

Shedding of Vortices from Vortex Rings

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NOTE

Shedding of Vortices from Vortex Rings

By Jun-ichi OKABE and Susumu INOUE

In a very interesting paper recently published MAGARVEY and BISHOP presented a number of photographs which gave evidence to support a stable drop wake configuration consisting of a double row of vortex rings.¹⁾

Several months ago, by ejecting a small quantity of water solution of fluorescein $C_{20}H_{12}O_5$ and sodium hydroxide NaOH upward from a mouthpiece immersed in water, the present writers took many pictures showing the successive stages in the whole process of the generation of vortex rings.²⁾

During the experiment, also the writers noticed a regular way of shedding of vortices from grown-up vortex rings. The followings are some extracts reproduced and enlarged from the unpublished 8-mm-movie films.

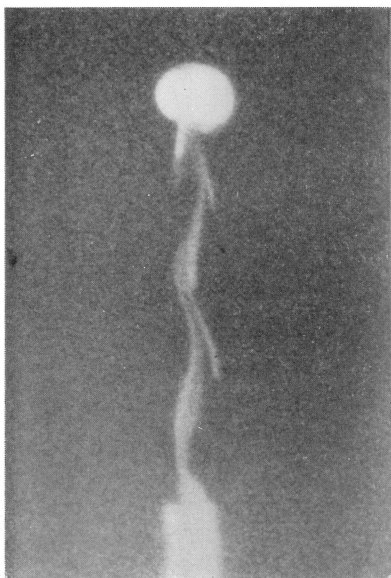
Photographs (I) and (II, III, IV) show the general view, and the fine structure, of the wake, respectively.³⁾ It seems to the present writers that in our observations the wake vortices are discharged in the form of a spiral from a vortex ring as a thread is unwound from a reel. Finally, in Photographs (V) is shown the mode of deformation of the wake when the second ring approaches and penetrates the first one. The Reynolds numbers referring to the outermost diameters of the rings and their advancing speeds are believed to be of order of 10^3 .

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1) MAGARVEY, R. H. and BISHOP, R. L., Wakes in Liquid-Liquid Systems, *The Physics of Fluids*, vol. 4 (1961), no. 7, pp. 800-805. The present writers are very grateful to Professor YAMADA of Kyoto University for his private communication in which he turned their attentions to the experiment of Drs MAGARVEY and BISHOP.

2) OKABE, J. and INOUE, S., The Generation of Vortex Rings, *Reports of Research Institute for Applied Mechanics*, vol. 8 (1960), no. 32, pp. 91-101. In this experiment the specific gravity of the solution was a little larger than unity, so in due course of time the emitted vortex ring and the wake began to descend slowly and finally collapsed.

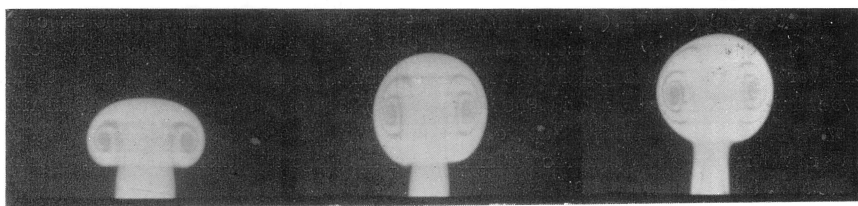
3) In the series (II)~(V) the camera is moving upward.



(I, 1)



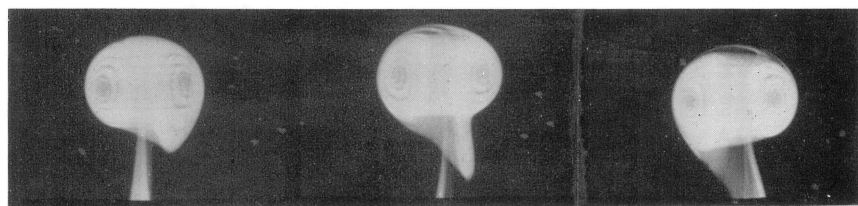
(I, 2)



(II, 1)

(II, 2)

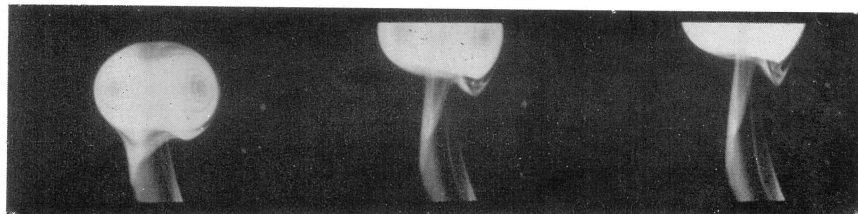
(II, 3)



(II, 4)

(II, 5)

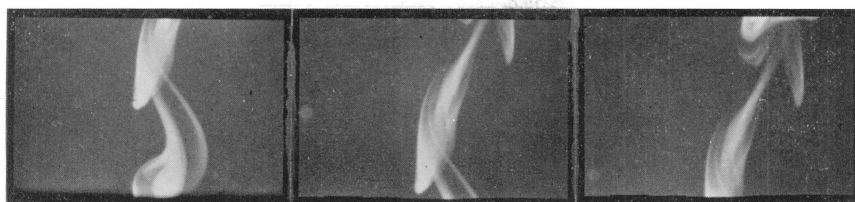
(II, 6)



(II, 7)

(II, 8)

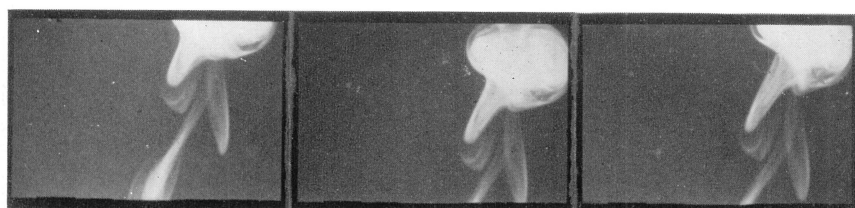
(II, 9)



(III, 1)

(III, 2)

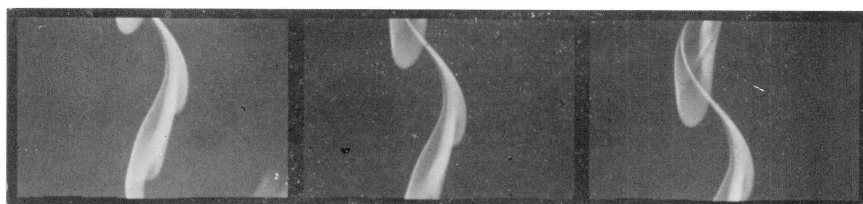
(III, 3)



(III, 4)

(III, 5)

(III, 6)



(IV, 1)

(IV, 2)

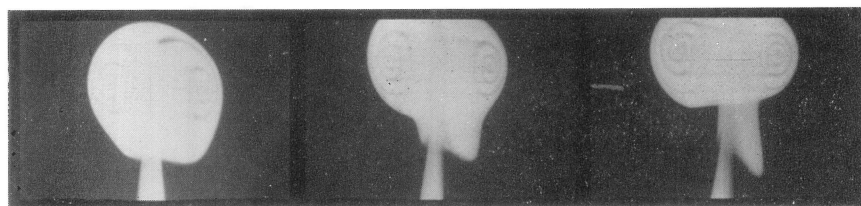
(IV, 3)



(IV, 4)

(IV, 5)

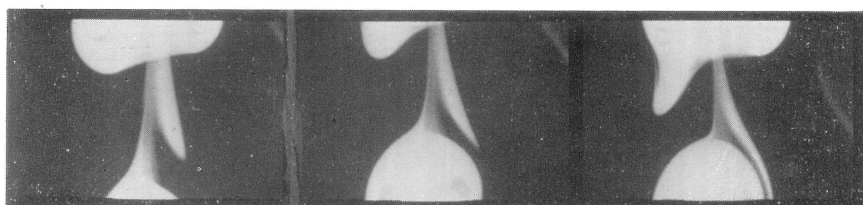
(IV, 6)



(V, 1)

(V, 2)

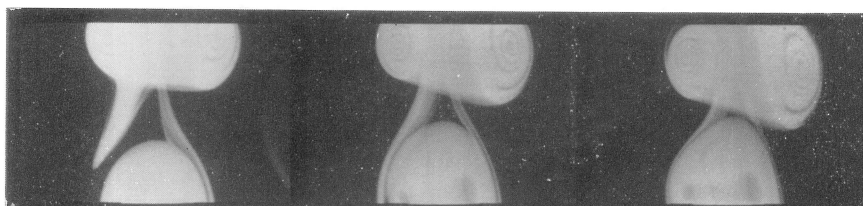
(V, 3)



(V, 4)

(V, 5)

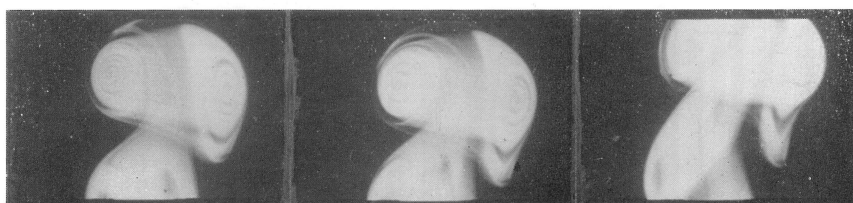
(V, 6)



(V, 7)

(V, 8)

(V, 9)



(V, 10)

(V, 11)

(V, 12)