Complex investigations of a cycloidal propeller in Ilawa in the 1960s

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Research work on the cycloidal propeller in the Department of Ship Propellers of the Institute of the Fluid Flow Machines, PAS (IMP - PAN), included:

- theory of cycloidal propellers (the hydrodynamic, kinematic and dynamic problems), including kinematic systems ensuring the required blade movements, with their designs and solutions avoiding the existing patent claims,
- propulsion tests of a harbour tug,
- propulsion tests of a push-train,
- manoeuvring tests of a push-train with the use of a photogrammetric method.

The last three groups of tests were carried out with an invaluable cooperation of the IMP-PAN Department of Ship Propellers and the GUT Department of Hydomechanics.

Before discussing some of the scientific aspects of that cooperation, I wish to express my greatest appreciation of the initiator of the two above mentioned Departments, prof. Lech Kobylinski. The founder of the Polish school of hydromechanics, he assembled a group of co-workers around his professional ideas of developing this scientific discipline for the needs of the Polish maritime economy, first in the GUT Chair of the Theory of Ships and then - in the years 1955-1962 - in the IMP-PAN Department of Ship Propellers. In both these centres the framework of the Polish contribution to the world ship hydromechanics was constructed. One may now conclude with some pride that lasting achievements of the Polish ship hydromechanics are known in the world. Ilawa is an impressive example how the Polish ship hydromechanics community was able to make up for the lack in the post-war years of an indoor towing tank and manoeuvrability test tank and to create substitute model testing facilities and later to develop those ideas into a centre of extensive research work. The initiator and „spiritus movens" of those activities was full of ideas and creative energy professor Lech Kobylinski.

The cooperation of both Departments in the Ilawa Experimental Centre was most often unconventional in the sense that the balance of mutual services was based on friendliness, confidence, without any trace of institutional egocentrism. As the IMP-PAN workers, we might use, and we did use in practice, all the facilities of the lake laboratory, its workshop and hotel, without unnecessary legal or financial formalities. On our part, we contributed, however modestly, to the development of that laboratory.

The workers of both Departments formed a good team overcoming all the difficulties inherent in that open-air laboratory exposed to all the changing atmospheric conditions. We remember with some satisfaction our living there in a spirit of community.

The IMP-PAN Department of Ship Propellers carried out in the GUT Shipbuilding Institute Experimental Centre a programme of investigations of a cycloidal propeller and its application as a harbour tug propeller and a river push-train propeller. The programme of lake tests included:

I. Construction of a tug model and outfitting it with two cycloidal propellers designed and made in our workshop.
II. Construction of two concrete barges, forming together with the tug a cycloidal push-train (21 m long).

***Phot.1** Bow cycloidal propellers on a tug*

***Phot.2** Cycloidal propeller before installing on a tug model*

III. Installation of a tower on foundations near the lake in Ilawa for the use of a photogrammetric method in the manoeuvring tests of a cycloidal push-train (tower height 35 m).

Phot.3 *Cycloidal propellers after installing on a tug model*

IV. Propulsion tests of the tug with bow cycloidal propellers.

V. Propulsion and manoeuvring tests of the cycloidal push-train.

Particularly interesting are points III and V of this research programme. The aerial photogrammetry methods were used for the manoeuvrability tests of the cycloidal push-train.

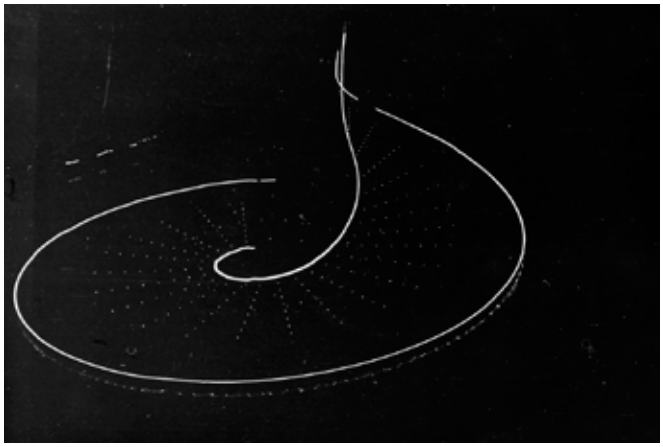
Phot.4 *Cycloidal push train*

A railway signalling-lighting tower (35 m high) removed from the Bydgoszcz railway station was obtained for the cost of its disassembly and transport to Ilawa. From the top of the tower the manoeuvring push-train was photographed by night and three its points (bow, stern and the centre of gravity) with continuous light and 8 points with flashing lights (distributed in straight line every 1 m from the centre of gravity towards stern and flashing simultaneously every 6 seconds) were recorded.

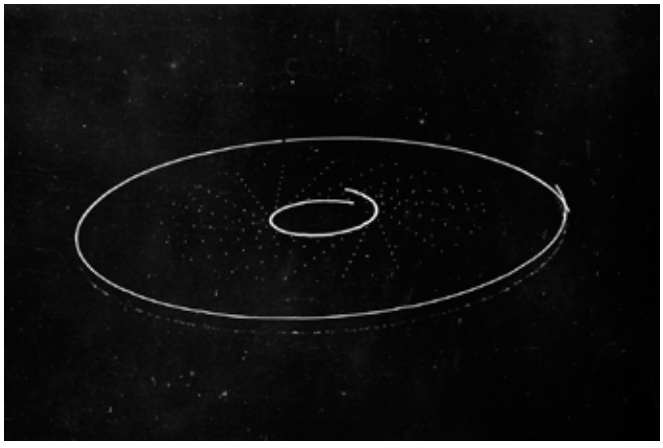
The proposed photogrammetric method provides full information on the push-train movement during the turning manoeuvre:

- path shapes of any number of selected points,
- velocities of the centre of gravity and other points,
- angular v elocity of the push-train,
- angular drift velocity.

The tests were carried out overnight and each circulation cycle (one full turn of the train) was photographed with open diaphragm during the whole cycle. Conversion of the photographs from the photographic plate plane to the push-train movement plane may be done by analytic processing. Uniqueness of the representation in the projection processing is ensured by four pairs of homologous points. Four light points are fixed in the movement plane for a unique mutual situation of the photographic plate plane and the train light plane. The proposed method allows to obtain precise picture of the kinematic relations in the push-train turning manoeuvre. It makes a valuable check on the results of the theoretical analysis of the push-train movement, by insight into the system of forces and obtaining practically verifiable theoretical solutions.



Phot.5 *Push train performing circulation, $V = V_0$*



Phot.6 *Push train performing circulation, $V = 0$*