It would seem to the writer that a good deal of caution must be used in the application of pitch to extinguish fire, even though it originates from a magnesium incendiary bomb. It has been the experience of the writer with a great variety of small fires in oil, metals and other materials, there is nothing so satisfactory and so foolproof as Portland cement as it is placed on the market. In many cases in the writer's experience it has been highly successful in extinguishing fires where water, carbon tetrachloride, foam and similar substances have been unsuccessful. This very common material so easily available and so safe to use should be placed at points where there is danger from fires either from incendiary bombs or from normal causes.

In our own laboratory, we provide such material easily available in kegs and find it far more successful than the usual fire extinguishers. Furthermore, it gives off no injurious gases and is in itself not combustible, as in the case of pitch.

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SCIENTIFIC BOOKS

CELESTIAL MECHANICS

The Analytical Foundations of Celestial Mechanics. By AUREL WINTNER. xii + 448 pages. Princeton University Press. 1941.

THE author states explicitly in the preface that the title of this volume is meant to imply that the general topological methods initiated by Poincaré are not discussed. For instance, virtually nothing is said of surfaces of section. Nevertheless, the author does find occasion to state (without proof) both the recurrence theorem of Poincaré and the ergodic theorem of Birkhoff, though not the mean ergodic theorem first proved by von Neumann. Also there are some well-chosen omissions from the purely analytical aspects of the subject: for example, the proofs of Bruns and Poincaré on the non-existence of integrals of certain types in the problem of three bodies. By making omissions of this kind the author has succeeded in isolating a well-rounded portion of celestial mechanics to which he has given an exceptionally thorough and scholarly treatment.

The first chapter opens with an explanation of the matrix and vector notation, which is used to advantage in many parts of the book for the sake of brevity, but which does not, in the opinion of the reviewer, add to the clarity of the exposition save in very exceptional cases: say, in the treatment of characteristic exponents in the following chapter. The first chapter, without actually mentioning the differential equations of Lagrange or Hamilton, introduces the idea of a "Lagrangian derivative" and gives an account of various mathematical formalities connected with the underlying group of canonical transformations. Certain special transformations are also treated: namely, rotations and the conformal transformations used later in connection with systems of two degrees of freedom.

In the second chapter are introduced the (conservative holonomic) dynamical equations with their Jacobi differential equations of variation. It is incidentally proved in this chapter (from the transversality conditions of the calculus of variations) that in a family of periodic solutions, in which the period is a function of class C' of the parameters, the period must be a single valued function of the energy alone. This interesting result, though well known and discovered independently by a number of mathematicians, has not previously (to the reviewer's knowledge) been published in any general treatise on dynamics. It is also in this chapter that mention is made of the ergodic theorem and that stability and characteristic exponents are discussed.

In the third chapter use is made for the first time of the hypothesis that the Lagrangian function is a quadratic polynomial in the velocities and that the purely quadratic part is positive definite. Various results are proved on the assumption that the coefficients of this polynomial are homogeneous of various degrees in the coordinates of the configuration space. Here also is presented the principle of least action and the closely related question of iso-energetic transformation. Systems with one and two degrees of freedom and systems with radial symmetry are considered in some detail.

In the fourth chapter we have a very extensive treatment of the problem of two bodies. Just because the derivation of the equations of planetary orbits from Newton's law of gravitation is a standard topic in elementary mechanics, we sometimes forget that the derivation of the coordinates as explicit functions of the time is by no means easy and indeed has been the subject of numerous classical investigations, leading, for instance, to the discovery of Bessel functions. Here the expansions connected with Kepler's equation are given an elaborate treatment. The problem is also considered with respect to a coordinate system rotating with uniform angular velocity about the center of gravity. This is a necessary preliminary to the systematic study of the restricted problem of three bodies.

The fifth chapter is largely an exposition of Sundman's work on the problem of n bodies (with special emphasis on the case $n = 3$). There is, of course, much about the Sundman theory which is intuitively evident.

Thus, in a motion in which r of the n bodies collide at $t=0$, one would expect the motion of the r colliding bodies to be relatively only slightly affected for numerically small values of t by the $n-r$ bodies which do not partake in the collision. Thus, for example, the theory of binary collisions is closely dominated by the theory of straight line motion of only two bodies, and Sundman's famous regularization of a binary collision is almost obvious. Even when the rigorous proofs are complicated (involving such things as Tauberian conditions), the theory is usually well motivated. A fundamental and deep result in this connection is to the effect that when all n bodies collide, the configuration ultimately becomes very close to a "central configuration." Hence a necessary preliminary for further progress (of certain kinds) in the n body problem is a detailed study of the central configurations and the closely related homographic solutions. Such a study is here given.

Also given in this chapter is a new explicit reduction of the problem of three bodies to a system of order 8, using the integrals of linear and angular momentum; or to a system of order 6, with use of the energy integral and elimination of the time. The coordinates used in the system of order 8 are, roughly speaking, the three mutual distances and the angle between the invariable plane and the plane of the three bodies. If there is no invariable plane, the motion takes place in a plane anyway, and it is this plane which is used instead of the invariable plane.

The last chapter is devoted to the restricted problem of three bodies with special reference to the limiting case considered by Hill in connection with the motion of the moon. Hill was able to compute numerically to a high degree of accuracy the coordinates of a one parameter family of periodic motions as functions of the time and period. The exact solution of this problem involves the solution of an infinite system of nonlinear equations, the appropriate existence theorems of which were first proved by Wintner some fifty years after the completion of Hill's calculations. This is probably the most important original contribution of the author, which is now published in a general treatise for the first time together with an account of Hill's original computations.

Other topics discussed in chapter VI are: regularization, the location and character of the critical points of the potential functions $\frac{1}{2}(x^2+y^2)+(1-\mu)[(x-\mu)^2+y^2]^{-\frac{1}{2}}+[(x-\mu+1)^2+y^2]^{-\frac{1}{2}}$ and $\frac{3}{2}x^2+(x^2+y^2)^{-\frac{1}{2}}$, and the non-planar restricted problem of three bodies. The book closes with a few general remarks about the divergent series of dynamics.

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PHYSICS

Physics. By W. F. G. SWANN, D.Sc., director of the Bartol Research Foundation, the Franklin Institute of Pennsylvania; with the assistance of Ira M. Freeman, Ph.D., associate professor of physics, Central College, Chicago. New York: John Wiley and Sons, Inc.

THIS book is one of a series under the general title of THE SCIENCES, which in the words of the general editor, Professor Gerald Wendt, Ph.D., provides "a brief but significant survey of the fundamental sciences, an elementary but sound foundation for the further study, but above all a key to the understanding of our environment and of the possibilities inherent in science." The editor's choice of an author of the book on physics was a very happy one. Dr. Swann is eminently qualified for the task. His occupation as a director of research has freed him from the habit-forming routine of the classroom, and he has been able to write a book which is easy to read, full of information and devoid of pedantry. He ventures "to utter the heresy that the *ideas* are more important than the *facts*," and in his presentation of the subject he emphasizes the ideas. He gives no irrelevant facts and avoids mathematical formulas and argument.

After a brief introduction on the scope and purpose of physics, the book takes up the subject of Dynamics, treated by "a general discussion in which the methods of thought employed in this science are established," in which besides the conventional subjects of force and mechanical energy, we find a section on vibrations, an account of the relations of heat and energy and a sketch of the kinetic theory of matter and of thermodynamics. Then follow chapters on the main divisions of physics, presenting mechanics and heat again and going on in the usual order to the end. It may be noted as unusual in such presentations that we find an account of the development of the tempered scale of the piano, and a long—in proportion—description of lens optics. The story closes abruptly with electromagnetic induction. The concepts of the electron and the proton are used in the discussion of electrostatics and of electrodynamics as well, and it is hard to see why such important parts of physics as the electric discharge in rarefied gases and radioactivity have been omitted. I hope that the author is holding them back to serve as the introduction to another book in which he will present the new philosophy of physics which has grown up in recent years, in which "the revolutionary nature of the ideas involved is so great that our grandfathers would have required a lifetime to become accustomed to the implications of even a part of them." Dr. Swann would do this work admir-