understanding of past and present philosophies and perhaps civilizations. This fact has not been generally recognized by the necessary change in the college or university curriculum.

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PUBLICATION BY PHOTOGRAPHIC REPRODUCTION OF TYPEWRITING

IN Volumes IV and V of the Transactions of the Astronomical Observatory of Yale University, recently published, very extensive use was made of a photographic reproduction of typewriting. As far as I am aware this is the first application of this process to the publication of extensive scientific results. The method employed is described in the introduction to Volume IV, page 31, thus:

> The tabular matter was typed with an ordinary typewriter on heavy Ledger Bond paper, backed with carbon so as to print on both sides, giving a black opaque impression. These sheets were then transferred photographically to zinc plates, reducing them in the ratio of four to five. . . . The catalogue was then run off on Chester Offset Bond paper. The cost of composition, paper and running off is about one third that of printing with ordinary lead type. Furthermore, one complete proof reading of all the material is saved; this is not only an additional economy, but entails fewer errors in the final impression. The pages do not seem to be inferior to type in their legibility.

An inspection of the tables thus reproduced shows that the results attained are all that is claimed for them.

The very great economy of the method naturally raises the question as to whether it could not be adapted to rather general use for the publication of scientific journals and books. Variety in the size of type or special characters or symbols should not cause any great difficulty. A large institution like a university press would equip itself with special typewriters according to its needs. Also a considerable improvement in appearance, perhaps sufficient to satisfy the more rigid requirements for general use, seems readily attainable. The irregular spreading of the ink on the typewritten sheet at present forms too big a proportion of the total width of the lines forming the letters and figures. This could be reduced and a clean-looking page obtained by making a radical improvement in the style of letters and figures, by the use of much larger type and by a greater reduction in the photographic step. The whole typewritten sheet would have to be larger so as to allow a reduction to perhaps one half instead of four fifths scale.

Publication of the results of research presents quite serious financial problems. The expenditure of a relatively moderate sum of money in the directions indicated above for the further development of the method employed so successfully by the Yale University Observatory would be well worth while. It seems quite safe to predict that such a considerable improvement could be attained that the main question would no longer be whether or not we may prefer the lead type but rather whether we shall be justified in continuing its use in the publication of much of our scientific work. The disproportionate economy of the newer method should go a long way toward balancing certain advantages of ordinary type and a considerable amount of prejudice which most of us would find it difficult to overcome.

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A SIMPLIFIED INDICATION FOR THE CONSONANT SOUND REPRESENTED BY THE LETTERS TH

WOULD it be a sufficient saving of type, printers' ink and muscular effort if instead of writing th we should express the same sound by a letter which is merely an h with the vertical arm crossed like a t? This sound is a very frequent one in the English language and in some others. Such a letter would be perfectly understandable wherever seen if the convention were once accepted. Of course, a number of languages have or have had a single letter to indicate this sound.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

FINELY REGULATED MOVEMENT BY USING HYDRAULIC DEVICES

IN designing a micromanipulator for the isolation of single bacteria and for microinjections the question arose of the value of an hydraulic system comprising a small controlling piston and cylinder forcing fluid into a larger cylinder and piston as a means of obtaining finely regulated movement. Several models were built and tested. The most satisfactory type had three pistons arranged at right angles to each other, having the vertical cylinder pivot on a base and the two horizontal pistons press against flat faces on the vertical piston. Springs were used to hold the flat faces of the vertical piston against knife edges on the horizontal pistons. The controlling pistons

were fitted with screw feeds and the cylinders were connected to the driving cylinders by flexible metallic tubing permitting convenient remote control. Large and small controlling pistons which gave a coarse and a fine feed were used. The systems were filled with a heavy oil. Such an instrument operated free from vibration, drift and annoying lag when movement was observed through a microscope at 800 to 1,100 diameters magnification.

As a further and more critical test of such a mechanism a mirror was attached to a piston of 0.875 inches diameter and this made the movable arm of a Michelson interferometer. The controlling piston was 0.125 inches diameter and fitted with a screw feed of forty threads per inch. This made the fineness of movement the equivalent of a screw with about 2,010 threads per inch, and a hundredth turn of the controlling piston would move the larger piston about 0.000005 inch, or one two-hundred-thousandth of an inch. The use of parallel fringes with the mercury line 5,460.74 A. U. as a source showed the vibration to be less than a millionth of an inch, the drift imperceptible and the lag less than 0.000005 inch. Measurements showed an error which was well within the probable error of the screw feed so that errors due to the hydraulic system *per se* were not apparent in this setup.

Because of the incompressibility of liquids at ordinary pressures and the ease of introducing remote control such hydraulic systems are especially adaptable for producing vibration-free movement, and apparently when the liquid wets the walls accurate movements are possible. Apart from the value of such devices in micromanipulator construction the question arises as to whether or not certain periodic errors inherent in screw feeds might not be minimized by using an hydraulic ratio such that they became negligible. Periodic errors might also be eliminated by using several controlling pistons operated simultaneously with each forcing fluid into the driving cylinder, producing a summation of the individual periodic errors.

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RAPID DETERMINATION OF THE MOISTURE CONTENT OF SOILS

ONE of the greatest needs in soils investigations, both in laboratory and under field conditions, is a simple and very rapid method for determining the moisture content of soils. The same need is undoubtedly felt in many other branches of science and industry. For the methods we have at present for determining moisture content of materials are laborious, slow and time-consuming.

In having developed and used in this laboratory the hydrometer method for estimating the mechanical composition of soils and also for determining the colloidal content of soils in only a few minutes, the idea occurred that the hydrometer method might be also used in determining the moisture content of soils. This could be done, it was thought, by mixing a definite volume of pure alcohol of known specific gravity and a definite amount of moist soil and determining again the specific gravity of the liquid. The difference in specific gravity between the pure alcohol and the mixed liquid ought to give the amount of water in the soil since the alcohol extracted the moisture from the soils which went to dilute its strength.

This idea was subjected to an investigation and it proved to be perfectly correct and successful. The experiments showed that the alcohol can extract the moisture from the soil from any moisture content down to considerably below the air-dry condition, and it indicates the amount so extracted correctly on its specific gravity. When the soil mass is in such a structure so the alcohol can penetrate it easily, the extraction of the moisture is accomplished almost instantaneously. The soil particles not being deflocculated by the alcohol, they settle to the bottom of the vessel very readily. On the other hand for more rapidity in operation the soil can be shaken vigorously and immediately filtered and taking the specific gravity of the filtrate. The results showed that whether the alcohol mixture was allowed to clear up by standing or filtered through a filter paper, the specific gravity was the same.

By means of this method the moisture content of a soil can be determined in only a few minutes. At this laboratory the moisture content of many soils have been determined in less than five minutes. The only soils which take more time are those which are puddled and the alcohol can not penetrate them. Vigorous shaking or stirring with a rod, however, hastens their breaking up.

This method seems to be absolute and not arbitrary. It seems that it is almost as absolute as the oven-dry method. With a very sensitive and accurate hydrometer, which is being made, the method can be very accurate.

The method ought to find a very wide application, not only in soils work, and possibly in plant tissues, but also in many other sciences and industries. It is somewhat strange that it has not been used long before this, because its principle we have known for so long.