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Development and Tests of New Zooplankton Samplers

by

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The series of tests and trials with various kinds and sizes of zooplankton samplers that we reported last year (Res. Doc. 67/110) led us to the general conclusion that none of the samplers we had tried would be wholly satisfactory for the purposes of the ICNAF-Georges Bank Survey. We, therefore, decided to design some new samplers based on the best features of those we had tested, and the work of others as reported in the literature. Our experiments as well as some others later conducted by Gehringer (personal communication) demonstrated the extreme inefficiency of the conventional bridled ring net as compared to the Bongo Net designed by McGowan and Brown (1966). Tranter and Heron (1967) have documented the extreme turbulence in front of a bridled net and the clean flowlines into an unobstructed sampler. They also show that an encased net only accepts about half of the water presented to it.

Our first decision, made after much discussion, was that the most efficient way to collect representative samples of fish eggs, fish larvae, and forage organisms was to make an oblique tow through the entire water column or at least deep enough so that we were sure that we were sampling the entire population. Our second was that each sample should filter a large amount of water, 1000-1500 m^3, so that we should stand a good chance of capturing animals that might be quite scarce at certain times and in certain places. The literature and the general consensus among plankton investigators also convinced us that tows made at high speed were necessary to catch the larger and more active organisms. These considerations led us to believe that the best solution would be a 15-minute haul, either single or double oblique, at 6 knots (185 m/min) with a sampler about .5 m^2 in mouth area.

The Bongo net met these specifications. It was, however, somewhat larger than we believed necessary, the two mouth openings are each about .4 m^2, and in addition was quite expensive. Most of the expense was caused by the opening and closing devices, which we did not require, and the complicated wire clamp associated with its horizontal swivel. We, therefore, decided to retain only the basic concept of a pair of nets, one on each side and forward of the towing wire, and design a new yoke and method of attachment to the wire. We also felt that two sizes would be desireable; a small sampler with fine mesh gauze to collect forage organisms and a larger sampler with coarser gauze to collect the fish eggs and larvae.

The Small Sampler - BCF BONGO (.03)

Sampler Bodies

These (Figures 1 and 3) are made of 28 cm lengths of commercially available polyvinylchloride (PVC) pipe. The pipe is nominally 8-inch and measures 20.3 cm inner diameter, an area of .0323 m^2, with a wall thickness of 8.2 mm. The lengths were cut off square on a lathe and then tapered on the leading edge. A shallow groove was turned in just forward of the trailing edge for the clamp which is used to fasten on the nets.

Yoke and Wire Attachment

The two sampler bodies are joined by a U-shaped yoke (Figure 3). The PVC tubes are bolted to the cheek pieces of the yoke. Reinforcing plates on the inside of the tubes distribute the load imposed by the drag of the nets while being towed. Within the U of the yoke is a pivoted barrel which is used to fasten the sampler to the towing wire. The barrel is made up of two concentric cylinders with a slot, somewhat larger than the towing wire, cut in along the after radius of the cylinders. The inner cylinder is spring-loaded so that its slot is held 90 degrees away from the slot in the outer cylinder, but the two slots can be brought into line by grasping the knurled end of the inner cylinder and rotating it. With the slots in line the sampler can be slipped on the wire; releasing your grip on the knurl allows the inner barrel to rotate closing the slot. A pin is then inserted to guard against the slots accidentally opening while the sampler is being towed. A stop on the wire holds the sampler in position.

Nets

The nets we have used on this sampler (Figure 1) are cylinder-cones. Using the dimensions shown in the drawing the ratio of filtering area to mouth area will range from 15:1 for #153 Nitex to about 18:1 for #760. The ratio can be adjusted by increasing or decreasing the length of the cylindrical section. The dacron collars at the front of the nets have a 6 mm nylon bolt rope sewn in to prevent the net from slipping under the stainless steel hose clamps which are used to fasten the nets to the sampler bodies.

The Large Sampler - BCF BONGO (.3)

Sampler Bodies

The sampler bodies (Figure 1) are made of fiberglass reinforced polyester resin with an inner diameter of 61 cm, a mouth area of .2928 m^2, and a 12 mm wall thickness. They are 30 cm long and have a tapered leading edge and a raised bead on the trailing edge. The wall thickness is increased to 19 mm and a steel plate is laminated in at the point of attachment to the yoke.

Yoke and Wire Attachment

The yoke is made up of two cheek plates 10 cm wide by 20 cm long by 12 mm thick, welded to the ends of a 38 mm diameter axle. The sampler bodies are bolted to the cheek plates with reinforcing plates on the inside of the sampler bodies. A split sleeve fitted with a nylon bearing is bolted around the axle. Eyes are welded to the sleeve so that the entire arrangement can be shackled into the towing wire with swivels to permit rotation in the horizontal plane.

Nets

The nets for this sampler are also cylinder-cones. The dimensions shown in the drawing give a filtering area to mouth area of about 8:1.

DEPRESSOR

An efficient depressor is an absolute necessity with these samplers if they are to be fished deeply at high speed. Towing at 5 knots with both samplers on 6 mm wire the depressor we have used, a Braincon 4-foot (122 cm) V-Fin, will get the gear down to 80 meters with 150 meters of wire out. Figure 2 shows a plot of the depth of the gear as a function of length of wire out for speeds of 3, 5, and 7 knots. Measurements made of the wire angle just above the depressor show it to be between 10 and 15 degrees from the vertical. The maximum cable tension we have observed was about 2,200 pounds (1,000 kg) with both samplers on, 280 meters of wire out, and towing at 7 knots in a moderate sea.

EFFECT OF SPEED, MOUTH AREA, AND LENGTH OF TOW

The first experiments with the new gear were designed to measure the effect upon catches of towing at different speeds and for different distances. Since we are able to haul both the small samplers and the large samplers on the same wire at the same time, we could also measure the effect of mouth area. We used a 2 X 2 X 2 factorial design with speeds of 3 and 6 knots (93 and 185 m/min.), distances of 1 and 2 nautical miles (1853 and 3706 meters), and mouth areas of 0.03 and 0.3 square meters.

The sampling area was a 10 mile (20 km) square within which we randomly selected four sets of eight stations. The sequence in which the four combinations of speed and distance would be made were also randomly selected; two of each combination in each eight station replicate. Two replicates were done in the day and two at night. Tows were made horizontally at about 15 meters depth. Nets were .505 mm nylon mesh with filtering ratios of about 8:1 in the large samplers and 15:1 in the small samplers. Flowmeters were mounted in both samplers and the distance the ship traveled was measured with a calibrated electromagnetic log.

Table 1 shows the catch per cubic meter of fish eggs and fish larvae for each of the tows made during this experiment, the mean catch for each sampler, each combination of factors, and the correlation coefficient between the two sizes of samplers. Table 2 gives a summary of the results for each factor alone and in combination after averaging the catch of the two sizes of sampler.

The data were then transformed by taking the natural logarithim of the catch per cubic meter plus one. Analysis of variance of the transformed data (Table 3) shows significant differences at the 5 percent level for the distance factor for both eggs and larvae but only in the daytime. The interaction of distance and mouth area is also significant but only for eggs at night. In all three cases the lower level of the factor has the higher value.

From this experiment we conclude that the catch of fish eggs and larvae per cubic meter of water filtered is not affected by the mouth area of the sampler or the speed of tow. We can offer no explanation for the observed superiority of a short tow over a long tow. The flowmeter records show that it was not caused by the nets clogging during the longer tows.

Table 1. Results of the factorial experiment designed to test the effects of speed, mouth area, and length of tow on catches of planktonic fish eggs and larvae. Data in numbers caught per cubic meter filtered.

ITEM	FISH EGGS				FISH LARVAE			
Time	Day		Night		Day		Night	
Gear	.03	. 3	.03	. 3	.03	. 3	.03	. 3
				3 Knots - 1 Mile				
	.79	.69	.02	.31	.64	.85	.59	.81
	.61	.87	.85	.76	2.17	1.20	1.90	2.12
	.28	.33	.93	.55	.43	.32	.55	.58
	Lost	.37	16.91	17.37	Lost	.40	5.10	3.60
Mean	.56	.63	4.68	4.75	1.08	.79	2.04	1.7[illegible]
				6 Knots - 1 Mile				
	.62	.56	.88	.43	1.32	.88	.21	.17
	5.92	5.32	1.75	1.68	4.28	4.32	3.53	2.43
	.47	.60	.41	.41	.60	.71	.24	.28
	1.37	1.43	.47	.53	1.15	1.21	.09	.09
Mean	2.10	1.98	.88	.76	1.84	1.78	1.02	.74
				3 Knots - 2 Miles				
	.33	.16	.57	.55	.78	.58	.40	.17
	.78	.27	1.23	1.71	.85	.44	8.30	9.40
	.37	.33	.72	.38	.27	.31	1.10	.73
	.67	.33	.66	.31	.43	.37	.27	.20
Mean	.54	.27	.80	.74	.58	.42	2.52	2.62
				6 Knots - 2 Miles				
	.16	.32	.18	.71	.12	.09	.41	.30
	.13	.26	.41	.54	.29	.42	.27	.61
	.47	.58	.28	.55	.41	.34	.40	.73
	.43	.21	1.12	1.00	.51	.42	.51	.57
Mean	.30	.34	.50	.70	.33	.32	.40	.55
r	.998		.988		.968		.998	

Table 2. Summary of results of the factorial experiment after combining the catches of the small and large samplers.

		EGGS		LARVAE	
Speed	Dist.	Day	Night	Day	Night
		$\bar{n}/m^3$	$\bar{n}/m^3$	$\bar{n}/m^3$	$\bar{n}/m^3$
3	1	.60	4.72	.94	1.91
6	1	2.04	.82	1.81	.88
3	2	.40	.77	.50	2.57
6	2	.32	.60	.32	.48
3	-	.50	2.74	.72	2.24
6	-	1.18	.71	1.06	.68
-	1	1.32	2.77	1.38	1.40
-	2	.36	.68	.41	1.52
-	-	.84	1.72	.89	1.46

Table 3. Analysis of variance of the factorial experiment. The values are the result of dividing the transformed catches made at the upper level of the factor by those made at the lower level of the factor. Asterisks show those effects that were significant at the .05 level.

ITEM	EGGS		LARVAE	
Time Effects	Day	Night	Day	Night
Speed	1.28	1.41	1.08	.49
Distance	.41*	1.20	.42*	1.07
Mouth Area	.52	2.86	.67	1.65
S-D	.52	.71	.47	1.03
S-MA	.85	.42	.66	.85
D-MA	1.05	.24*	.93	.30
S-D-MA	2.02	3.19	1.34	2.41
Variance	.4570	1.0945	.4166	1.9295
Mean ($\ln(n_o/m^3+1)$)	-.6523	-.5316	-.5740	-.6813
R.S.D.	1.04	1.97	1.12	2.04

REFERENCES

McGowan, John A. and Daniel M. Brown. 1966. A new opening-closing paired zooplankton net. SIO Ref. 66-23.

Tranter, D.J. and A.C. Heron. 1967. Experiments on filtration in plankton nets, Aust. J. Mar. Freshwat. Res. Vol. 18 pp 89-111.

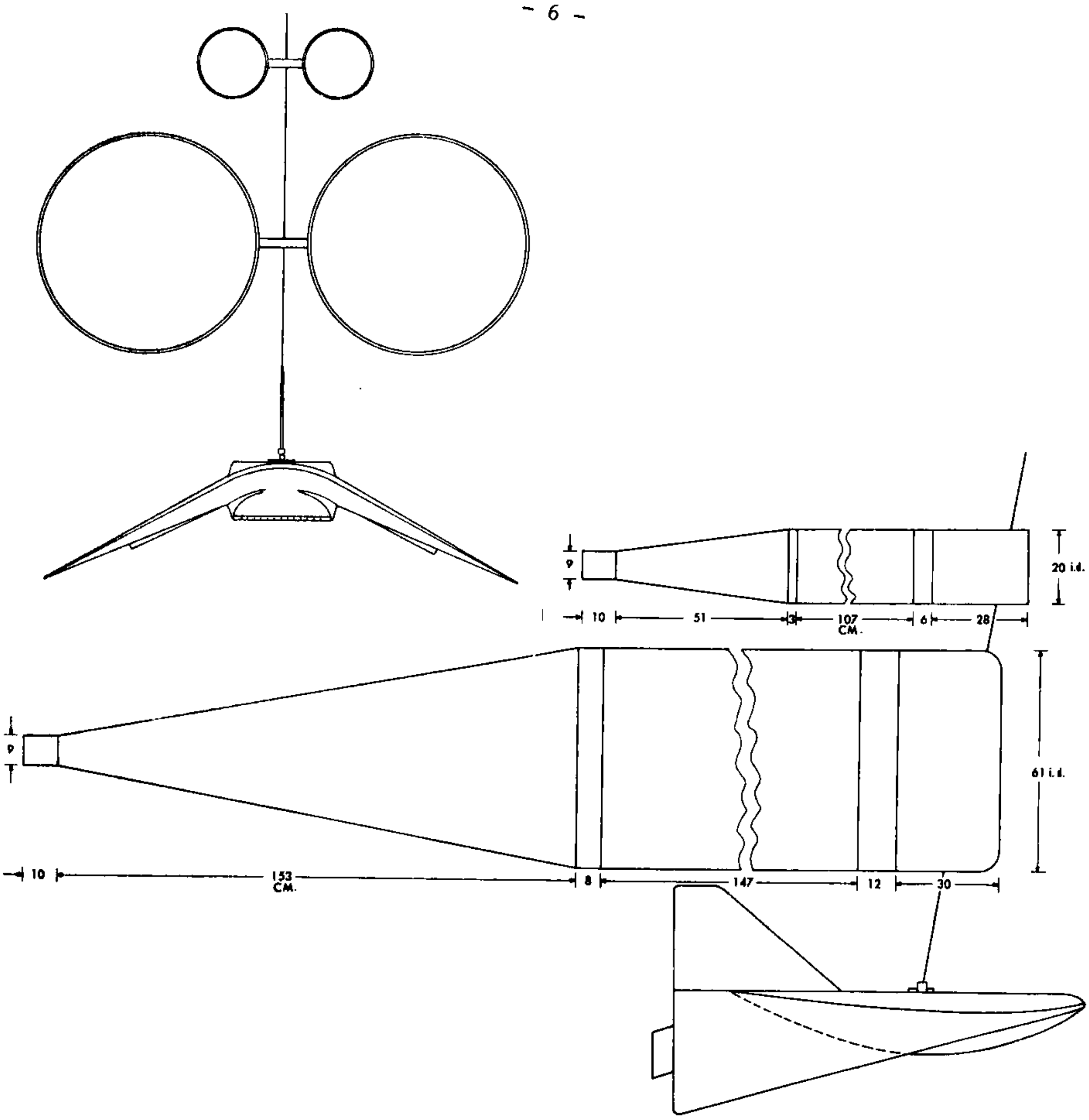

Figure 1. Front and side views of the samplers when they are towed together.

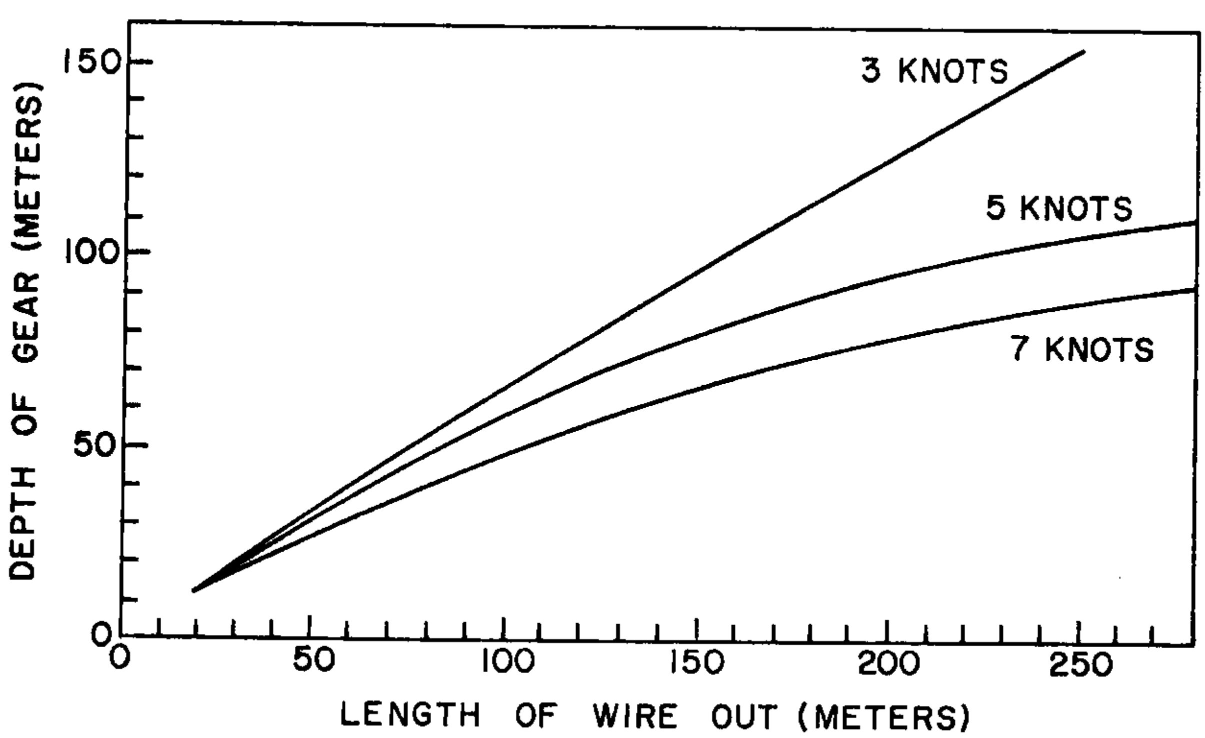

Figure 2. The depth of the gear as a function of the length of wire out at 3, 5, and 7 knots with both the large and small samplers on 1/4-inch (6mm) wire with a 4 foot (122cm) V-FIN.

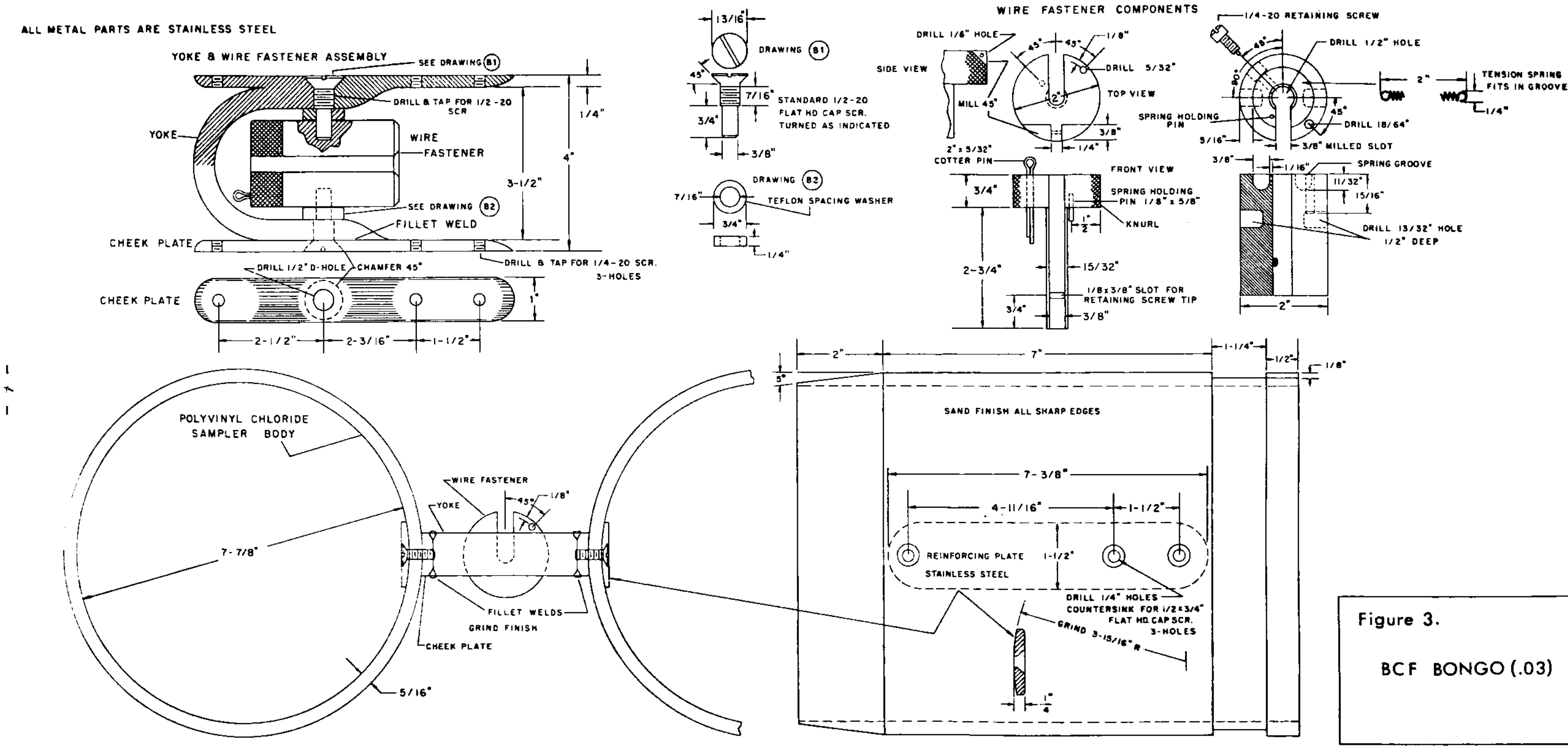

Figure 3.

BCF BONGO (.03)