THE EXPERIMENTS ON TURTLE EXCLUDER DEVICES (TEDs) FOR SHRIMP TRAWL NETS IN THAILAND

by

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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, respectively, 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 the 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 trawlers[1] 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 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 Chumporn 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 vessel. 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 Maxican 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 codend extension part. Experiments started from the early morning till late at night. A total of eight trawling operations for each type of TEDs and a total of two hauls without TED were carried out separately into two periods, the day- and the night-time, within 2 days. For the two hauls without TED were made during the first day only as control net trawling. The period for each haul was one hour. In the experiments with TEDs, the exit of the TEDs were covered with a cover net in order to measure the amount and species of fish escape. The fuel consumption of the vessels with and without TEDs and for each type of TED were also recorded. To find a suitable TED the experiments were made into two series, as first and second experiments.

2.2.1 First Experiment

The first experiment was carried out in the water off Chumporn province during September of 1996. A total of 60 hauls comprised of 12 hauls without TEDs and 48 hauls for six types of TEDs 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 water off Songkhla province during October of 1996. Six types of TEDs; 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 TEDs which replaced the Anthony Weedless TED were tested on board the M.V. Pramong 1. A total of 60 hauls comprised of 12 hauls without TEDs and 48 hauls for the six types of TEDs.

2.3 Data Analysis

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

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

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 TEDs were computed and compared to that of the control net (without TEDs). 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 without TEDs and with TEDs were discussed.

3. RESULTS AND DISCUSSION

The species composition by catch from 120 hauls indicates 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 type of TED for day- and night-time operations. The ratio of escape between the economic species groups and the trash fish was different in day and night. In addition, three types of TEDs namely the Super Shooter, Georgia Jumper and the Thai-KU had 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/groups 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.

Although 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 the 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 TEDs 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 TEDs 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 the 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 TEDs for day- and night- operations. The figures also show that the main escape fish for both day- and night-time operations was trash fish compared to the 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 means no shrimp escaped out of the TED during the day-time operation.

3.3   Fuel Consumption

The fuel consumption for a one hour trawling operation with different types of TEDs was compared to the control net operation in Figure 8. The figure shows there was not much difference in consumption of the fuel for the six types of TEDs 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.

5.   ACKNOWLEDGEMENT

6.   REFERENCES

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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
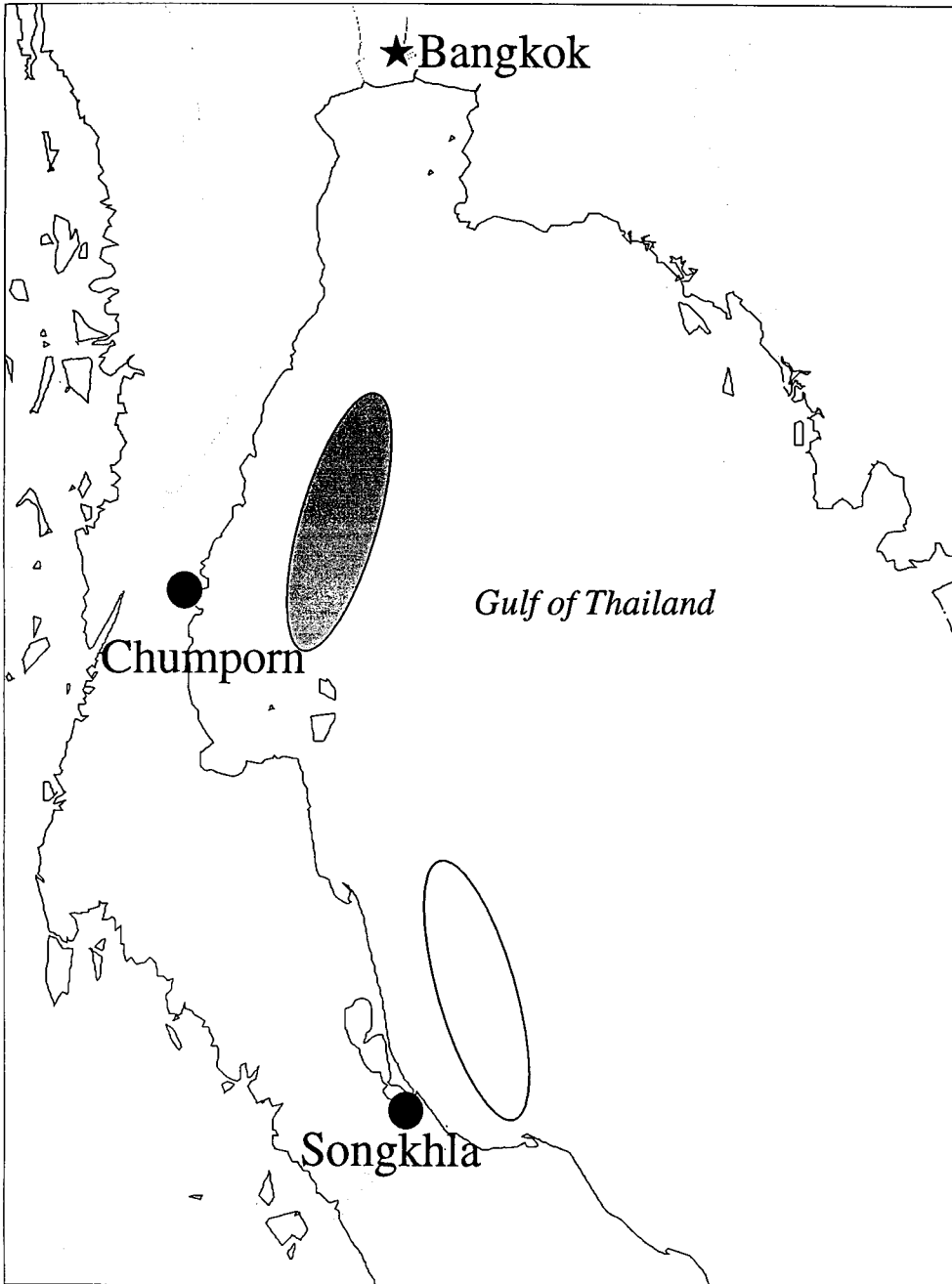
Fig. 1. Fishing areas for shrimp trawl experiments with TEDs
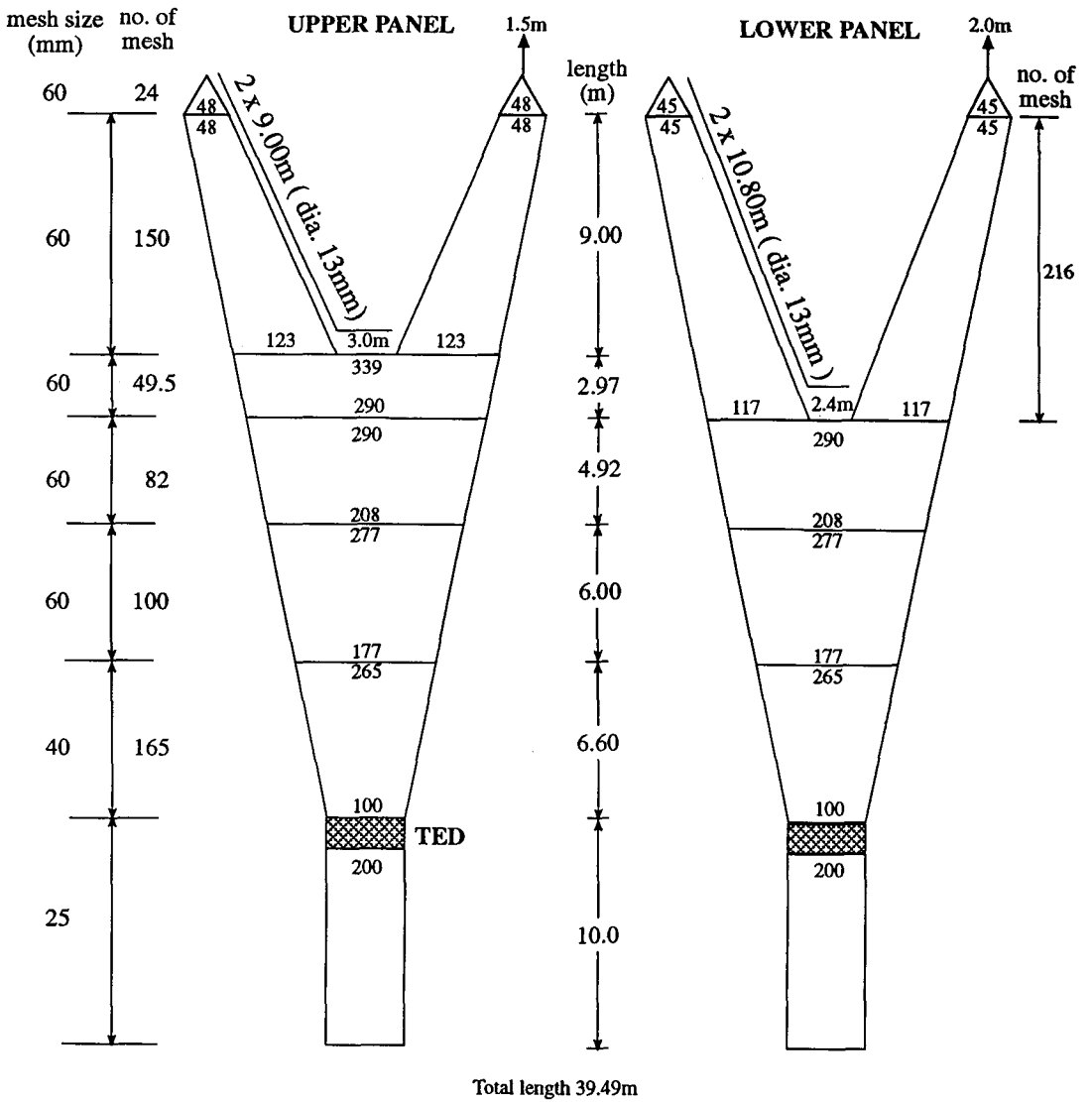
Fig. 2.   The diagram of the shrimp trawl
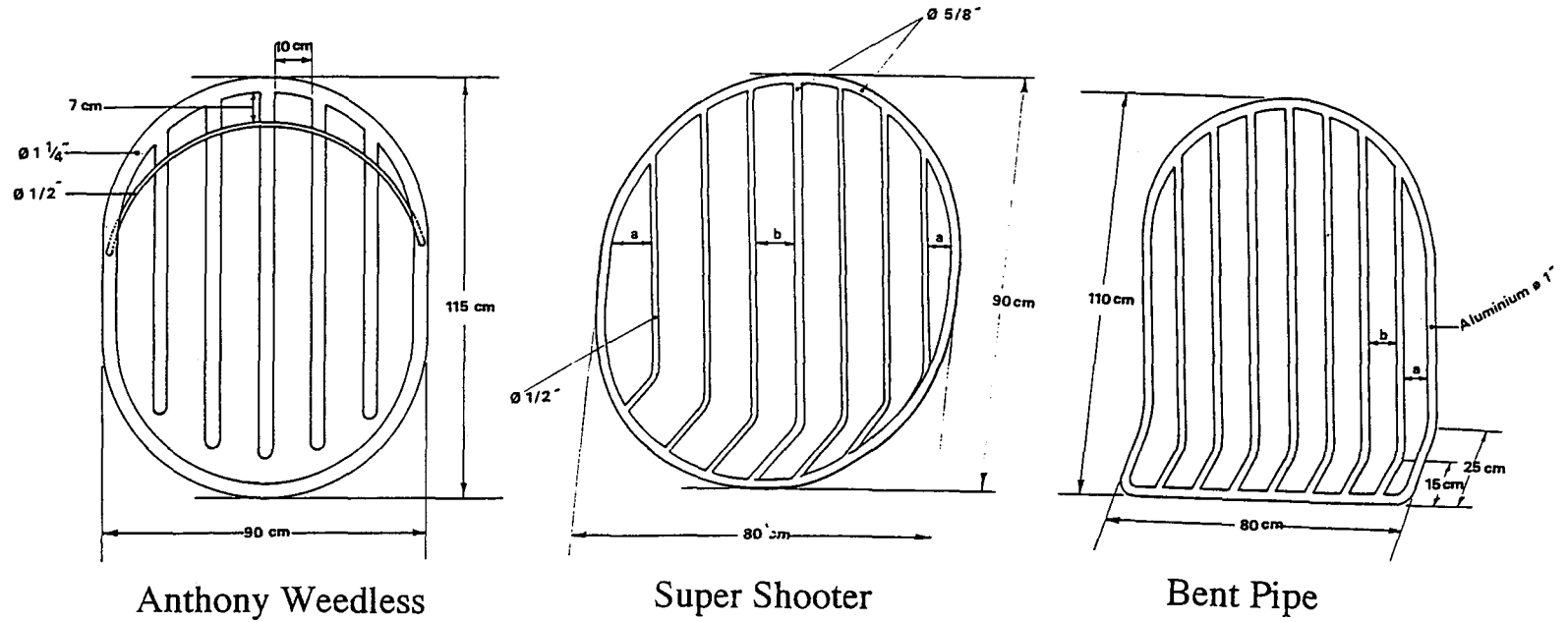
Fig. 3a. Three types of TED from U.S.A.

Georgia Jumper   Mexican
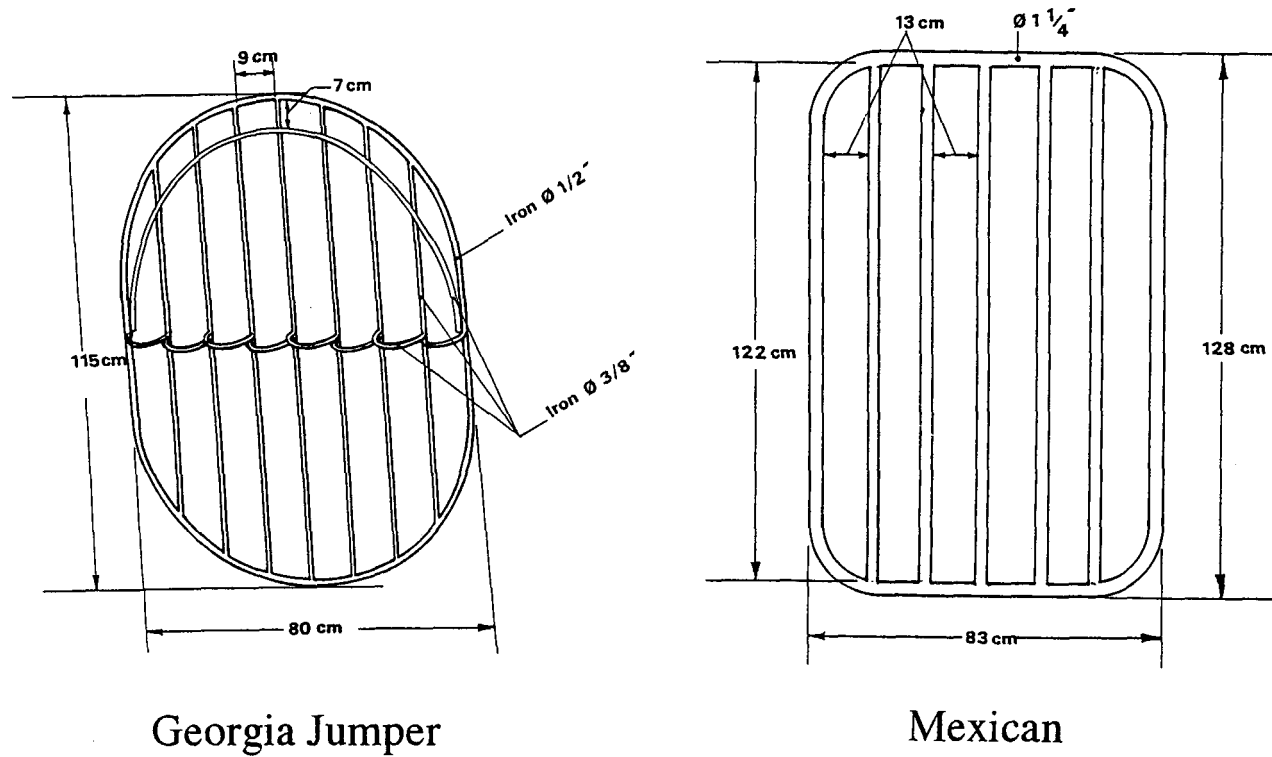
Fig. 3b. Two types of TED from Mexican.
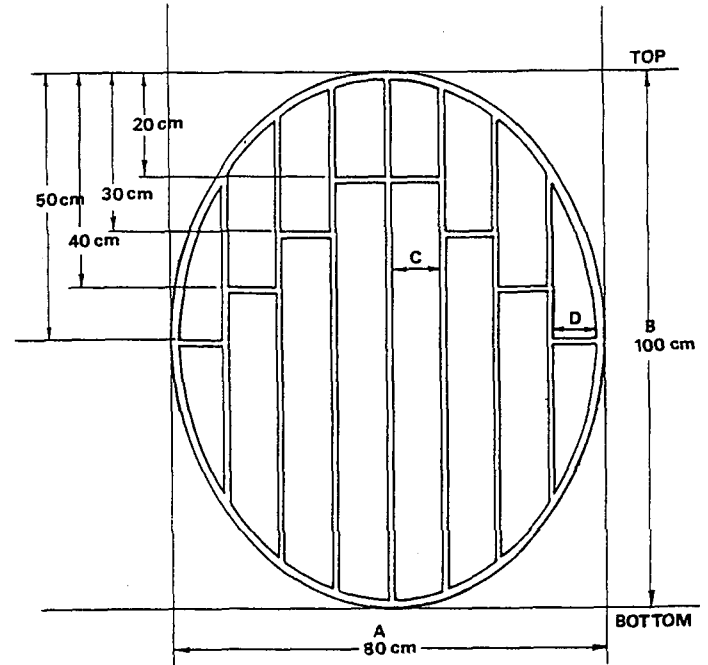
Fig. 3c. Two types of TED from Thailand.

Thai-KU

Thai Turtle Free Device (TTFD)
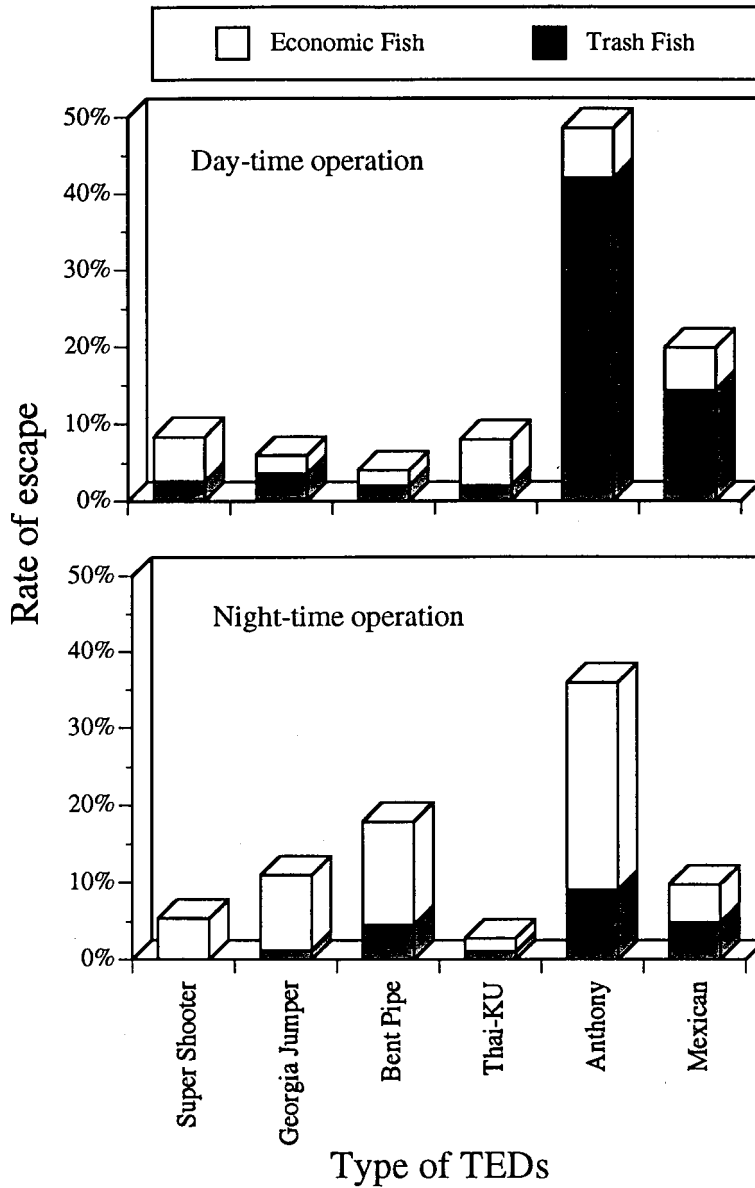
Fig. 4. The escape rate relatives to type of TEDs used for the day- and night-time operation in the first experiment.
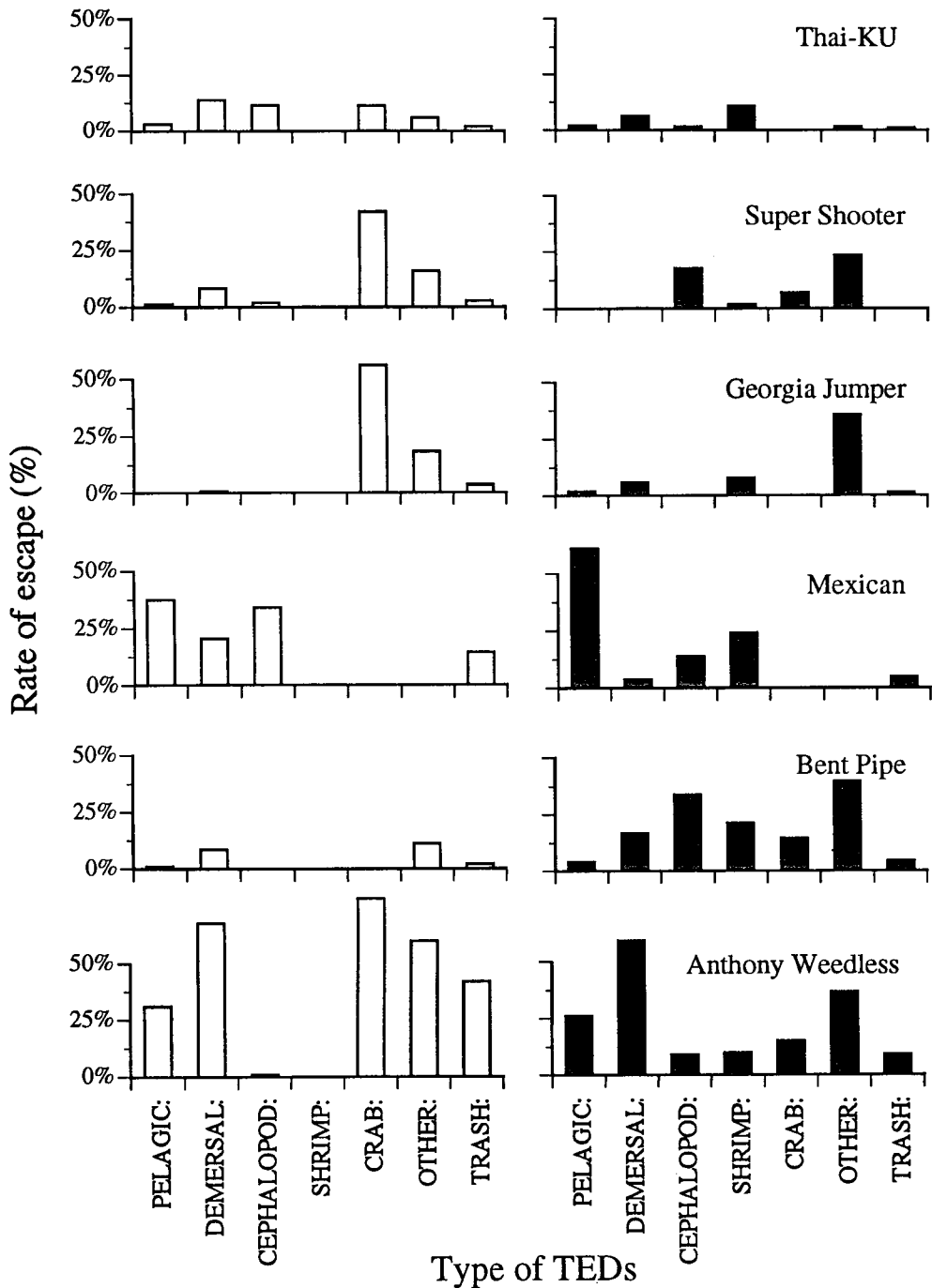
Fig. 5. Rate of escape by total weight of the economic fish for different types of TEDs in the first experiment.

☐ Day-time operation

■ Night-timeoperation

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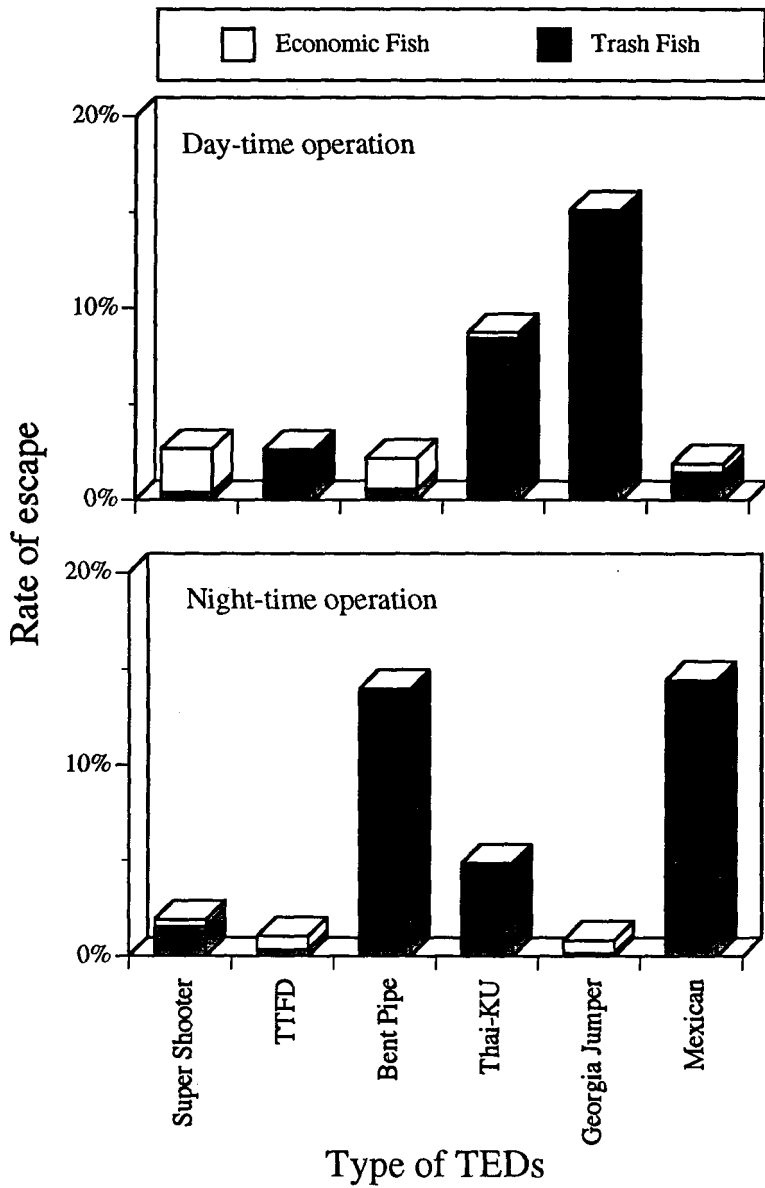
Fig. 6. The escape rate relatives to type of TEDs used for the day- and night-time operation in the second experiment.
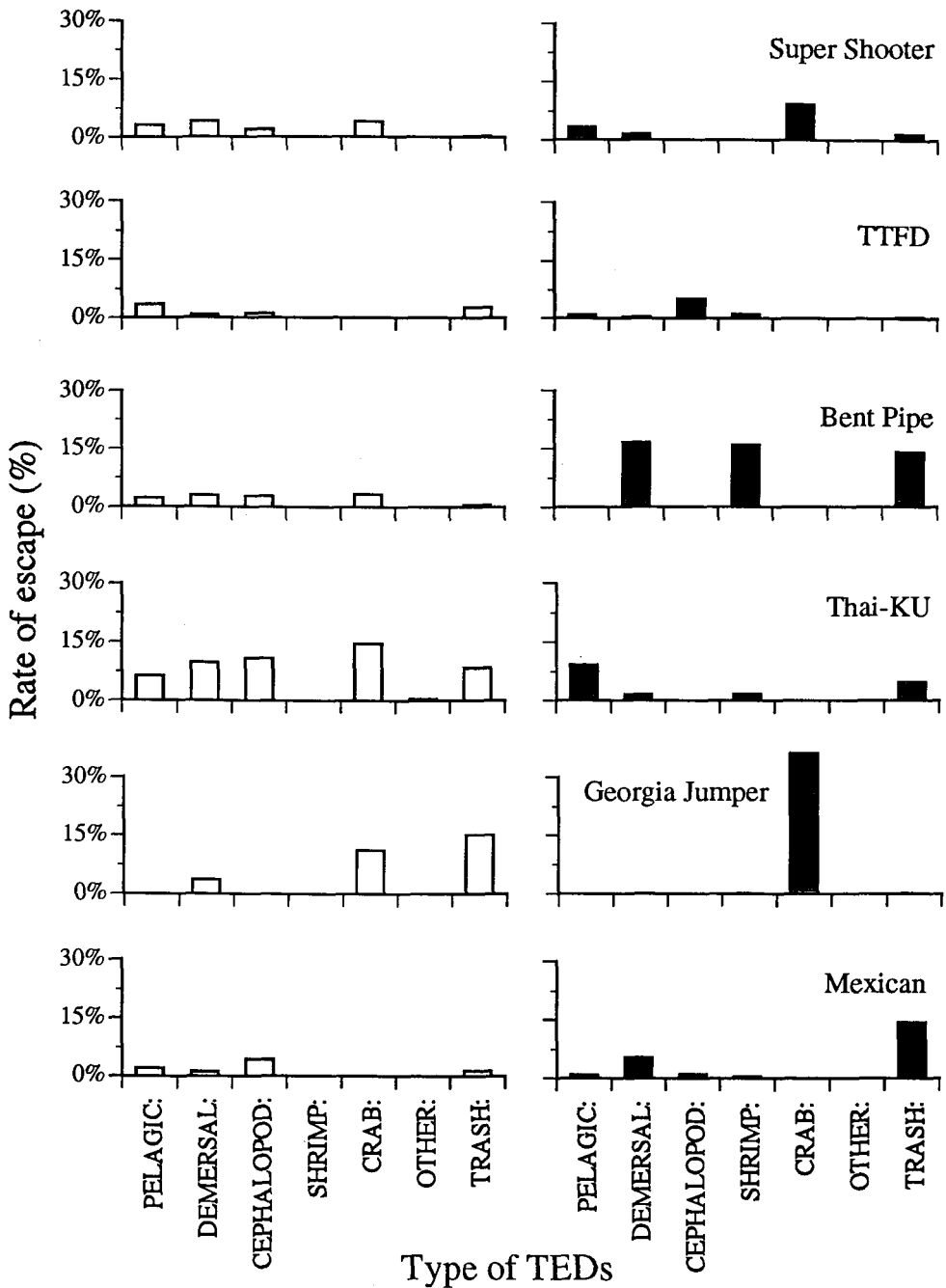
Fig. 7. Rate of escape by total weight of the economic fish for different types of TEDs in the second experiment.

☐ Day-time operation

■ Night-time operation
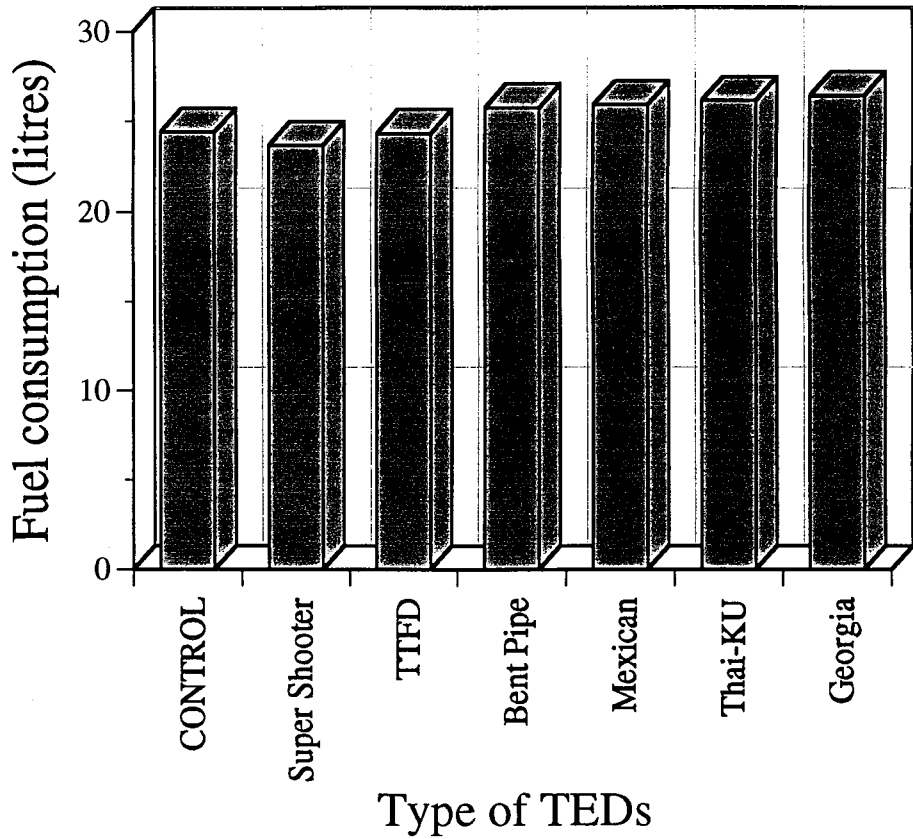
Fig. 8   Fuel consumption relatives to type of TEDs.

TTFD Construction and Installation
(SMALL SIZE)

1.   Construction of the Frame

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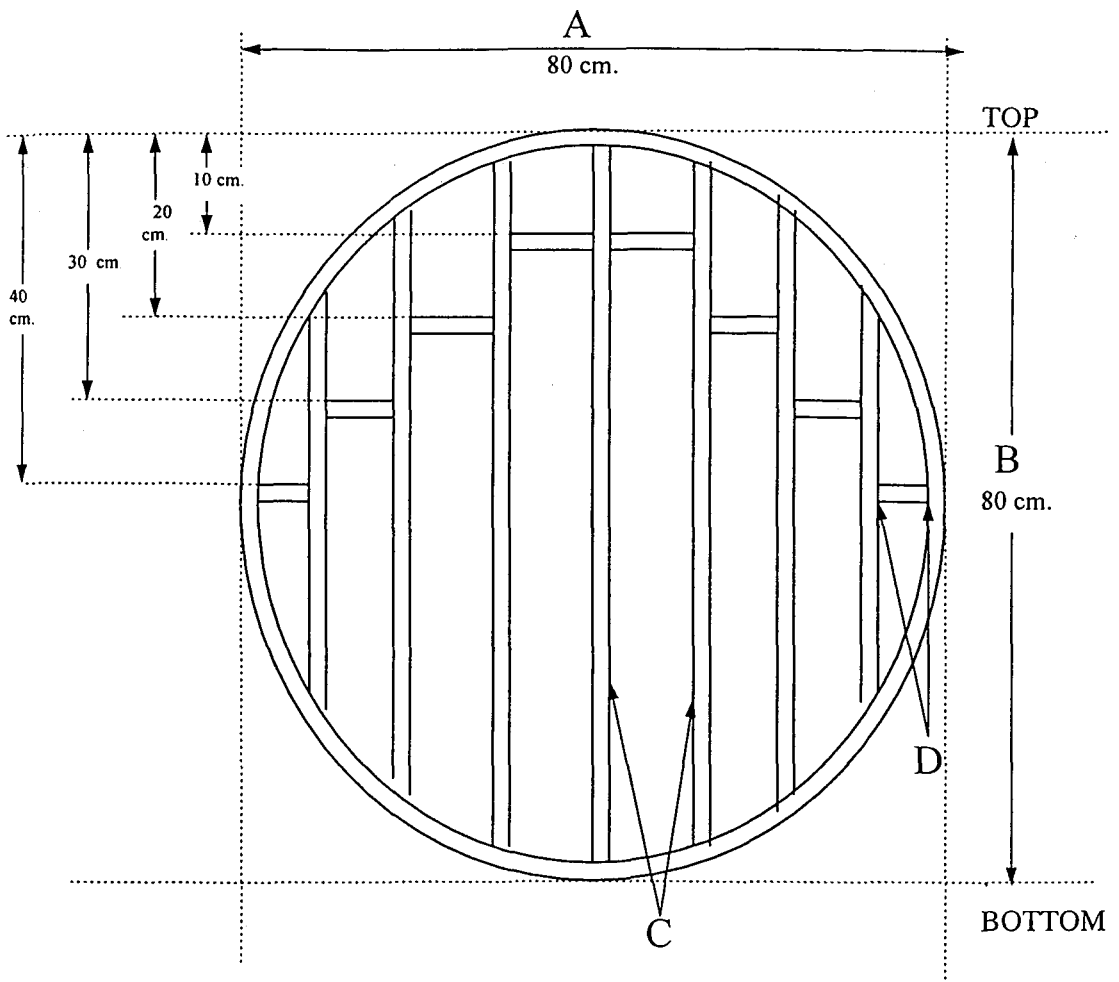
Small size (80 x 80) for shrimp trawl net with length of ground rope of 12 - 18 meters.

2. Construction of the TTFD extension

The TTFD extension is construction from a single piece of (250d/6) polyethylene ,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.
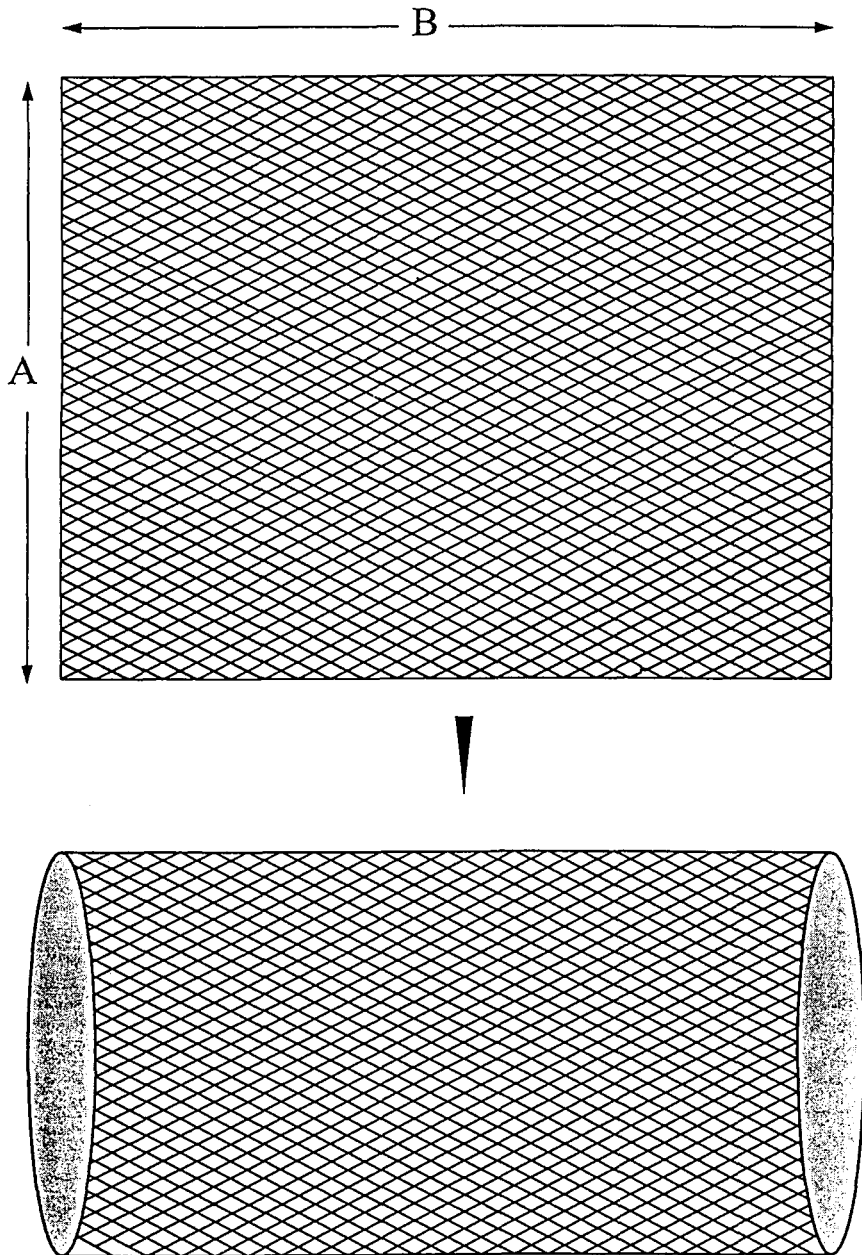
3.   Construction of the metal hoops.
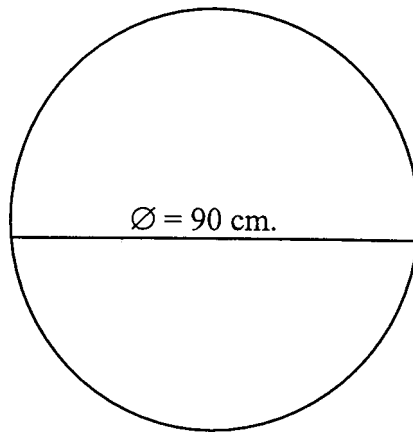
Two metal hoops 90 cm. in diameter.

$\varnothing = 90$ cm.

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).
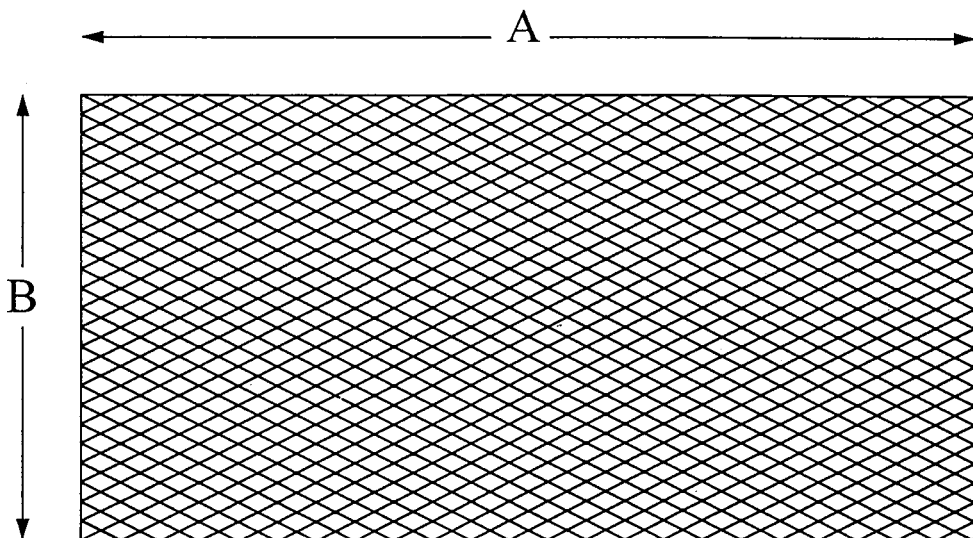
A

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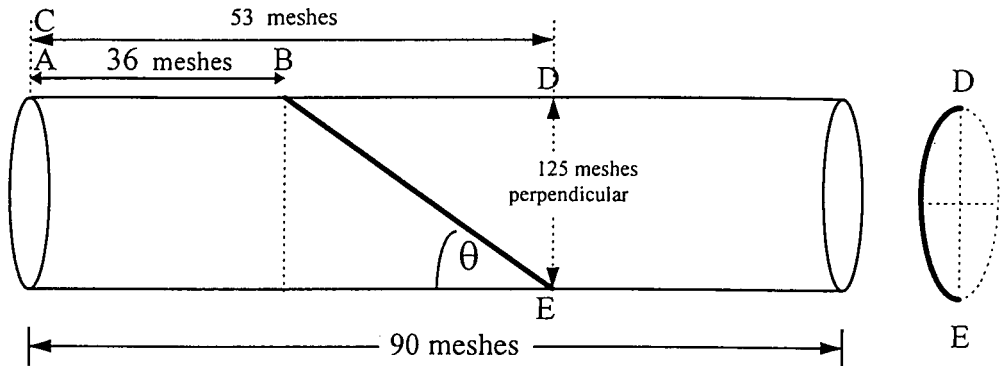
Once the bottom of the TTFD frame has been attached to the extension, the sides of the device are then sewn evenly from the top attachment point to the bottom corners of the TTFD frame. The grid angle is 55° for proper operation.
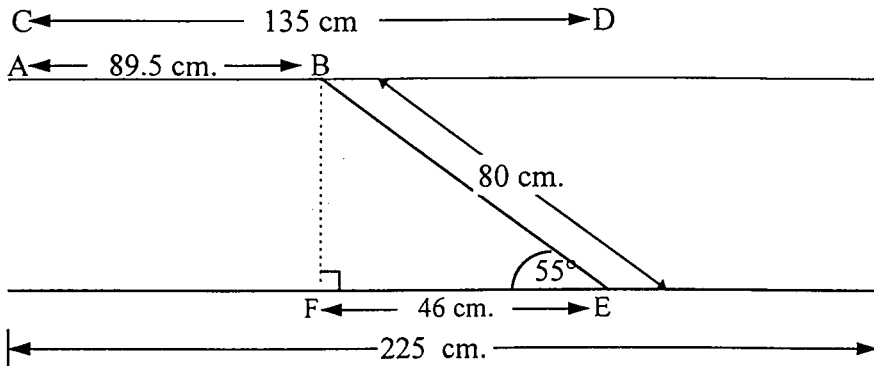
Note:

$$BE = 80 \text{ cm.}$$
$$FE = 46 \text{ cm.}$$

$$\cos \theta = \frac{46}{80}$$
$$\theta = 55°$$

6.   Cutting the exit hole

Begin with all bar cutting all bar from the 1 and 7 grid bars frame. Continue the cut along the bars, maintaining all bar cut distance until the distance from G to H measured 28 meshes.
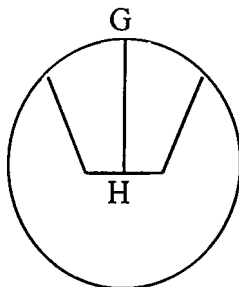
7.   Attachment of the exit hole cover (flap).

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.
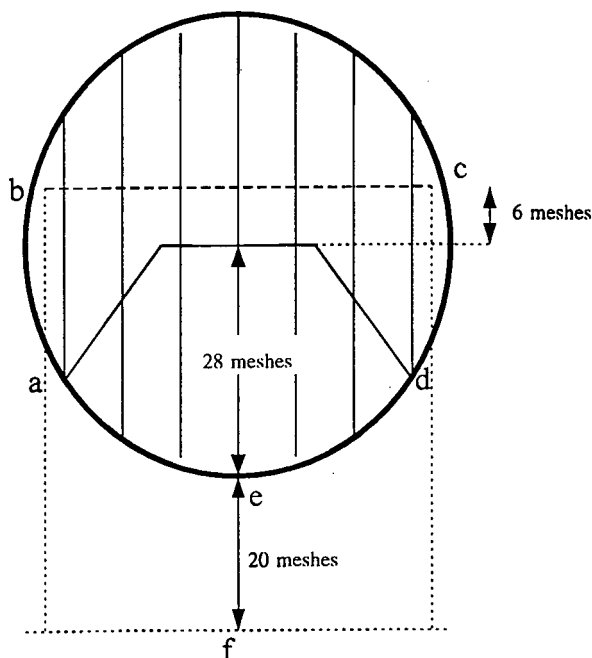
8.   Chafing gear and floatation.

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 though 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.

TTFD Construction and Installation
(MEDIUM SIZE)

1.   Construction of the Frame

Construction 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.
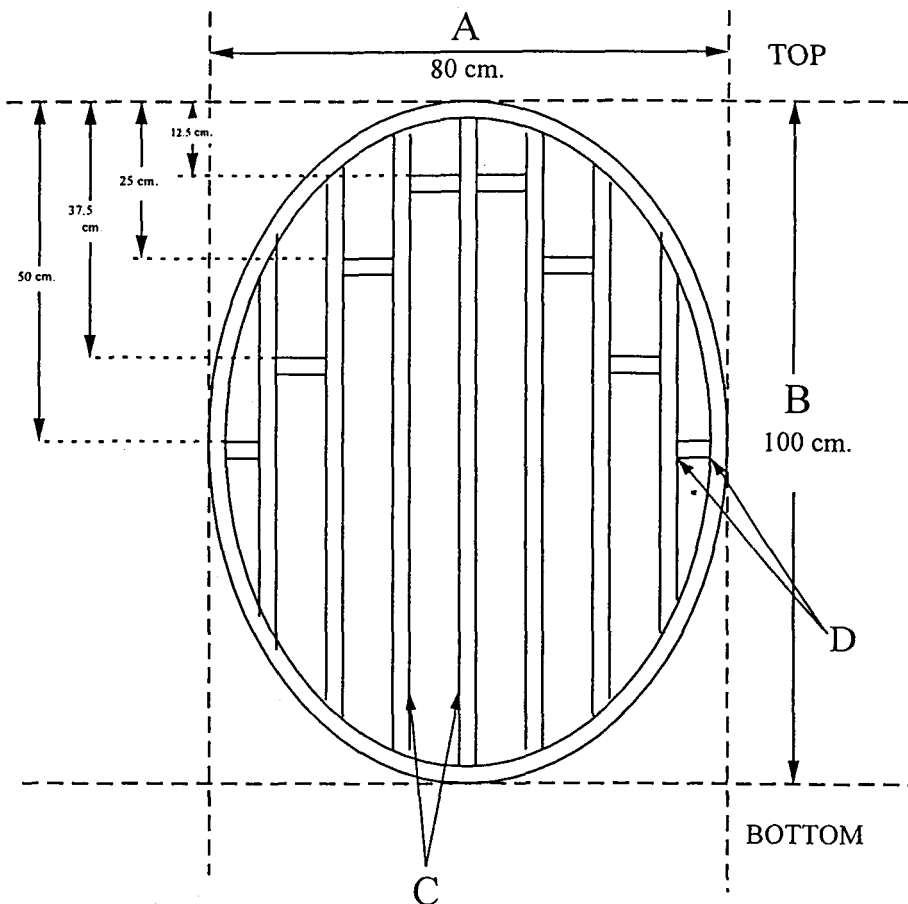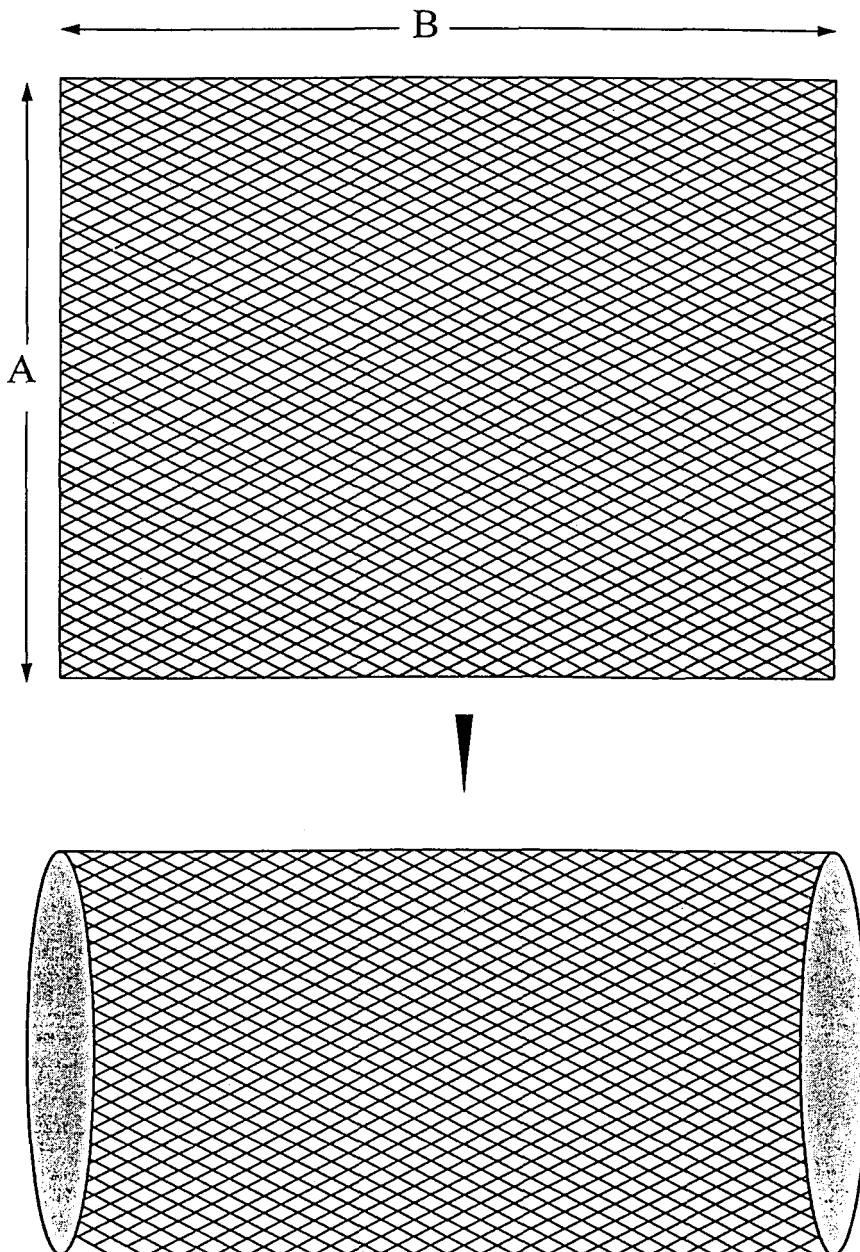

Medium size (100 x 80) for shrimp trawl net with length of ground rope of 18 - 24 meters.

2. Construction of the TTFD extension

The TTFD extension is constructed from a single piece of (360d/18) polyethylene ,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.
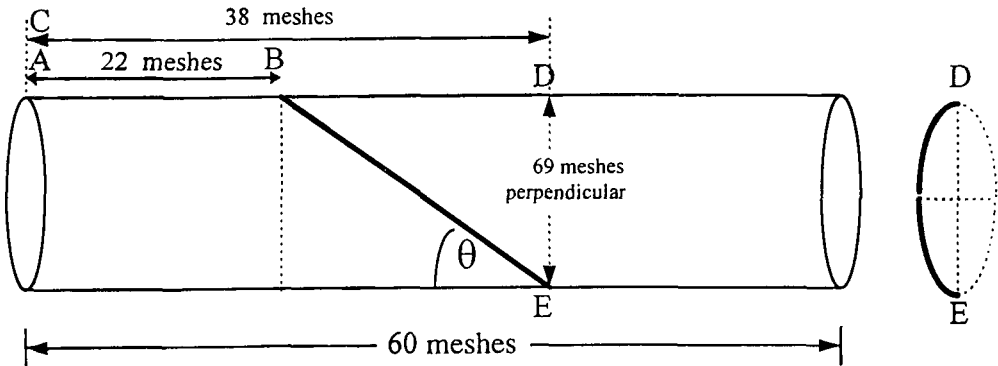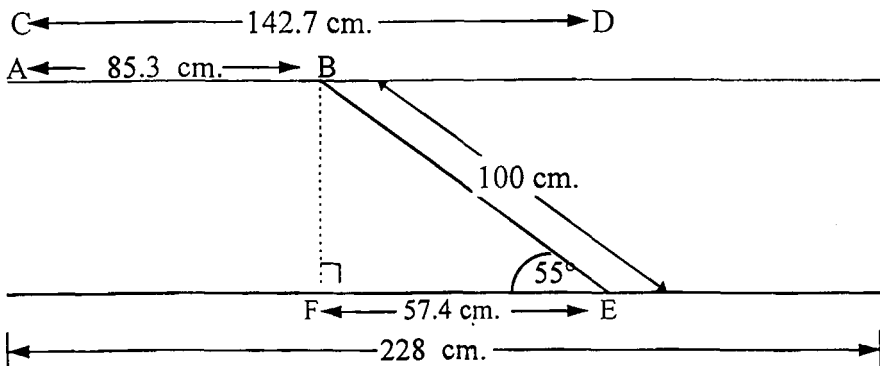
Two metal hoops 90 cm. in diameter.

$\varnothing = 90$ cm.

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).

A

B
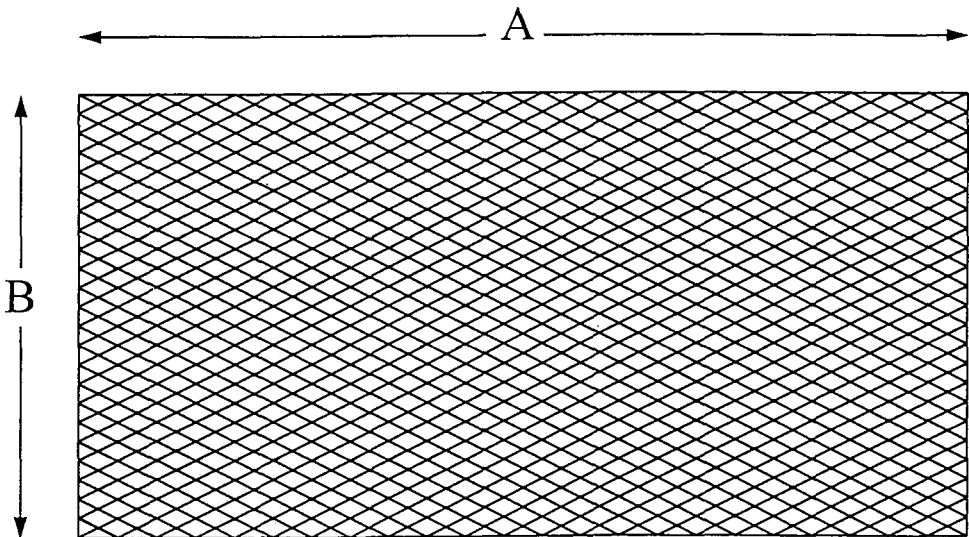
5.   Obtaining the correct grid angle.

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 seamto 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.
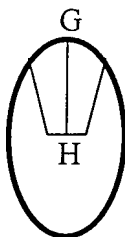

Note:

$$BE = 100 \ \text{cm.}$$
$$FE = 57.4 \ \text{cm.}$$

$$\cos \theta = \frac{57.4}{100}$$
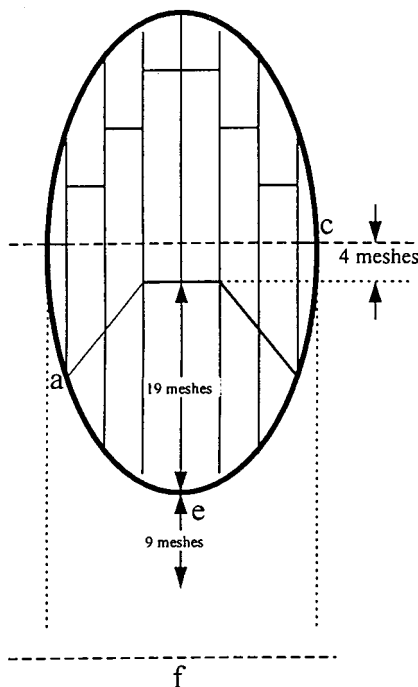$$\theta = 55°$$

6. Cutting the exit hole

Begin the net cutting all bar from the 1 and 7 grid bar frame. Continue the cut along the bars, maintaining all bar cut distances until the distance from G to H measuring 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, 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 though 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.

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TTFD Construction and Installation
(BIG SIZE)

1.   Construction of the Frame

Construction 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.
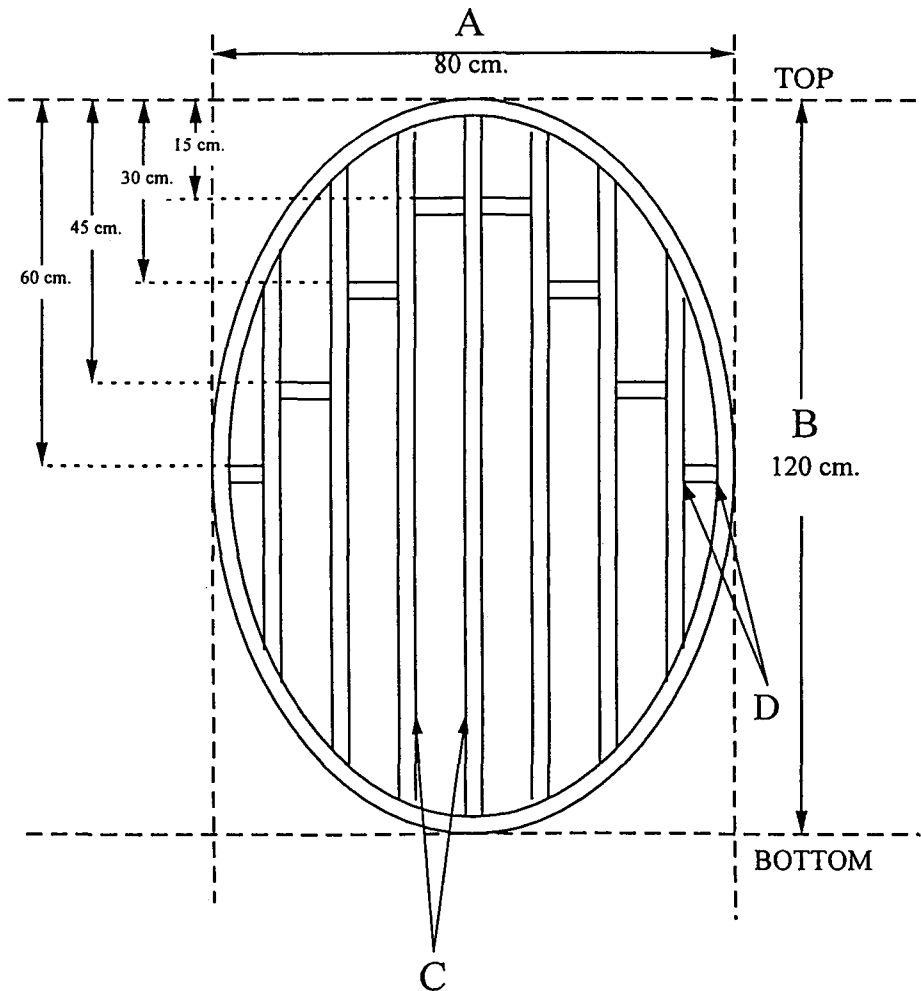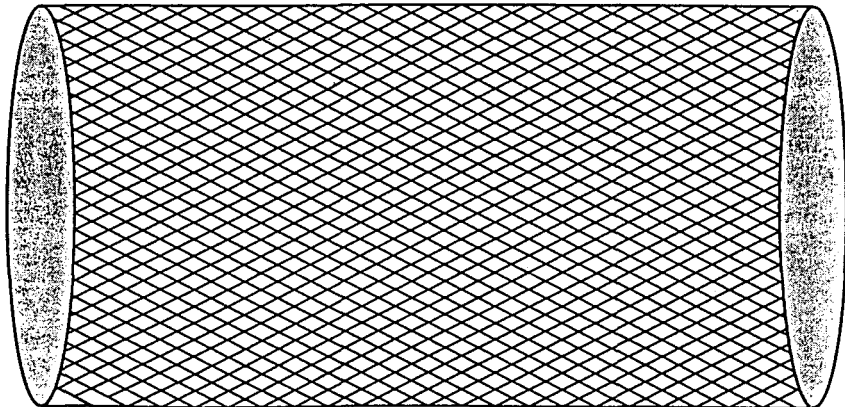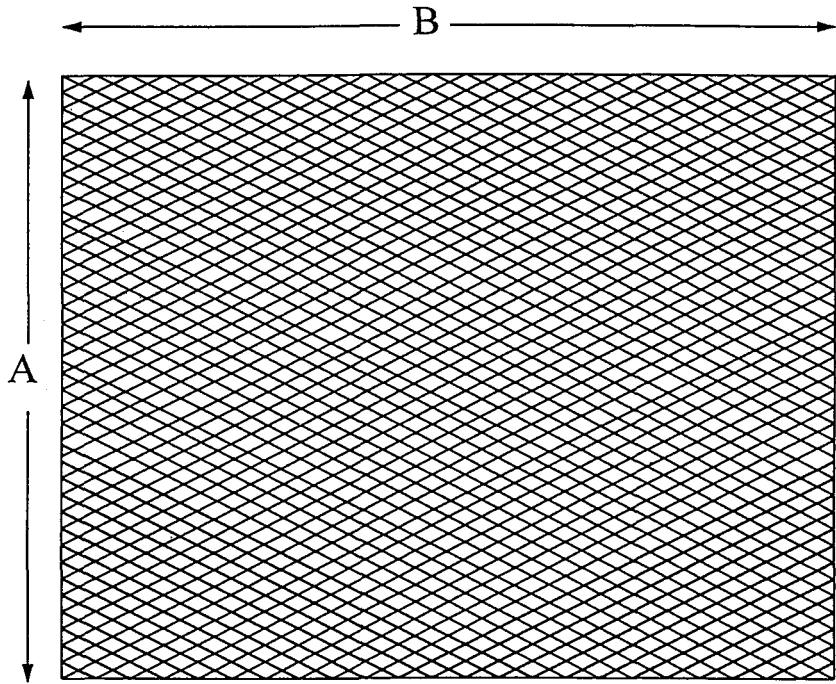

Big size (120 x 80) for shrimp trawl net with length of ground rope of 24 - 30 meters.
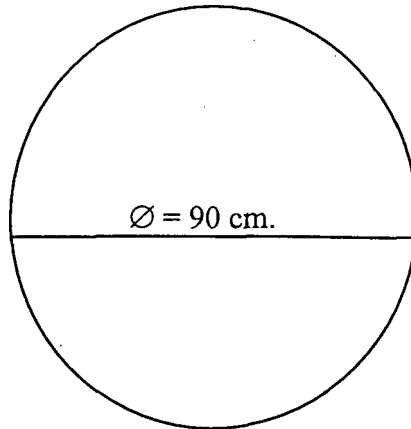
2. Construction of the TTFD extension

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.
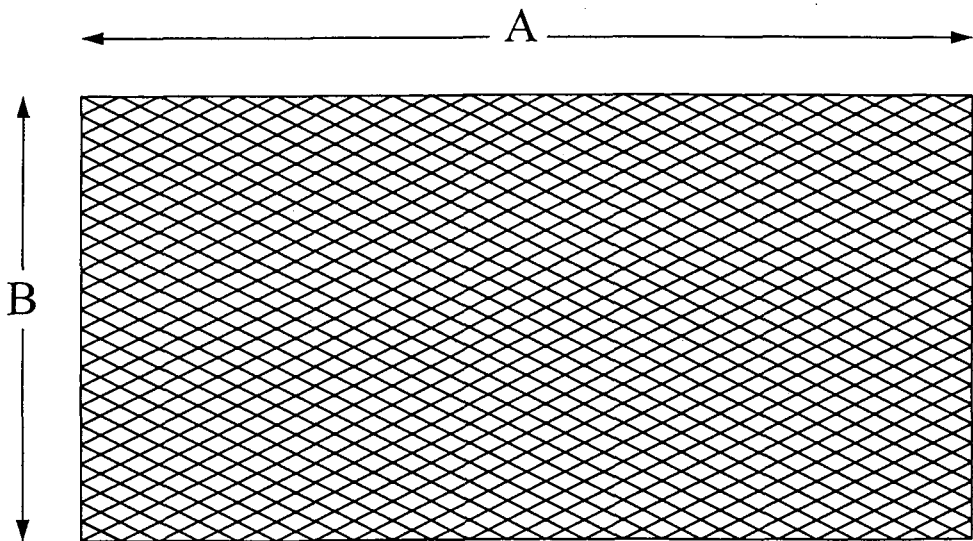
3. **Construction of the metal hoops.**

Two metal hoops 90 cm. in diameter.

$$\varnothing = 90 \text{ cm.}$$

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).

A

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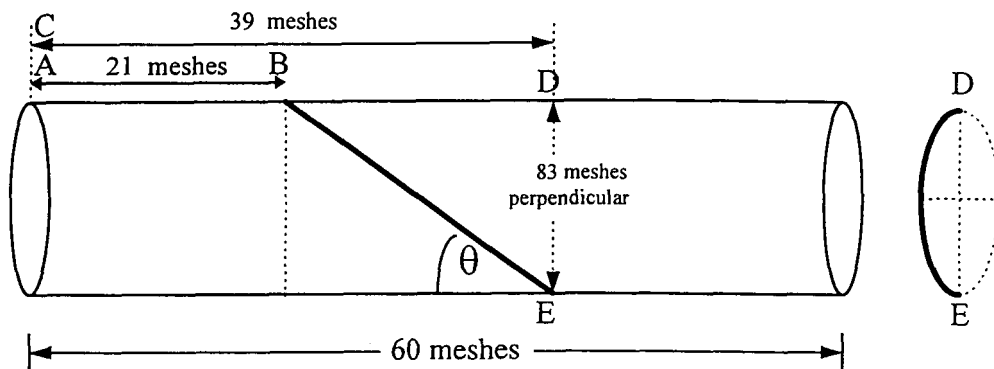
Once the bottom of the TTFD frame has been attached to the extension, the sides of the device are then sewn evenly from the top attachment point to the bottom corners of the TTFD frame. The grid angle is 55° for proper operation.
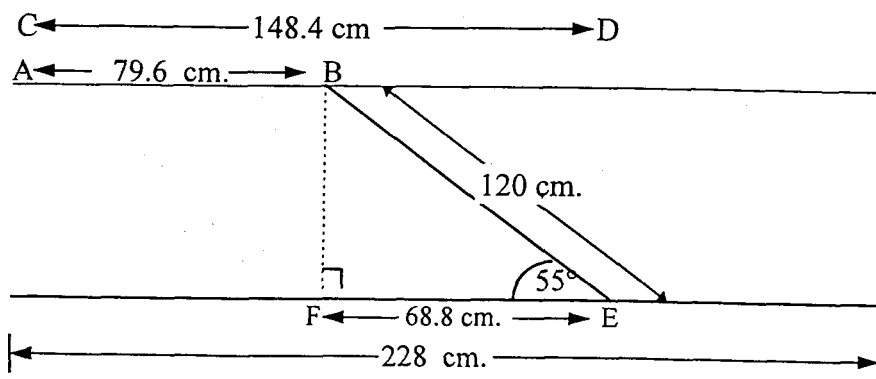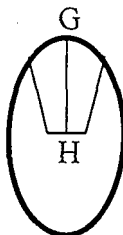

Note:

$$BE = 120 \text{ cm.}$$
$$EF = 68.8 \text{ cm.}$$
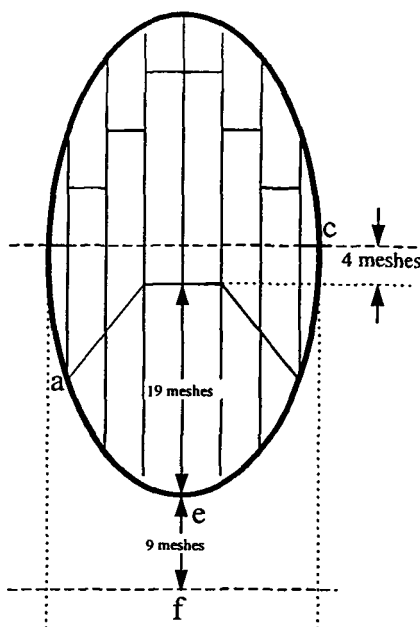
$$\cos\theta = \frac{68.8}{120}$$
$$\theta = 55°$$

6. Cutting the exit hole.

Begin the net cutting all bar from the 1 and 7 grid bar frame. Continue the cut along the bars, maintaining all bar cut distances until the distance from G to H measuring 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, 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 though 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.