

IN CONNECTION WITH THE REPLY OF B. A. SHULYAK

A. A. Gukhman

1. In point 1 of my letter it is asserted that in my book the bases of similarity theory are expounded without any drawing on dimensional analysis (the π -theorem in particular). The obvious meaning of this assertion is that a separate specific apparatus of study, not resting to any extent on dimensional analysis, is developed and applied. All the results, including all that is connected with the concept of the similarity criterion, of course, are obtained with the help of this apparatus, i.e., completely independently of dimensional analysis.

In the "Reply" this assertion is not only not denied, it is not even taken up. It is impossible to understand for what purpose the citations are presented in which it says that the π -complexes are correctly called similarity criteria or that some of them have begun to be denoted by the first two letters of the names of scientists.

The content of point 1 of the "Reply" is not connected at all with the question of the method of expounding the bases of similarity theory, which should be the subject of the discussion. This question is replaced by another – on the relationship between dimensional analysis and similarity theory. Although the discussion thus wanders off to the side, I consider it helpful to note the following. In my book dimensional analysis is examined in a limited aspect as a method of determining the total set of dimensionless power-law complexes corresponding to a given problem, with attention being concentrated on the fact that its (this method's) correct application leads to a set which is always reduced to the set obtained in similarity theory directly through an analysis of the equations of the problem. In this, i.e., in the fundamental identity of the two sets, is the essence of the question.

2. In point 2 of my letter it is mentioned that in all cases the criteria are obtained from the equations of the problem. For an objection to this assertion it would have been enough to present at least one example contradicting it, especially since the question of "just where and in what way in my book are the criteria obtained apart from an equation," is directly posed in my letter. There is no such example in the "Reply." Instead there are citations connected with the problem of the uniqueness of the solution, but not having any relation to the question of the methods of obtaining the similarity criteria.

3. In point 3 it is said that the representation of the results of a study in the form of an equation by which one of the π -complexes is determined as a function of all the other complexes is alien to the very spirit of my book. Equations by which the desired variable is determined as a function of independent variables (all variables are in dimensionless form) and similarity criteria (as the constant parameters) are presented as examples which, in the opinion of the author of the "Reply," refute this idea. How a person who has at least a superficial acquaintance with my book can identify these two forms of representation remains a mystery to me.

4. In point 4 of the letter it is asserted that an excessively large role is not ascribed to the Reynolds number in my book. As a refutation of this assertion the "Reply" mentions the fact that in the analysis of the equation of motion of a heavy liquid criteria appear which are not taken into account in my book; consequently, the property of self-similarity is erroneously ascribed to the motion only because these criteria are excluded from consideration, even when the Reynolds number becomes unimportant – a clear indication of the hypertrophy of its role.

However, the problem of self-similarity is considered only in application to purely forced motion, i.e., under conditions when the effect of the force of gravity can be neglected. This is said very clearly on pp. 120 and 126 of my book. Therefore the objection under consideration obtains any meaning at all only in

Translated from *Inzhenerno-Fizicheskii Zhurnal*, Vol. 28, No. 5, pp. 759-760, April, 1975.

©1976 Plenum Publishing Corporation, 227 West 17th Street, New York, N.Y. 10011. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, microfilming, recording or otherwise, without written permission of the publisher. A copy of this article is available from the publisher for \$15.00.

case the author of the "Reply" assumes that the model of the motion of a heavy liquid is physically valid only under the conditions of degeneration of the Reynolds number. But there is no foundation for this: the possibility of neglecting the effect of the force of gravity under these conditions only means that it is small either in comparison with the force of internal friction (the region of very small Re) or in comparison with inertial forces (the region of very large Re). Experience leaves no doubt as to the actual reality of self-similar flows in both cases.

5. In point 5 it is noted that a tendency to apply different criteria containing the viscosity to the same processes is absolutely not a characteristic of the book. It is obvious that here too at least one example should have been cited as a refutation. Instead a discussion is presented on the fact that in the course of the application of dimensional analysis one can obtain different π -complexes, which means different criteria, for one and the same process. After all that has been presented above it is completely clear that such discussions little concern my book.

6. In point 6 of the letter it says that nothing like that procedure of formulation of the controlling criteria which leads to criteria not corresponding to the equations of the problem was presented either in my last book or in the first article written on this question by M. V. Kirpichev together with me over forty years ago. It follows from the interpretation given by the author of the "Reply" that his remark does not pertain to works under which my name stands.