sisippi during the last four years, has been promoted to be professor of municipal engineering.

Mr. D. Keilin, of Magdalene College, Cambridge, has been appointed assistant to the Quick professor of biology.

DISCUSSION AND CORRESPONDENCE

THE RÔLE OF BOYLE'S LAW IN CLINICAL SPHYGMOMANOMETRY. A REPLY TO A. M. BLEILE

In a paper read before the American Physiological Society Dr. Bleile[1] discusses an application of Boyle's law which I made in developing the theory of the oscillations of pressure produced in the compression chamber of a sphygmomanometer by the arterial pulse.[2] My statement of this law, worded so as to fit the conditions obtaining in my experiments, was as follows: ". . . the rise of pressure determined by the addition of a given volume of incompressible material to a confined, gas-filled space is proportional to the pressure of the gas filling the space." Dr. Bleile illustrates the action of the law by paraphrasing the example in my paper thus:

> With a given volume pulse change, if the arm band pressure is at 100 mm., the pulse wave shown by the arm band manometer would be *only half as great* as it would with the same volume pulse but with the arm band pressure at 200 mm.

He then goes on to say that

> upon testing this hypothesis by the help of a suitable physical model it is demonstrated that such is not the case. On the contrary, it is demonstrated that the oscillations of volume occupied by a given mass of gas produce inversely proportional oscillations of absolute pressure. Or, in other words, the absolute pressure of a given mass of gas is inversely proportional to the volume. . . . Therefore, the results of the present work are in harmony with Boyle's law but are contrary to Erlanger's hypothesis.

This statement would lead one to suppose that in my application of Boyle's law I have committed the mistake of making the relation between pressure and volume a direct instead of an inverse one. This, however, is not the case. If my statement of the law is compared with Dr. Bleile's, it will be found that in this respect there is not the slightest difference between them. Thus, to paraphrase my statement so as to make it conform with Dr. Bleile's, "the addition of a given volume of incompressible material" *reduces* the volume of the given mass of gas; this reduction causes a "*rise* of pressure," which "is proportional to the (initial) pressure of the gas filling the space." In this statement the relation between volume and pressure (italicized) obviously is an inverse one. What evidently confused Dr. Bleile is the introduction into my statement of the word "proportional" for the purpose of expressing the relation between the *initial pressure* of the confined gas and the *final pressure* developed upon reducing its volume. That this relation is correctly expressed can easily be, and has been, confirmed by the use of very simple apparatus.

Having made it clear that there is no discrepancy between my and Dr. Bleile's statements of Boyle's law, I now desire to add that Dr. Bleile is right in criticizing my *example* of the application of the law. For I inadvertently employed in the example the pressures read directly from the mercury manometer instead of the absolute pressures, though, in the form in which Dr. Bleile repeats it, the example is in perfect accord with Boyle's law, if it is understood that the pressures are absolute. The failure to express the pressure in absolute terms affects, however, only the magnitude of change, not its sign, and therefore does not alter in any material way the development of the theory of the compression oscillations; for my only object in invoking Boyle's law was to show that under the particular set of ideal conditions premised, namely a rigid compression chamber, a compressible transmitting medium and an inextensible artery, the amplitude of the pressure oscillations resulting from the filling and emptying of the artery must *increase* as the compressing pres-

[1] "An Application of Boyle's and Avogadro's Law to the Oscillations of the Manometer in Clinical Measurements of Blood Pressure," *Am. Jour. of Physiol.*, 1917, XLII., 603.

[2] "The Mechanism of the Oscillatory Criteria," *Am. Jour. of Physiol.*, 1916, XXXIX., 401.

sure increases from the diastolic to close to the systolic level. And it was shown that under approximately this set of conditions such is actually the case (see Figs. 10 and 11).

But even if Boyle's law did (and it actually does not) determine a diminution instead of an increase in the amplitude of oscillations with increasing compressing pressure, the development of the theory of compression oscillations would not have been affected in the least. For in the further development of the theory it is shown (Figs. 12 and 13) that under the influence of additional conditions obtaining in sphygmomanometry the consequences of Boyle's law become relatively so insignificant that the amplitude of oscillations, instead of increasing, as the compressing pressure rises from the diastolic to the systolic level, actually decreases.

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THE UNIT OF PRESSURE

TO THE EDITOR OF SCIENCE: The announcement that the French Meteorological Service has, beginning January 1, 1917, decided to publish atmospheric pressure data in units of force instead of millimeters as heretofore, makes it necessary once more to call attention to the fact that the proper unit for the expression of pressure is not the *millibar* but the *kilobar*. The scientific reasons for this have been given elsewhere at length. Another valid reason, however, may be now mentioned.

There has recently been developed a new type of condensation high-vacuum pump. I refer to that of Professor Langmuir. Pressures as low as 10^{-5} bar have been obtained; and there is little doubt that very much lower pressures can be produced by cooling the bulb to be exhausted, in liquid air, so as to decrease the rate at which gases escape from the walls.

The unit *bar* is here used (and I believe this is the practise of the General Electric Company and will of course be followed by physicists, chemists and others working on allied problems) in its right sense, namely, the accelerating force of one dyne per square centimeter. This is 10^{-6} megabar. In the case of this type of pump we have a pressure of 10^{-11} megabar or 10^{-11} standard atmosphere.

The millibar then in daily use becomes what it properly is, 10^{-3} bar. The European Weather Services trying to express atmospheric pressures in millibars are in error, and the correct values are one million times greater.

Fortunately, it is an easy matter to change *mb* to *kb*. And this should be done on all tables, charts, etc., published by European meteorologists.

ALEXANDER MCADIE

A RELIEF MAP OF THE UNITED STATES

TO THE EDITOR OF SCIENCE: With reference to the suggestion in SCIENCE of March 9, relative to a large relief map of the United States, may I be allowed to state that this is a matter which I often discussed with the late E. E. Howell, who at one time had it under serious consideration? It was then my view, to which I still adhere, that there was a limit in size for such objects, beyond which nothing was gained. This was particularly impressed upon me some years ago while studying some of the maps of celebrated battlefields in German museums. In these large models, details toward the center, on account of distance from the eye, were as inconspicuous as though on a smaller scale and closer at hand. In short, the effect of the enlarged map was wholly lost owing to the necessary distance of the observer. A small map near at hand would be much less expensive, and fully as satisfactory.

With Dr. Clarke's remarks in SCIENCE for March 23 I fully agree, data not being at hand for anything but the most general topographic features over a large portion of the area of the United States. The plan, as it appears to me, is wholly impracticable.

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QUOTATIONS

RESEARCH IN MEDICAL SCHOOLS

AN important report[1] in this issue of *The Journal* shows that of the twenty-six founda-

[1] "Medical Research in Its Relation to Medical Schools." A Report by Drs. Frederic S. Lee, Richard M. Pearce and W. B. Cannon, composing