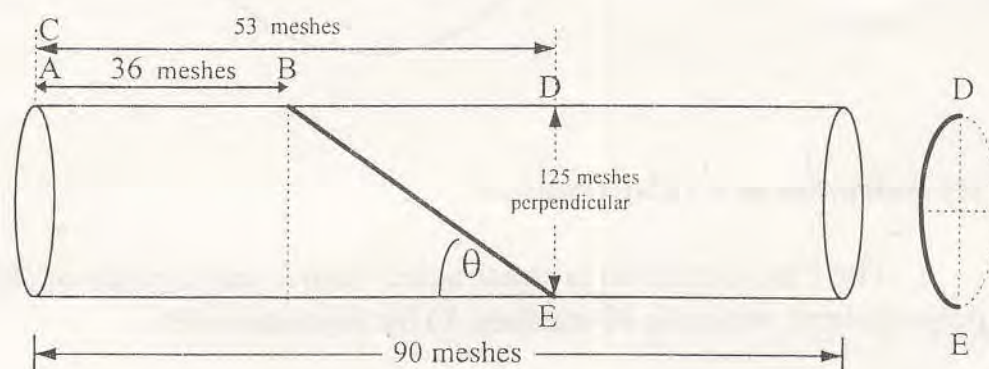
4. Construction of the Flap extension.

The Flap extension is constructed from a single piece of (250d/6) polyethylene, which is 90 meshes (A) by 54 meshes (B).

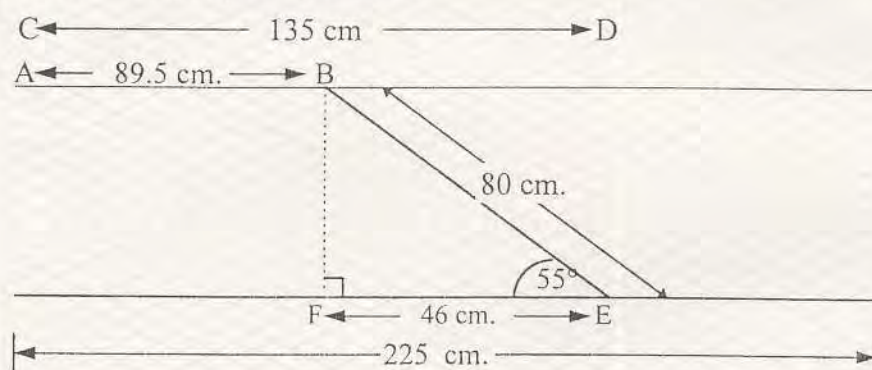


5. Obtaining the correct grid angle

Sliding the frame into the extension. Lace a metal hoop into each end of the extension. Using the metal hoops, stretch the extension tube so it is taut. Position the stretched extension so the seam is positioned along the top. Starting at the leading edge of the extension, count back 36 meshes along the seam and attach the top center of the TTFDs frame to the netting. In order to find the bottom center attachment point for the frame, count 53 meshes along the seam from the leading edge of the extension. From this point count 125 meshes perpendicular from the seam to arrive at the bottom center attachment point. Attach the TTFD to frame to the extension at this point.



Once the bottom of the TTFD frame has been attached to the extension, the sides of the device are then sewn evenly from the top attachment point to the bottom corners of the TTFD frame. The grid angle is 55° for proper operation.



Note:

$$BE = 80 \text{ cm.}$$

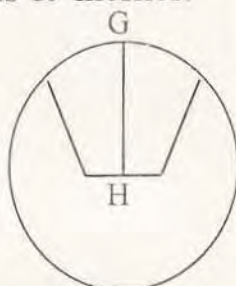
$$FE = 46 \text{ cm.}$$

$$\cos \theta = \frac{46}{80}$$

$$\theta = 55^\circ$$

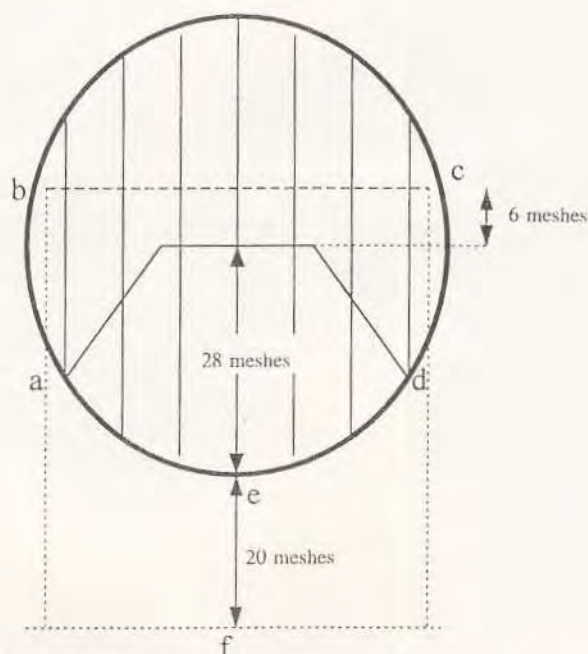
6. Cutting the exit hole

Begin by cutting all net bars from the 1st to 7th bar frame. Continue the cut along the net bars, maintaining all bar cut distances until the distance from G to H is 19 meshes.



7. Attachment of the exit hole cover (flap).

Attach the side of the flap to the side of the opening by sewing the flap to the extension ahead from a → b → c → d, remaining 4 meshes of the flap to 6 meshes of the extension behind the TTFD frame. The remaining 20 meshes of the flap behind the TTFD frame should be left unattached.



8. Chafing gear and floatation.

To prevent chafing of the net around the TTFD a length of 9.5 meters of 10 mm. polyethylene rope is laced around the frame through alternate meshes.

Attach two PVC floats 9 cm. in diameter by 14 cm. length to the outside of the TTFD for weight compensation and stabilization of the device.

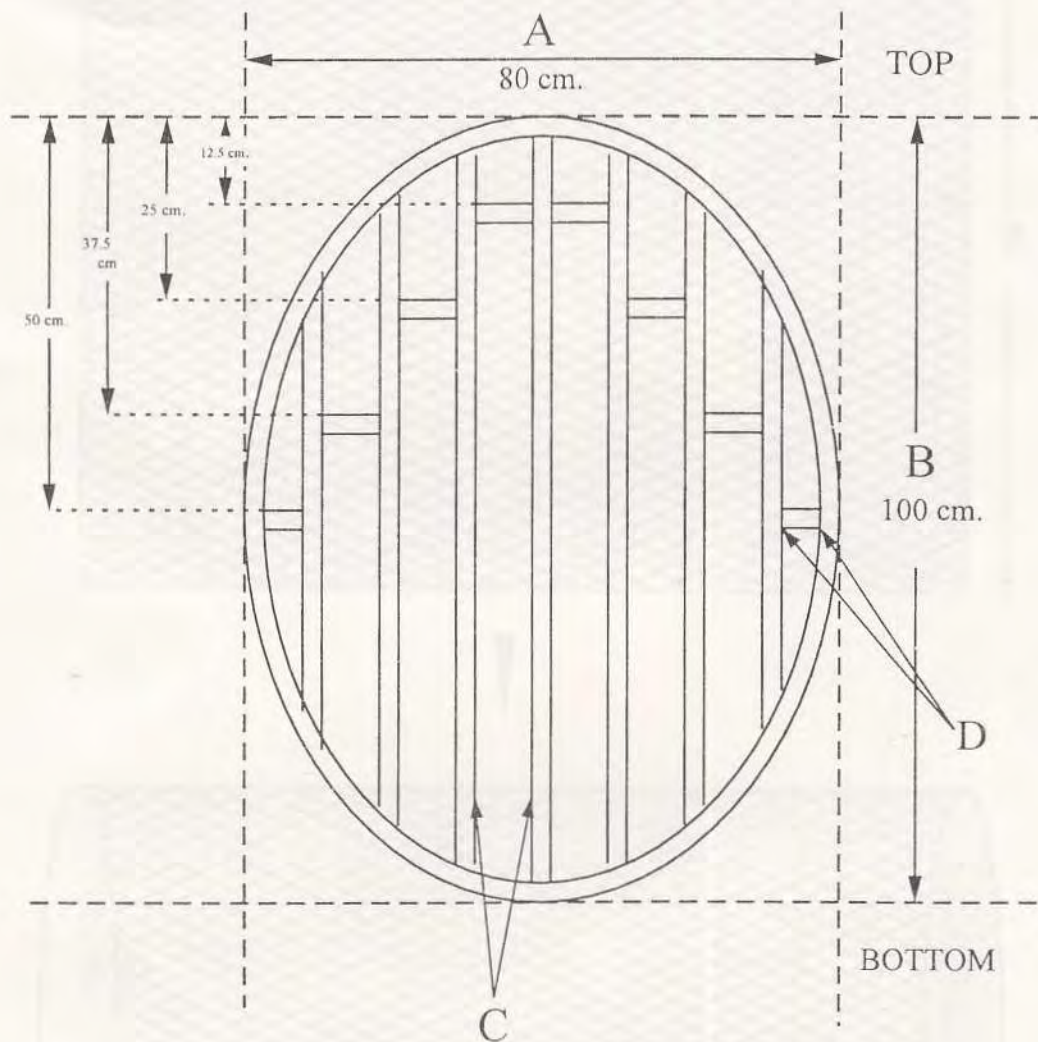
Appendix 2

Construction and Installation of Medium Size TTFD

TTFD Construction and Installation (MEDIUM SIZE)

Construction of the Frame

Construct an oval frame measuring 100 cm. high by 80 cm. wide. The outer ring of the frame is steel rod of 1.27 cm. diameter. The vertical grid bars are 0.95 cm. diameter metal steel rod. The spacing between deflector bars (C) is 9 cm. and between deflector bars and frame (D) is 7.5 cm.

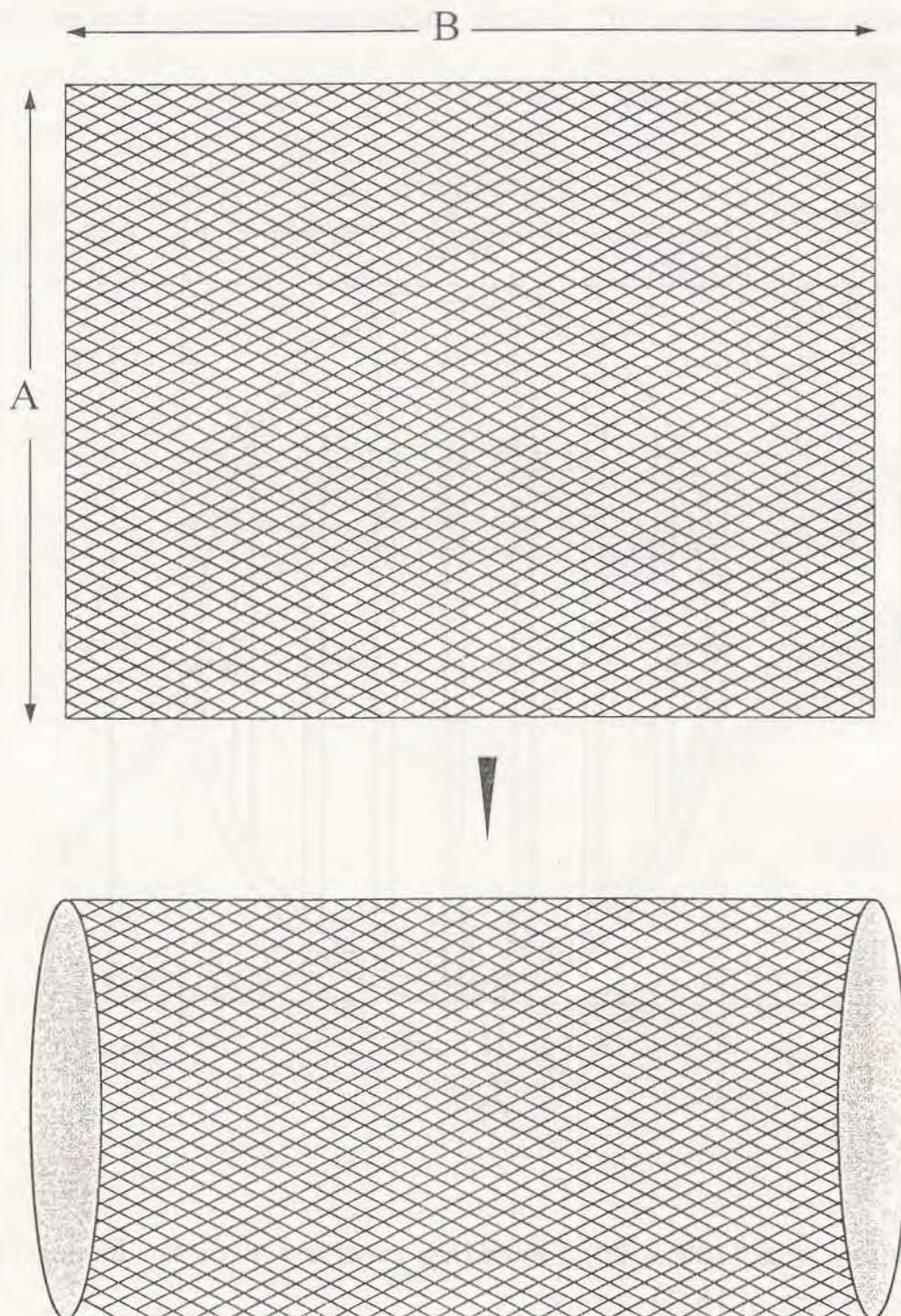


Medium size (100 x 80) for shrimp trawl net with the length of the ground rope of 18-24 meters.

2. Construction of the TTFD extension

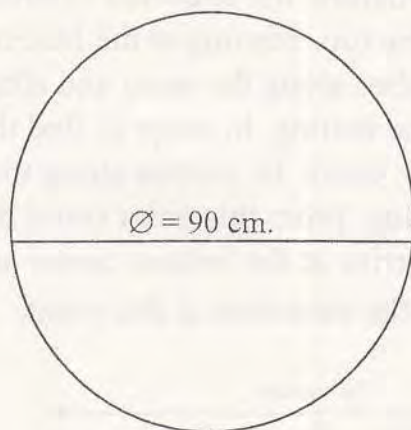
The TTFD extension is constructed from a single piece of (360d/18) polyethylene net, which is 138 meshes by 60 meshes, (mesh size is 3.8 cm.)

Construct a cylinder from the piece by sewing the 60 (B) mesh sides together.



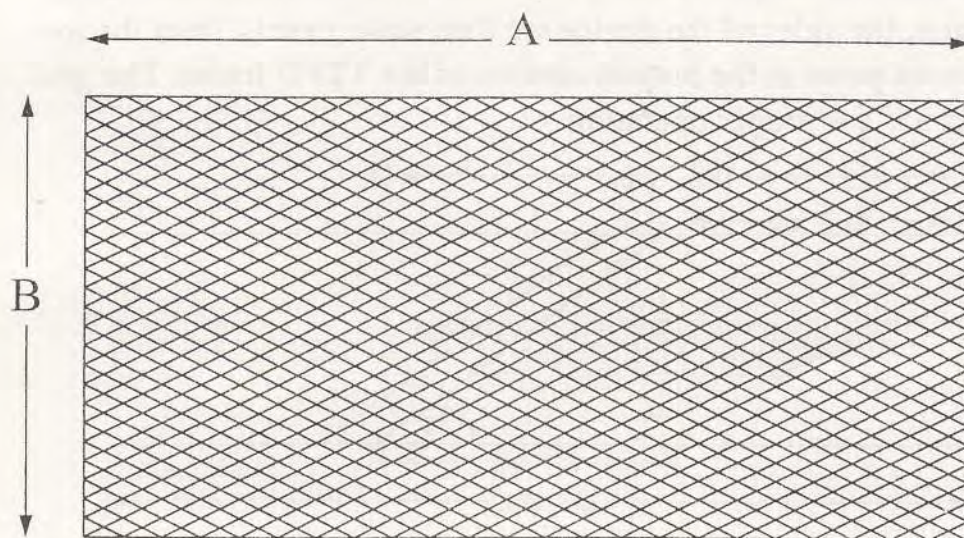
3. Construction of the metal hoops.

Two metal hoops 90 cm. in diameter.



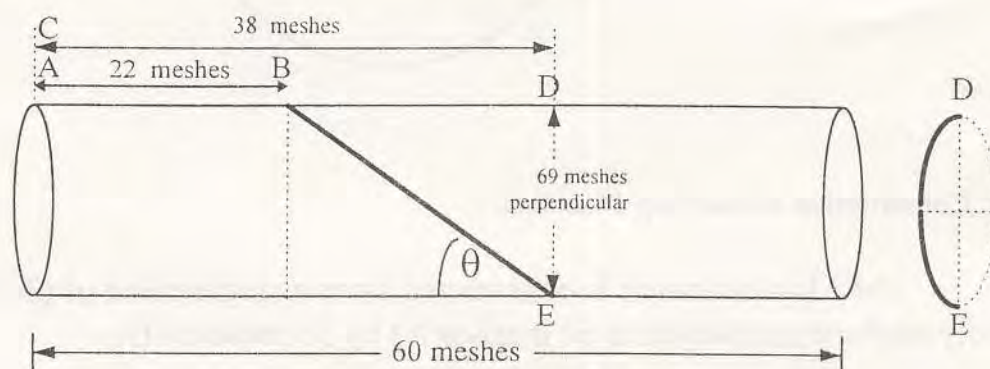
4. Construction of the Flap extension.

The Flap extension is constructed from a single piece of (360d/18) polyethylene net, which is 60 meshes(A) by 35 meshes (B).

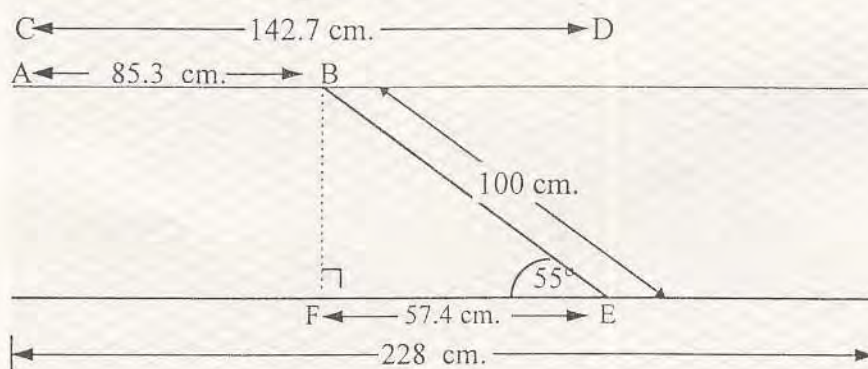


5. Obtaining the correct grid angle.

Sliding the frame into the extension. Lace a metal hoop into each end of the extension. Using the metal hoops, stretch the extension tube so it is taut. Position the stretched extension so the seam is positioned along the top. Starting at the leading edge of the extension, count back 22 meshes along the seam and attach the top center of the TTFDs frame to the netting. In order to find the bottom center attachment point for the frame, count 38 meshes along the seam from the leading edge of the extension. From this point count 69 meshes perpendicular from the seam to arrive at the bottom center attachment point. Attach the TTFD to frame to the extension at this point.



Once the bottom of the TTFD frame has been attached to the extension, the sides of the device are then sewn evenly from the top attachment point to the bottom corners of the TTFD frame. The grid angle is 55° for proper operation.



Note:

$$BE = 100 \text{ cm.}$$

$$FE = 57.4 \text{ cm.}$$

$$\cos \theta = \frac{57.4}{100}$$

$$\theta = 55^\circ$$

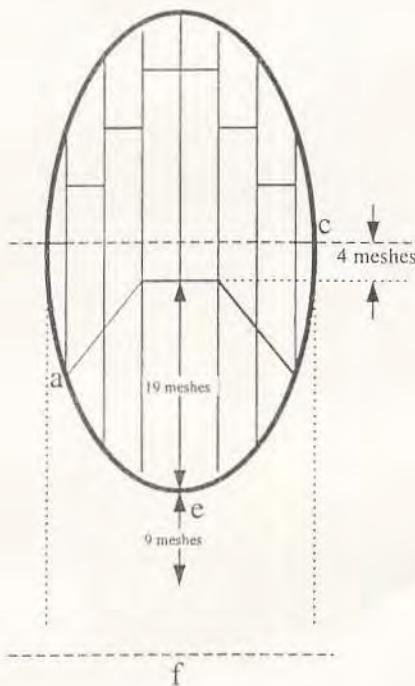
6. Cutting the exit hole

Begin by cutting all net bars from the 1st to 7th bar frame. Continue the cut along the net bars, maintaining all bar cut distances until the distance from G to H is 19 meshes.



7. Attachment of the exit hole cover (flap).

Attach the side of the flap to the side of the opening by sewing the flap to the extension ahead from $a \rightarrow b \rightarrow c \rightarrow d$, the remaining 4 meshes of the flap to 4 meshes of the extension behind the TTFD frame. The remaining 9 meshes of the flap behind the TTFD frame should be left unattached.



8. Chafing gear and floatation.

To prevent chafing of the net around the TTFD a length of 9.5 meters of 10 mm. polyethylene rope is laced around the frame through alternate meshes. Attach two PVC floats 9 cm. in diameter by 14 cm. length to the outside of the TTFD for weight compensation and stabilization of the device.

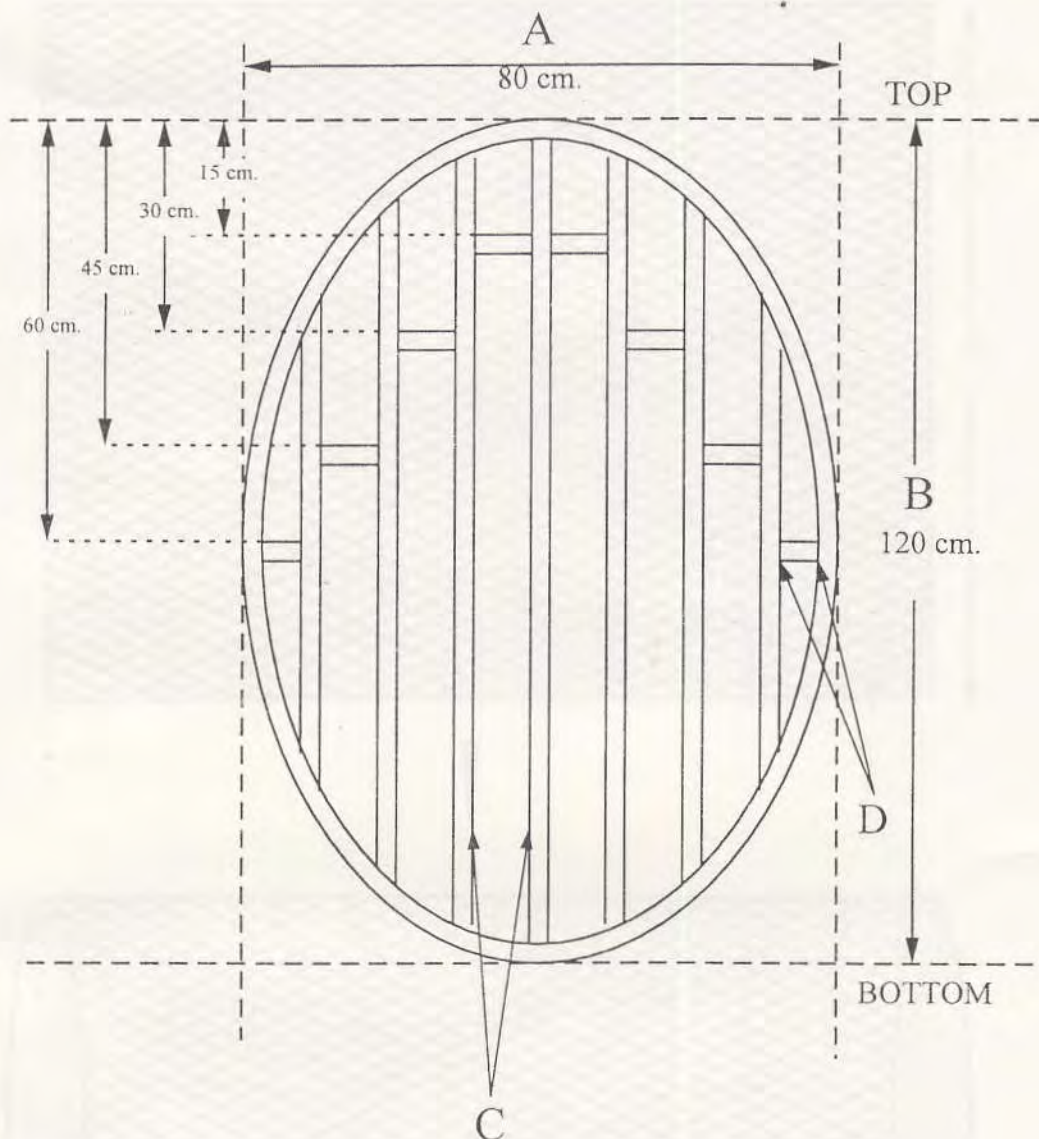
Appendix 3

Construction and Installation of Large Size TTFD

TTFD Construction and Installation (BIG SIZE)

Construction of the Frame

Construct an oval frame measuring 120 cm. high by 80 cm. wide. The outer ring of the frame is steel rod of 1.27 cm. diameter. The vertical grid bars are 0.95 cm. diameter metal steel rod. The spacing between deflector bars (C) is 9 cm. and between deflector bars and frame (D) is 7.5 cm.

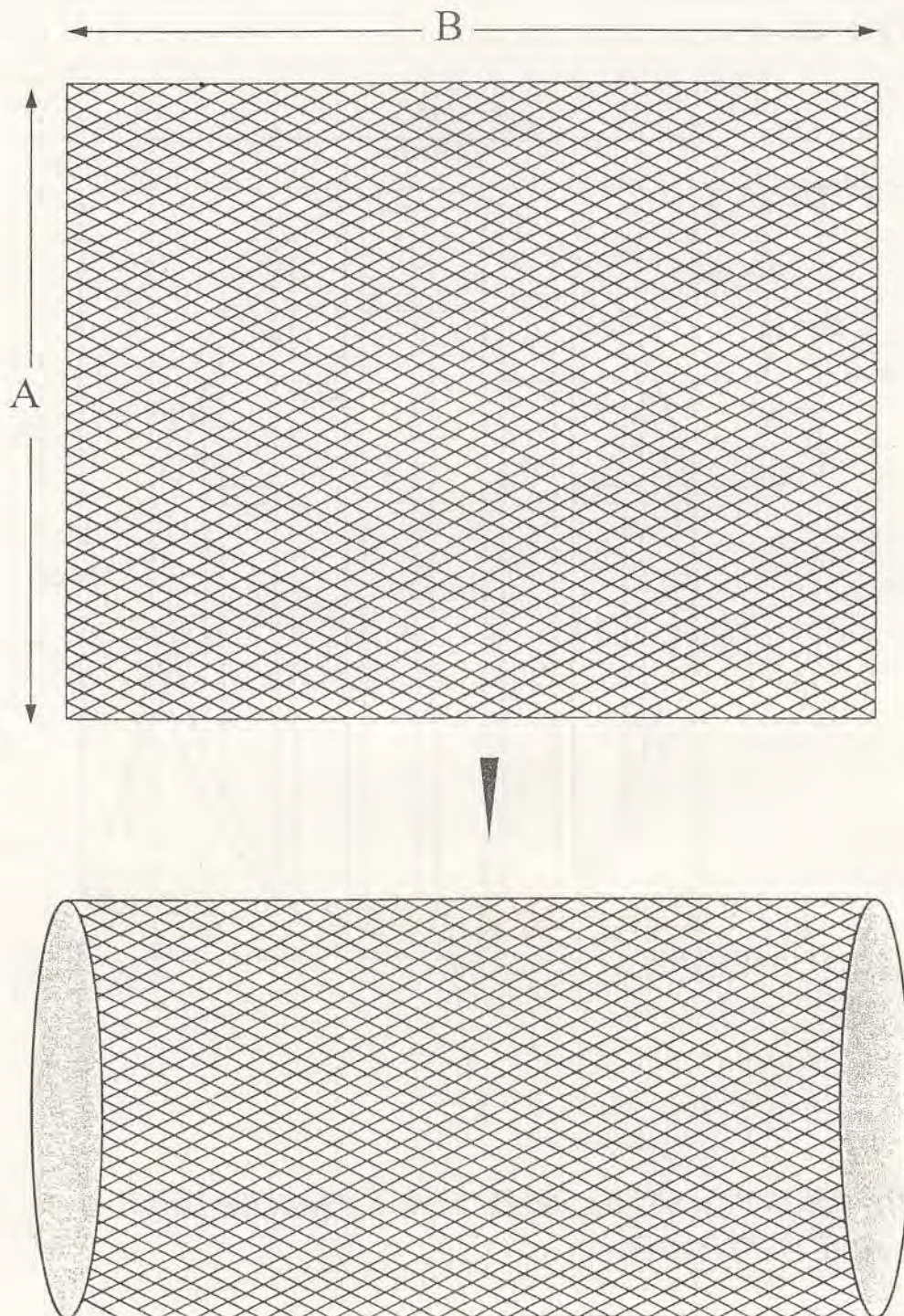


Big size (120 x 80) for shrimp trawl net with the length of the ground rope of 24-30 meters.

2. Construction of the TTFD extension

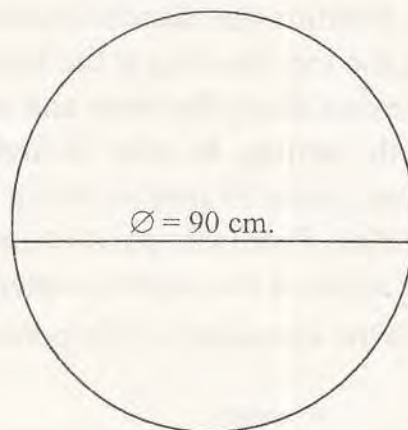
The TTFD extension is constructed from a single piece of (360d/18) polyethylene net, which is 165 meshes by 60 meshes, (mesh size is 3.8 cm.).

Construct a cylinder from the piece by sewing the 60 (B) mesh sides together.



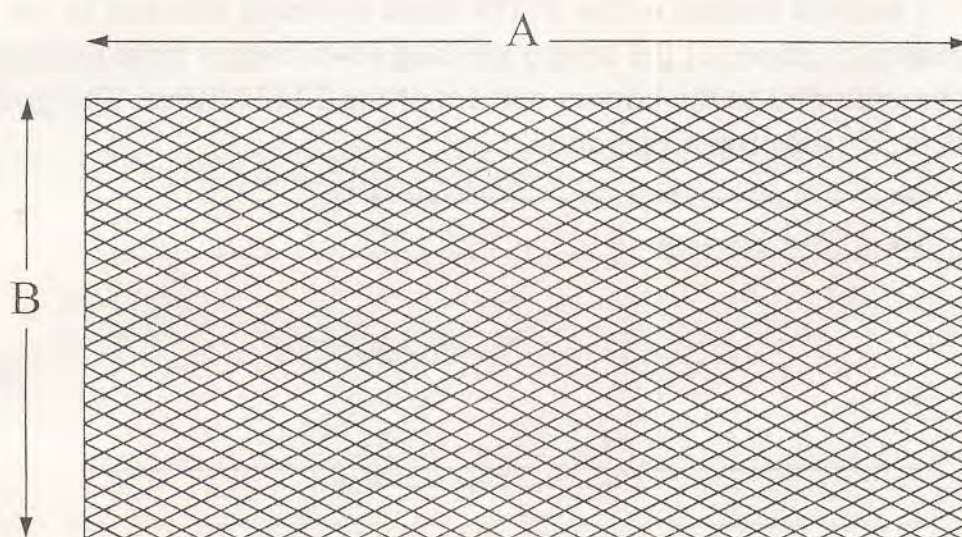
3. Construction of the metal hoops.

Two metal hoops 90 cm. in diameter.



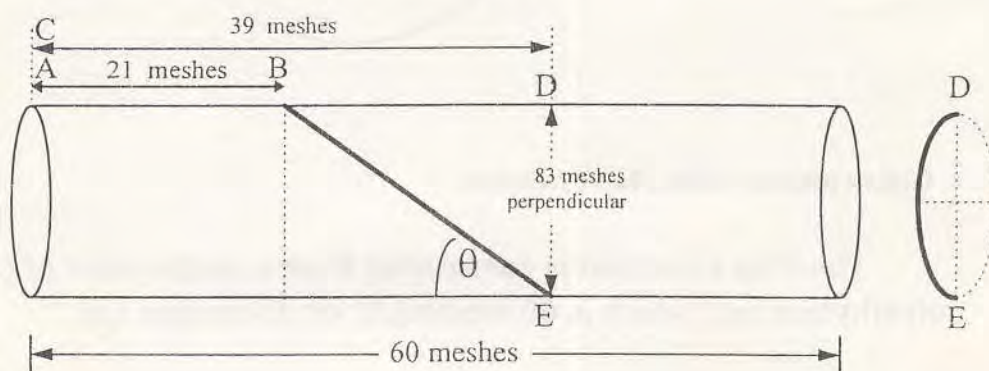
4. Construction of the Flap extension.

The Flap extension is constructed from a single piece of (360d/18) polyethylene net, which is 60 meshes (A) by 35 meshes (B).

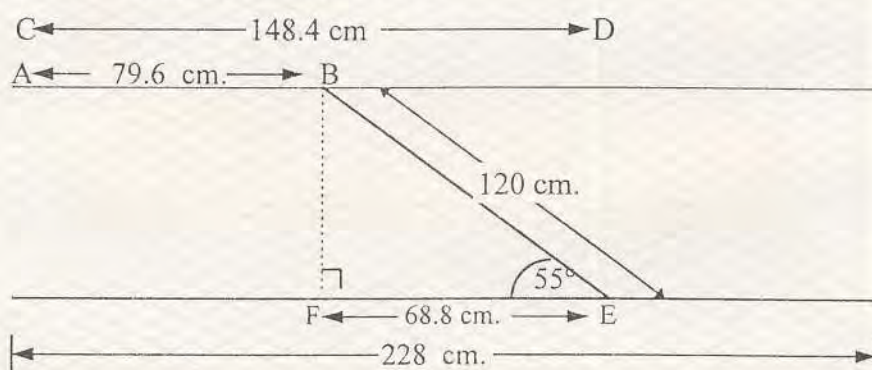


5. Obtaining the correct grid angle.

Sliding the frame into the extension. Lace a metal hoop into each end of the extension. Using the metal hoops, stretch the extension tube so it is taut. Position the stretched extension so the seam is positioned along the top. Starting at the leading edge of the extension, count back 21 meshes along the seam and attach the top center of the TTFDs frame to the netting. In order to find the bottom center attachment point for the frame, count 39 meshes along the seam from the leading edge of the extension. From this point count 83 meshes perpendicular from the seam to arrive at the bottom center attachment point. Attach the TTFD to frame to the extension at this point.



Once the bottom of the TTFD frame has been attached to the extension, the sides of the device are then sewn evenly from the top attachment point to the bottom corners of the TTFD frame. The grid angle is 55° for proper operation.



Note:

$$BE = 120 \text{ cm.}$$

$$EF = 68.8 \text{ cm.}$$

$$\cos \theta = \frac{68.8}{120}$$

$$\theta = 55^\circ$$

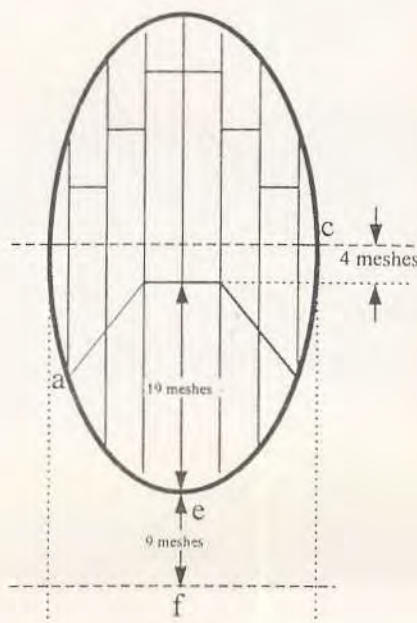
6. Cutting the exit hole.

Begin by cutting all net bars from the 1st to 7th bar frame. Continue the cut along the net bars, maintaining all bar cut distances until the distance from G to H is 19 meshes.



7. Attachment of the exit hole cover (flap).

Attach the side of the flap to the side of the opening by sewing the flap to the extension ahead from $a \rightarrow b \rightarrow c \rightarrow d$, the remaining 4 meshes of the flap to 4 meshes of the extension behind the TTFD frame. The remaining 9 meshes of the flap behind the TTFD frame should be left unattached.



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