

This is a thoroughly modern text-book, not handbook, of its subject. The fact that it carries a preface by Professor Michelson is a sufficient assurance of its scientific character. As any really to-day's treatise on any branch of general physics must do, it supposes an elementary acquaintance with the calculus; and its pages bristle with equations which signify hard work for the reader and full compensation therefor. Descriptions of instruments and statements of experimental results are summary, not to say skeletal.

Still, the essentials are given. As a matter of course, optics is here treated as a branch of the theory of electricity. The work consists of four parts (which nobody can suspect a German professor of simply numbering consecutively)—the first, on geometrical optics; the second, on the phenomena of light treated in the general manner of Fresnel; the third, on the electrical theory and the optical characters of crystals, metals, etc.; the fourth, on radiation. The assignment of one principal part to radiation is a mark of modernity; and the distribution of space among the four parts is significant. Taking the second part, which is a trifle under 150 pages, as a standard of comparison, the geometrical part is three-fourths as long, the electrical part is half as long again as the second, the discussion of radiation one-third of the same unit. The book is not at all overloaded, like so many German books; nor is there any undue partiality to any particular topic. The matter is judiciously selected, and contains nothing more than ought to be familiar to everybody whose business or amusement it is to be acquainted with the theory of optics. The fault, if there be any, is rather in the omission of interesting topics. The student will derive from it all the pleasure that there is in the sense that one's thoughts are guided by a master-mind.

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AVIATION

Travels in Space: A History of Aerial Navigation.

By E. Seton Valentine and F. L. Tomlinson. London: Hurst & Blackett. 1902. Pp. 328.

Aerial Navigation: A Practical Handbook on the Construction of Dirigible Balloons, Aerostats, Aeroplanes, and Aeromotors.

By Frederic Walker. D. Van Nostrand Co. 1902. Pp. 151.

CSP, identification: Haskell, *Index to The Nation*. See also: Burks, *Bibliography: List of Articles*; MSS L 159.211-212; MS 1456 (draft).

Should the reader entertain the theory that books showily printed on calendered paper, with abundant illustrations, more or less splurgy, are not particularly apt to prove attractive reading, we cannot say that 'Travels in Space' will tend to convince him he has been wrong; albeit the nature of its subject renders it readable. It would be unreasonable to expect it to present the strange experiences of ballooning with all that life and reality that Mr. Bacon's 'By Land and Sky' did, last year, because that was a masterpiece. A glance at the volume will inform him that it is

not a work of research, like Mr. Chanute's 'Progress in Flying-Machines,' from which, by the way, it copies extensively, almost verbatim, without acknowledgment, and to which it is vastly inferior in all respects in which the two works come into comparison, excepting in a very few details. It is later in date by more than eight years, and its scope is wider. The field still remains open, however, for a really workmanlike history of aeronautics.

The building of an airship is as much more difficult than the building of a steamer, like the *Kaiser Wilhelm II.*, as the latter is than the throwing of a trussed suspension-bridge across the North River. Consequently, Mr. Walker has judged a duodecimo of a hundred and fifty pages to be the proper sort of volume in which to convey the airship-building art. For, once problems reach a certain pitch of difficulty, and the more profound they are, the less is the knowledge generally thought requisite for attacking them. The first chapter of Mr. Walker's "practical" book is entitled "The Laws of Flight." The only statement of a law which it contains is the following:

"When a moving body is directly opposed by a *vis mortua*, such as a pressure or resistance like that of gravity, the measure of such *vis mortua* required to neutralize the force [of the moving body] and bring the moving body to rest must form the basis of the measurement of the force."

Thus, the persons who Mr. Walker assumes are to undertake the construction of airships, and for whose encouragement he has provided his handbook, are supposed to be in need of this information; while further dynamical science, he would appear to presume, is quite beyond their comprehension. Later in the book, it appears that they are persons who need to be told what a sine and cosine are. What Mr. Walker fails to tell them, but, on the contrary, implicitly denies, is that, with such an outfit, they will make great fools of themselves if they undertake the building of an airship.

Vessels to sail the air are of four types. The first is that of a machine with ascensional power, but with no motor. Such is a simple balloon or other aerostat, a kite-balloon, or a system of attached balloons. Much may be done with a skilfully managed balloon. Its great advantage over other air-sailing vessels lies in its comparative safety. Let any other kind of airship decisively come to grief, and instant death ensues for all its crew. But if a balloon bursts, not too near the ground, the calm and skilful aeronaut can take measures to save himself. This accident happened to Wise in Pennsylvania in 1836, at an elevation of 13,000 feet, but he was so far from being reduced to a pulp by the fall that, jumping up, he remarked upon the heat of the lower atmosphere, and, before many minutes had elapsed, had determined to repeat the experiment at the first opportunity. The fatal falls (other than drowning cases) have usually been from moderate heights, or have been due to the fright or inexperience of the operator. When Simmons met his death in 1888, he fell only 50 feet; yet neither of his two companions was killed, and one of them was not even injured. Capt. Dale's balloon in 1892 burst at a height of 600 feet, he and Mr. Shadbolt, a professional aeronaut, being killed, while two amateurs who were with them escaped unhurt; but experts opined that with proper management all might have been saved. This comparative immunity arises from the fact that the

lower half of a falling balloon of the ordinary shape invariably cups into the upper half, forming the best of parachutes. Immunity, therefore, does not extend to aerostats stiffened with hoops or made of aluminium. A serious fault of the ordinary balloon is that there is no level at which it is in equilibrium unless the gas be confined, which is too unsafe. When it goes up, it retains the same ascensional force, and continues to be accelerated upward until it loses gas; and its momentum of perhaps a couple of tons moving four or five hundred feet per second will carry it up long after the gas has so swelled and spilled that, by the time it ceases to rise, it is much heavier than the air, and would come down to earth if ballast were not thrown out; and so it goes, alternately rising and falling until its ascensional power is quite wasted. Mr. Walker does not make this matter at all clear, but talks, as aeronauts are apt to do, of the level "to which the balloon must rise," just as if it were a closed bottle. A metallic balloon would be free from this objection, having a definite level at which, if tight, it would remain in equilibrium, or oscillate above and below it, indefinitely. Schwartz's machine of 1894 demonstrated that an aluminium balloon can be made sufficiently light (its ascensional power must have been about 7,000 lbs.) and can be filled with hydrogen; but it is very unfortunate that the inexperienced operator took fright and destroyed the airship, though not his miserable self, before it had risen high enough to show whether or not at its level of equilibrium it would have been able to withstand the pressure of gas within. The excess of gas would naturally be allowed to escape; but if this escape were too rapid, all the advantage of the metallic construction would be lost, while if it were not very rapid, the excess of pressure from within would become very considerable. Though such things are subject to calculation, actual experience is extremely welcome. To-day it is probable that such a vessel would be made of magnalium, not of pure aluminium. Somebody with a spare million could make an interesting experiment by combining the metallic balloon with a suggestion of the celebrated Monge that has never yet been tried. He was eminently a practical man as well as a mathematician of the first order. His suggestion was that of an air-snake, to be composed of twenty-five aerostats strung together, the vermicular or serpentine motion being brought about in a vertical plane by the transfer of ballast from one to another.

The second type is that of machines having both ascensional power and motors. Mr. Walker maintains that this is the only practical form, on the ground that this alone affords safety in case the machinery goes wrong. Plausible as this sounds, facts are against it, and reason too. Notwithstanding the thousands of ascensions that still take place in vessels of the first type for every one in a vessel of this second type, four times as many men have been killed since 1892 in ascensions of the latter type as of the former. It would be quite absurd to maintain that carrying a motor adds to the security of a balloon. That the addition of a balloon to an airship with a motor is a most serious source of peril would seem obvious enough, even if indirect effects of danger are left out of account. It may, however, be that a ship of this type supports a minor accident better than does any other. The breaking of the steering-apparatus of Count Von Zeppelin's great air-ship at its grand gala trial on Lake Constance did not prevent its accomplishing a little excursion and effecting a beautiful descent upon the lake; and M. Santos-Dumont, on his

first ascension in Paris, broke his rudder, successfully landed, mended it, and continued his performance. Many engineers of standing have declared in favor of this type, which is the only one that has as yet attained some undeniable success; yet those who have most deeply studied the problem are opposed to this type. Sir Hiram Maxim, in a preface which he has contributed to 'Travels in Space,' argues that "it is not possible to make a balloon strong enough to be driven through the air at any considerable speed [meaning above six or seven miles an hour] and at the same time light enough to rise in the air." But he gives no assurance that this judgment is based upon calculations relating to magnalium balloons. Besides, it has been urged in reply, by Von Zeppelin and others, that a velocity of seven or eight miles an hour, or even less, would be all-sufficient for the peculiar purpose to which air-ships must be restricted. For, it is said, it is quite unreasonable to suppose that a vessel sailing the air should ever be able to compete with an ocean steamer, and quite ridiculous to imagine it should ever carry freight or many passengers. Its distinctive superiority lies in the fact that, moving in the three dimensions of space, it can never be intercepted or obstructed except by the most improbable chance. Its service must, therefore, always be to go where nothing else can go, without carrying or bringing back anything but intelligence. Its function will be to hunt up lost explorers, to spy out an enemy's doings, to visit the upper atmosphere, and in short to act as a reporter. Now for this business it is contended that great speed is needless. One can but feel, however, that it is highly desirable that the reposting air-boat should not be carried quite away from its course by anything short of a moderate gale; which would demand a velocity of at least twenty miles an hour.

The third type is that of machines provided with motors, but heavier than the air. This is the form advocated by Langley, Maxim, Barton, Hargreaves, and, in short, the general body of those who have in our day studied the subject in a scientific manner. It is the only form which by any possibility could ever decidedly distance the "ocean greyhound" of to-day. Its real merits cannot be estimated until it has been embodied in some practical shape.

The fourth type is that of instruments neither possessed of ascensional power nor carrying any engine. To be sure, they may, and hitherto generally have, supposed a man to be kept hard at work during their trips. But how little his could amount to, as mechanical work, becomes manifest when we reflect that the more powerful of a man's muscles are unadapted to the long-sustained production of impulses at a greater frequency than, say, two per second. If therefore, such impulses were to be relied upon to prevent the instrument from falling, since in the interval from one to another, the machine would have fallen four feet, it follows that the labor the man would be called upon to perform would be equivalent to that of taking the instrument (say, a hundred-weight) on his back and running up stairs with it at the incessant rate of eight feet per minute, or four hundred and eighty feet per hour. Each reader can speak for himself as to how many hours at a time he would contract to keep up that lively exercise.

It has many times been demonstrated that there is no very formidable difficulty in constructing an instrument weighing about a hundred pounds which shall lift a man, or even two men, up into the air in a fresh breeze, and carry them up into the wind. It is supposed that they could sustain themselves indefinitely, if they were

skilful enough, without any particular expenditure of energy, in the same way in which birds ranging in size from the lark to the condor soar. A condor will weigh eighty pounds and will soar all day long without any sign of effort or of fatigue. Various facts go to support the theory of Professor Langley that it is by taking advantage of the puffiness of the wind (its "internal work," as he calls it) that birds soar; though it is not certain that other factors, of which three readily suggest themselves, may not contribute to the effect. It is quite certain that a considerable weight is one requisite. The most successful of the flights of Le Bris occurred one day when the rope by which his instrument (which was intended to carry only himself) became accidentally wound round a second man. Le Bris, not noticing what had happened, carried the man up two or three hundred feet into the air, and forward into the wind for a furlong or so, and could apparently have gone indefinitely further. But when he had descended sufficiently to set his captive passenger free, he found that without that ballast he could no longer fly. Thus far, however, no man has found it possible to acquire the necessary skill to manage such an instrument, in advance of getting killed by his blunders. The thing has not really had a fair trial. Le Bris was a very poor man, a common sailor, and circumstances prevented his practising on the water, although his machine had been specially constructed with a view to that. Consequently, before he could learn the art, his machine was smashed; and he lacked the means to reconstruct it.

Although Mr. Walker contemplates the construction of airships of the second type alone, yet, owing to this type reuniting the positive features of the others, his volume contains many facts pertinent to the construction of any airship. As far as our verifications have extended, his numbers are accurate. But nothing more inaccurate and unintelligible than his statements of mathematical rules and formulæ can be imagined. For example, on pp. 17 and 18 is an attempted explanation of the manner of calculating the elevation from the pressure of the air. Not until one has corrected several misprints, including the uniform printing of exponents as factors, do the difficulties of finding out what the man means (although the reader knows what he ought to mean) fairly emerge. They are not confined to any one sentence. A number has been obtained, and, being correct, there is substantially but one way in which it could have been reached; yet what relation there is between what is said and this operation, one cannot make out. So it is, in lesser degree, throughout the volume.

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The Origin and Significance of Hegel's Logic: A General Introduction to Hegel's System.

By J. B. Baillie. Macmillan Co. 1901. 8vo, pp. xviii, 375.

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This book is, on the whole, of any that we have seen, the most helpful for a student prepared to take up the study of Hegel. It is not designed as a substitute for reading Hegel's own works, but, as the title-page proclaims, as an introduction to