average, to ± 0.002 sec. The average distance between the spark point and the paper is about .5 mm. and the average angle of deflection of the spark is less than half of 45°; therefore the average variation in the spark is less than ± 0.001 sec.

The chronoscope may be adapted for the measurement of longer intervals, as in the study of association, by two minor changes which can be made in a minute. A small weight is fastened on the top of the upper bob. This makes the pendulum swing so slowly that it takes three seconds to cover the arc of the scale. A corresponding scale, graduated empirically in hundredths of a second, is clamped over the regular scale. The accuracy is nearly proportional to the speed of the pendulum.

Similarly, if there should be a demand for finer readings than those obtained by the standard adjustment, an extra weight may be placed on the lower bob that will cause the pendulum to cover the arc of the scale, for example, in one third of a second. If the corresponding scale is graduated in thousandths of a second each unit will occupy, on the average, 1 mm. of space. The degree of accuracy will be nearly proportional to the speed, because the latent time of the spark is negligible and the action is frictionless.

Much of the value of a chronoscope lies in its adaptation to the attachment of a variety of accessories. The possession of the soundless make and break contacts for the stimulus circuit makes it possible to connect all sorts of electric stimulus apparatus, such as the telephone receiver, the touch key, the tachistoscopes, etc.

For regulating time-exposures, a movable pendulum contact is attached to the front of the base and adjusted, by reference to the scale, for any desired length of exposure from a hundredth of a second to three seconds. This contact may be used either as a make or break and the circuit may be completed either through the make or the break of the stimulus contacts.

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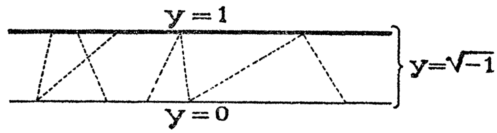
A VECTOR DIAGRAM

Apropos of Carl Barus's interesting note in Science of August 2, p. 149, it may not be amiss to call attention to a representation that I used in a communication to the March meeting of the Chicago Section of the American Mathematical Society.[1]

I represent a real point (x', y') in the plane by a dot and call it a black point, while an imaginary point $(x' + ix'', y' + iy'')$ is represented by a blue point coincident with the real point $(x' + x'', y' + y'')$ and joined to (x', y') by a real vector. Where no confusion



is caused the real vector is drawn straight, but otherwise it may be curved, it being understood that the direction is determined by the end points. Furthermore, if the vector moves its end points describe a black curve and a blue curve. Thus the line

$$y = \sqrt{-1}$$

is represented by joining every point in the black line

$$y = 0$$

to every point in the blue line

$$y = 1.$$

In the accompanying diagram the "blue line" is drawn heavy, the "red lines" broken.

Ellery W. Davis

QUOTATIONS

LIVING ON OUR CAPITAL

The passion to beat our records in material advancement tends to blind the thought to the fact that we are rapidly consuming the very fundamental resources on which the prosperity of the country rests. Without doubt the timber supply of the United States is disappearing far more rapidly than any increment of growth. The treatment of the soil in much

[1] *Bulletin of the American Mathematical Society*, June, 1907, p. 436.

of the best agricultural lands is still of the kind that exhausts fertility and makes crop failures inevitable.

In the use of the iron ore deposits there is not even the possibility of duplication in preventing the exhaustion of supply. The rate of utilization has for several years been going on at from 25,000,000 to 30,000,000 tons a year. The country has been taking out, say 400,000 tons of copper a year and the coal mines of the country yield 475,000,000 tons. The annual lumber and timber products, including fire and pulp wood, are probably valued at no less than $1,000,000,000. Excepting agriculture and lumbering, there is no possible way of replenishing supplies once exhausted, except by the discovery of new sources of production.

The forests, the coal beds, the iron ore and the copper, along with the fertility of the soil, are essential parts of the capital of the nation. The annual output from them is not simply income; it is to a large extent a spending of capital. Expenditure of capital resources always points to a time when the community will be put to the necessity of finding substitutes for any one or more of these fundamental elements of national strength. Without attempting to forecast the time of such exhaustion the policy of the present requires that efforts be made in two directions to put off as far as possible the day of reckoning. For the nation that has lost its elements of might in material resources cannot hope to maintain its ascendency among its more powerful and farseeing competitors.

The two things which a nation can do are to economize consumption and to discover substitutes. The natural effect of rapid consumption is productive of higher prices, which in themselves supply an automatic check. But before the check of advancing prices sets in there are always wasteful methods at work which are themselves to no small extent the cause of advancing prices. Only after billions of dollars have been lost in the treatment of the soil, of the forests and the mines, does the policy of more economical management force itself upon those in control. The natural law of supply and demand compels man in his treatment of nature to become a better husbandman. Yet this is too much like locking the stable after the theft of the horse fully to meet the case.

The real remedy for rapid and wasteful exhaustion of natural resources is to be found in technical and scientific research. The endowment of such research is one of the greatest financial problems of American industry. The state and federal governments have already provided for agriculture and applied foresight to the use of the public forests. The consolidation of iron ore properties under the control of a smaller number of large corporations is in itself a promise of a more economical method of handling them. But the real gain must come from the laboratory, whether in the iron and steel plant or in the experimental rooms of our universities and technical schools. The single item of applying electricity economically to the smelting of ores would in itself, for instance, be worth thousands of times the cost of experimentation and research in a single year's output.—*Wall Street Journal.*

ABSTRACTS FOR EVOLUTIONISTS

Madreporarian Corals.—In a magnificent work on the Madreporaria of the Hawaiian Islands and Laysan,[1] Dr. T. W. Vaughan takes up the difficult questions relating to the species and varieties of these animals, and while leaving them unsettled, gives a most interesting and suggestive discussion, with an abundance of facts, and very good illustrations, the latter occupying no less than ninety-six large plates. The following quotations will be of general interest:

> Variation in corals is, we know, great and complex. If we knew its limits, we should know the limits of the different species. Bernard, in cataloguing the Perforate Corals of the British Museum (Natural History), experienced so much difficulty in defining them from the collections at his disposal that he decided to abandon the Linnæan system of nomenclature, and to use in his catalogues a geographical number system (p. 4).

> Studies of variations, such as those contained in this paper, may appear elaborate to persons who have not gone deeply into the subject, but in reality they are of only a preliminary nature, for

[1] Bulletin 59, U. S. National Museum, 1907.