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Report on the development of an electrified shrimp-trawl in the Netherlands

by

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Introduction:

In studying the possibilities of increasing the efficiency and selectivity of the shrimp-trawl (beam trawl) our attention fell upon the research work carried out in the United States, on the development of an electrified shrimp-trawl (Pease, 1967; Pease and Seidel, 1967; Klima, 1968; Seidel 1969). The species they investigated were the American pink shrimp (Penaeus duorarum Burkenroad) and the American brown shrimp (P. aztecus Ives). Our commercial important shrimp is the European brown shrimp (Crangon crangon (L.)), a much smaller species. Shrimps in our waters are caught during the night as well as during the day. The fact that they are also caught during the day-time finds its origin in the turbidity of the coastal waters, with strong tides (Wadden Sea). In clear water, as for example along the coast during wintertime, day catches are very poor. The reason is that a high light intensity is an inhibitive factor on the activity. Therefore shrimps are burrowed during the day-time, especially in clear water. (Fuss and Ogren, 1966; Hughes, 1968; Dornheim, 1969). As there is nowadays a trend for the shrimp fishermen to move out of the turbid Wadden Sea into the deeper and clearer off-shore North Sea Waters, an electrified shrimp-trawl might open the possibility to fish during the whole 24 hour period with success.
By introducing this electrified shrimp-trawl we hope to be able to reduce the destruction of immature flat fish, sole and plaice, by fishing with a less heavy gear.

Material and methods:

The experiments were carried out for the main part in a former oyster basin in the Scheldt estuary, Yerseke (30 x 10 x 1,5 m). The water level could be regulated by a system of sluices in combination with the tide (salinity 28°/oo. The basin was densily stocked with a shrimp population, caught in the estuary. For the experiments we used an electrode array mounted in a frame of 2 x 2 m. The distance between the six electrodes was 35 cm and they were alternatively positive and negative. A program has just started to test our findings on a commercial vessel, a 150 hp double rigged beamtrawler (WR 213). One of the trawls was electrified by an array of three electrodes in parallel with the groundrope and 50 cm apart. The electrodes consisted of a double copper litze wire (Ø 4 mm) twisted into a polyethelene cable for

The pulse generator was made to our specifications by a private firm. The peak voltage can be regulated in steps between 2.5 and 60 V. The pulse frequency can be regulated continuously between 1 and 50 impulses per second (i.p.s.). The facility to interrupt the pulse cycle was added later. The pulse cycle can be interrupted in a frequency of ½ to 10 Hz. The discharge capacitors have a total capacity of 9520 uF to be regulated in steps, viz. 2 x 34; 9 x 68 and 13 x 680 uF. The total number of discharge capacitors is 1400. They are of a very high quality and can withstand a short circuit. The discharge capacitors are quickly charged by 4 electrolytic buffer capacitors of 10 mF each. The discharge capacitors are switched on and-off by silicon controlled rectifiers (SCR), which are activated by the pulse frequency switching unit.

The discharging time is maximum 6 msec., the charging time is from 14 to 994 msec. depending on the pulse repetition rate 14 msec. at 50 i.p.s. and 994 msec. at 1 i.p.s.. The electrical resistance of the electrode array was figured to be about 0,1 ohm for a commercial trawl. This figure was found to be in agreement with the American findings (Seidel, 1969).

Results

A representative part of the results of the experiments in the oyster basin is given in Table I. The optimum pulse length (RC) is appr. 0.2 msec., although the shrimps still react with pulses of 0.1 msec. A burrowed shrimp in sandy bottom will become as a rule visible after the first pulse, will emerge completely after the next one, and will jump at the third pulse.

This seems to be the minimum number of pulses required to make a completely burrowed shrimp jump high enough to be caught by the net. However, this will be only the case when the pulse rate does not exceed 5 i.p.s.. The fact that not all of the shrimps present between the electrodes will jump after the first three pulses, may be due to the orientation of the shrimp (body-axis) towards the electric field. The reaction time was established by counting the number of pulses needed to make the shrimp jump at a known number of i.p.s.. Although the pulse shape differed from a capacitor discharge shape because of the long cables (50 m) between pulse generator and electrode array, this did not influence the reactions (De Groot and Boonstra, 1970).

The height of the initial jump was estimated to be about 10 - 20 cm, however, by means of additional swimming shrimps often reached the surface (bottom to surface about 60 cm).

In the field experiments which only just have started, we were able to increase the total catch with about 50% when the trawl was electrified.
However, in very turbid water the catch of the electrified trawl was sometimes even lower than the catch of the non-electrified trawl.

Discussion:

Already from the first results we may conclude that it is possible to increase the catch of the shrimp-trawl by means of electricity. The results also confirm that the reaction to electricity of the European brown shrimp is quite similar to the reaction observed in the American pink and brown shrimp (Pease, 1967; Pease and Seidel, 1967; Klima, 1968; Seidel, 1969). The optimum pulse length in the experiments was established as being 0.2 msec, which is in agreement with what Kessler found for the American pink shrimp, 0.14 msec (Kessler, 1965). The impulse rate, 5 i.p.s., is also quite in accordance with Klima. The voltage given in Table I is the voltage between the electrodes; no measurements of field strengths were taken.

The turbidity of the water plays an important role upon the activity cycle of the shrimp. A high turbidity, a lower light intensity, will activate the burrowed shrimp to come out of the sand even during the day-time (Hughes, 1968; Dornheim, 1969). These conditions prevail especially in the Wadden Sea where shrimps are actually caught on a commercial scale during the day-time. It is very likely that a shrimp already out of the sand will escape easier with his jump (escape reaction) the electrified shrimptrawl. The electric field extends in front of the groundrope, and will warn the shrimp sooner of the nearing danger than the groundrope of the non-electric trawl. The time interval needed to deburrow will now be used for escaping. This may be an explanation for the lower catches during the day-time in very turbid waters of the electrified trawl compared with the non-electric trawl.

As we have observed an increase in the catch using an electrified trawl in less turbid waters compared with the non-electrified trawl we expect that in the clearer offshore waters the electrified shrimp-trawl may prove to be useful.

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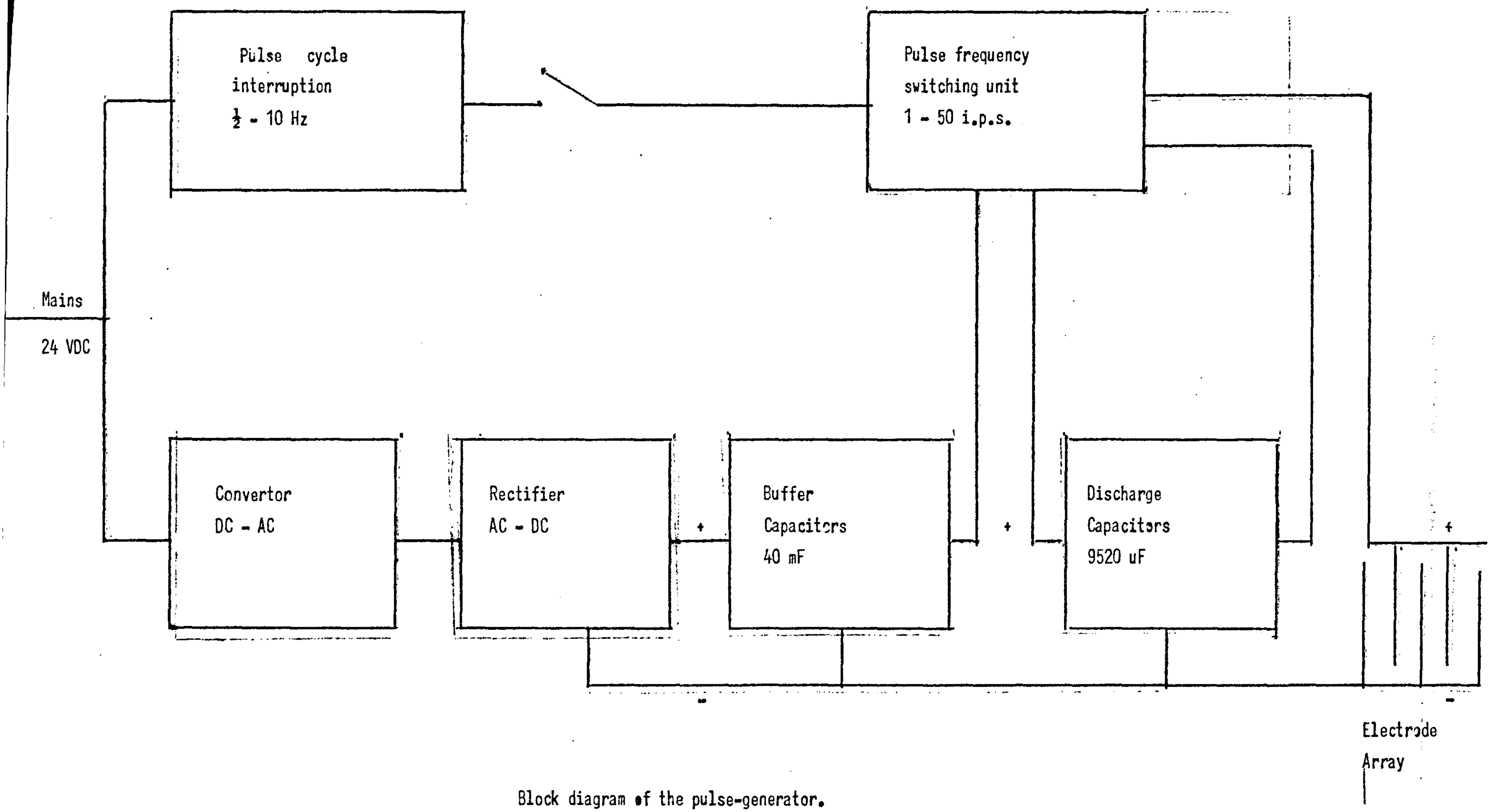
Experiments in the oyster basin

The resistance R of the electrode array at $7^{\circ}C$ is approx. 0.3 ohm.
100% reaction is reaction at 60 V 1360 uF during 10 seconds.
S = sand; M = mud.

No.	Voltage	Cap. in uF	i.p.s.	bottom	reaction percentage	reaction time
52	50	340	2	S	50	after 2 pulses = 1 sec.
53	50	340	2	S	75	after 3 pulses = 1½ sec.
54	60	680	2	S	100	after 3 pulses = 1½ sec.
55	60	680	5	M	100	after 5 pulses = 1 sec.
56	60	680	5	M	100	after 5 pulses = 1 sec.
57	60	680	5	M	100	after 5 pulses = 1 sec.
58	60	680	5	S	100	after 5 pulses = 1 sec.
59	60	680	1	S	50)	after 5 pulses = 5 secs.
60	60	680	3	S	100	after 15 pulses= 1 sec.
61	60	680	5	S	30)	after 5 pulses = 1 sec.
62	60	680	3	S	100	after 30 pulses= 10 sec.
63	60	680	2	S	30)	after 4 pulses = 2 secs.
64	60	680	2	S	100	after 20 pulses=10 secs.
65	60	680	3	S	75)	after 6 pulses = 2 secs.
66	60	680	3	S	100	after 30 pulses= 10secs.
67	60	680	2	S	80)	after 4 pulses = 2 secs.
68	60	680	2	S	100	after 20pulses =10 secs.



Block diagram of the pulse-generator.