

the parallax, and gives as a consequence a marked accentuation of the pseudoscopic effect. If, again, the smaller mirror on the right be moved so as to come be-

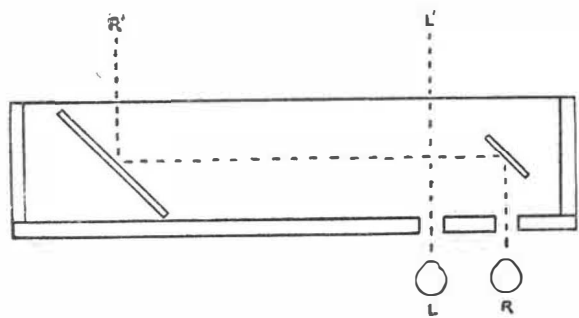


FIG. 2.—EXAGGERATED PSEUDOSCOPIC VISION.

fore the left instead of the right eye (as in Fig. 3). *L'* and *R'* are then in the same relative positions as the eyes to which they respectively lead; the pseudoscopic effect consequently disappears, and the instrument becomes what has been termed a "telestereoscope," giving an abnormal relief to objects in the foreground and carrying the stereoscopic effect out into the distance which normally seems "flat."

The advantages of this instrument over the ordinary pseudoscope which makes use of reversed stereoscopic photographs are obvious. In this, as in the Wheatstone pseudoscope, one looks directly at the objects themselves and not at their dull copy. There is, however, no right and left reversal of things, such as the Wheatstone instrument produces, and one can readily get a much larger field of view than ordinary prisms

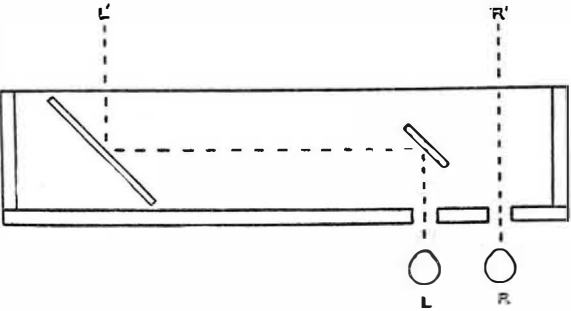


FIG. 3.—EXAGGERATED STEREOSCOPIC VISION.

give. Besides this, an indefinite range of variation of the apparent interocular distance is possible for both pseudoscopic and stereoscopic vision, and consequently an elasticity in experimental use which neither of the other forms permits. For nice experiment with objects very near at hand some correction might be introduced by lens or otherwise, so as to compensate the slight inequality of accommodation in the two eyes, resulting from the greater distance which the light reflected in the mirrors has to travel, compared with the light which comes to the other eye direct.

In applying this contrivance in the present case, the distance between *R'* and *L'* was made equal to that between *R* and *L*, and in other respects the arrangement was that shown in Fig. 1. The landscape seen under these conditions shows pseudoscopic reversals, but not so often an apparent change of convex into concave objects, and vice versa, as a transposition of the relative distances of objects from the observer. A tree, for example, between the person and a background of other trees may now seem to lie beyond those trees and to be seen through them. There is a distance in the landscape, however, beyond which such transpositions are not noticed, so that the foreground alone shows the pseudoscopic effect, strictly speaking. But where two objects actually suffer such a transposition, one may safely assume that at least the nearer of them is still within the range of binocular perspective. For the transposition is brought about merely by the reversal of the usual binocular differences; and if the objects were so far away as to make their distances binocularly indistinguishable, then the pseudoscope ought to leave them indistinguishable, and no reverse perspective would result. Where the instrument does produce an alteration of perspective it is evident, therefore, that the objects have an effective binocular difference, or, in other words, that at least one of the objects is inside the limit of stereoscopic vision.

But the pseudoscope is effective even beyond the region where actual reversals take place. In this farther zone, though, it gives no pseudoscopic effect in the ordinary sense of the term, but merely saps the stereoscopic life of the scene and leaves it with only the perspective that a skillful painting might have. When the instrument is removed, these more distant objects instantly show a clear stereoscopic relief, which is lost the moment the apparatus is again put before the eyes. The rapid alternation which is thus possible makes one for the first time unmistakably conscious of the presence of real binocular effect. There is, however, a distance at which this perceptible difference between the normal and the pseudoscopic view is lost. Things in this outermost zone look the same—absolutely flat—whether we look at them in the one way or the other. But where there is a rhythmic loss and re-appearance of stereoscopic relief, according as the pseudoscope is put to the eyes or taken away, it must be that we are still within the range of true binocular influence. If we were looking quite beyond that range, there could not possibly be the alternation of flat and depth effects which was noticed under these conditions.

The limit beyond which all distances become binocularly indifferent can be roughly approximated in this way. Much more careful series of experiments than I have yet carried out would be necessary, however, before one could speak unguardedly, even as to the mere general position; but I feel certain that the alternation just spoken of is still perceptible in objects 580

meters distant and seen against a varied background of wooded plain several miles away. My own experience has been confirmed by three careful persons—the only ones who were called on—one of these being Prof. Le Conte, who very kindly consented to make the observation. Tests were also made to see whether we were not being tricked into an illusion of stereoscopic perspective by the mere added brightness which the scene showed when both eyes received the light direct, in contrast with the pseudoscopic view where one eye received an image slightly dimmed by the absorption of light in the mirrors. Instead of removing the pseudoscope and looking at the scene in the usual way, an additional set of mirrors was placed in front of the instrument, so that the left eye, too, received a doubly reflected image of the scene, but so that the line of sight, *L'* in Fig. 1, was carried over the full interocular distance (but no more) to the left of *R'*. As soon as the lines of sight were thus restored to their normal relation the stereoscopic perspective returned, although in this case the scene was dimmer than the simple pseudoscopic view. If the supposed perspective had been an illusion due merely to the increased light, and not to binocular differences, it would, of course, have failed to appear under these special conditions.

While this more direct method of determining the range of binocular effect seems to me to be important, yet the actual result would after all be but the substitution of a new number for the old, were it not for certain theoretical consequences which the new number implies. The interocular distance in my own case is between 65 and 66 mm., so that in the two retinal impressions of an object distant 580 meters and projected on a background infinitely remote there would be an inequality amounting to less than 24". Yet under very favorable conditions, differences of position less than 50" can no longer be consciously discriminated,* and even under the most favorable conditions—the discrimination of fixed stars†—points have never been distinguished when separated less than 30".

If my present results are at all trustworthy, they would imply, therefore, that the spatial character of the presentation may be perceptibly altered by the presence of differences so minute as to be of themselves entirely inappreciable. The limit of conscious discrimination of angular differences consequently gives no exact basis for computing the limit of conscious binocular effect; on the contrary, this effect may be produced by differences which elude our introspective scrutiny, or which are subconscious, if we wish to use the term in this sense. Those who hold that direct introspective analysis must give the sole and final word as to the constitution of a mental state might, I imagine, still maintain that the stereoscopic aspect of the perception cannot be due to factors which our inner sense is unable to report; that if these elements are indistinguishable, it were better to deny that they exist. It would seem to me more reasonable, however, to hold that the causes of this peculiar relief are the same wherever it appears, they being spatial differences in the two visual images, and perhaps, to some extent, differences in the orbital sensations when different parts of these images are superimposed; and that these motives are of themselves directly perceptible when at their best, but in their subtler phases they escape our introspection completely, although still capable of producing an effect which is introspectively apparent. This persistent efficiency, in consciousness, of motives which have become subliminal seems to me the interesting fact which the present experiment illustrates.

We are indebted to The Psychological Review for the above interesting article.

DISTILLED WATER—ITS PREPARATION BY A SIMPLE AUTOMATIC AND INEXPENSIVE APPARATUS, AND ITS PRESERVATION.‡

By H. T. CUMMINGS, M.D.

IN view of the fact that distilled water is an absolute necessity for many pharmaceutical purposes, the writer desires to describe an easily worked, inexpensive and automatic apparatus for producing the substance, and also to consider means for its proper preservation. But first he would consider chemical methods for purifying unsuitable waters and rendering them fit for ordinary purposes when the excessive refinement of distilled water is not necessary.

NATURAL WATERS.

The present edition of the Pharmacopœia defines "aqua" as "natural water in its purest attainable state;" but it goes on to prescribe definite properties which it shall have. It must be a "colorless, limpid liquid, without odor or taste at ordinary temperatures, and remaining odorless while being heated to boiling." And it must be free from metallic impurities, and not possess more than the "limit" of ammonia, soluble salts, sulphates, chlorides, nitrates, and organic or other oxidizable matters, which limits are determined by chemical tests described. If the apothecaries of Maine could turn the Poland or the New Gloucester Shaker Springs into the back rooms of their shops, the pharmacopœial demand would be easily complied with, as these are the sources of the purest water known in Maine, the amount held by them in solution, including organic matter, being somewhat less than four grains to the gallon.

But as springs, wells, rivers, and lakes are generally loaded with substances dissolved or suspended therein, it becomes a problem of no little importance how to purify water taken from these sources with the least trouble and the greatest expedition. "No water in nature is perfectly pure; rain and snow water caught even in perfectly clean vessels contain, especially at the beginning of rain, foreign substances which are present in the atmosphere as dust or vapor. Ammonia, nitrous and nitric acids, chlorine, sulphuric acid, lime, soda, potash, magnesia, and organic matters have been found therein by many observers." And in addition to all this, the natural waters, in percolating through the soil, take up whatever is soluble; besides, where they are exposed to the direct rays of the sun, they develop confervæ, as well as more distinctly phanero-

gamous species of plants. In cisterns where rain water is collected and stored, remarkable growths of confervæ and other microscopic plants are produced, which do not improve the taste or the odor of the water. The purification of such waters often becomes a serious question, even if it is not desired to obtain them chemically pure.

PURIFICATION BY CHEMICAL MEANS.

The purification of foul waters for pharmaceutical or domestic use, or to render them drinkable, is accomplished in various ways. Sometimes simple filtration through powdered silica, sand, charcoal, paper or other media is sufficient. Water may be perfectly clean and devoid of foreign taste, but yet prove deleterious, or even beget fatal diseases, carrying into the human system the germs of typhoid, cholera, diphtheria, or tuberculosis. In such cases neither filtration nor chemical agents seem to have much power for good. The application of a boiling heat alone proves a protection against infection; and this action is earnestly advised where there is the slightest chance of danger. It had best be done, too, immediately upon drawing the water, for it has been found that bacteria increase remarkably in numbers within a few hours. Miguel found, for instance, that certain water at 60° F. contained in a cubic centimeter 48 bacteria; while three hours later, at 69° F., it contained 125; twenty-four hours later, at 70° F., 38,000; and after seventy-two hours, 590,000, notwithstanding which the water was perfectly clear and appeared as good as the purest potable water.

While there is no reason to fear infection, chemicals may be employed with good effect to fix some volatile bodies and to throw down others, and thus withdraw them from solution. One formula which is reasonably effective for this purpose is that of Kletziński, published in the twenty-third volume of the Proceedings of the American Pharmaceutical Association. It is as follows:

Phosphate of aluminum.....	1 part
Phosphate of oxide of iron.....	2 parts
Phosphate of magnesium....	2 parts

dissolved in a sufficient quantity of the phosphoric acid of the Austrian Pharmacopœia (16 per cent. strength). The phosphates must be freshly prepared and the solution filtered. When required as a purifying agent, the solution, which will keep any length of time, is added to the water in small quantities, as long as cloudiness is produced; the water is then allowed to stand until the precipitate has subsided, and the clear water may then be used for drinking or other purposes. The action of the phosphatic liquor is explained thus: The lime salts usually contained in water will abstract the phosphoric acid that holds the phosphates of aluminum, iron, and magnesium in solution, and these salts, being deprived of their solvent, will precipitate along with the phosphate of calcium (lime) formed, carrying with them, either mechanically or in chemical combination, such impurities as may exist in the water. The magnesium absorbs all the free ammonia, the iron combines with the sulphureted hydrogen and other gases of decomposition present, while the aluminum and phosphate of calcium will mechanically drag down suspended impurities. The addition of a slight excess of the precipitant is in no way objectionable.

For the removal of mud from water there are two modes of operating. R. F. Fairthorne, of Philadelphia, has found that water can be clarified expeditiously and well by shaking one gallon with one ounce of phosphate of lime, allowing it to settle, and then after two or three days filtering it through absorbent cotton, pressed tightly into the throat of the funnel. The other method is as follows: Filtering paper is soaked in a mixture of 43 parts of liquor ferri chloridi and 57 parts of water, and then dried; a soda paper is made similarly with a saturated solution of sodium bicarbonate. The water is shaken first with a strip of the iron paper, and then with a strip of the soda paper. The carbonate of iron formed absorbs all impurities. The water is then strained through sponge or absorbent cotton.

F. B. Kilmer, of New Brunswick, N. J., has described a method of purifying water fully as simple as that of Fairthorne, mentioned above, and which in the hands of the present writer has proved very effective, namely, the solution of 1½ ounces Troy of crystallized alum in 32 fluid ounces of water. This solution, used in the proportion of ¾ ounce to half a gallon of foul, ill-smelling, and discolored water from the bottom of a cistern, will render it clear and bright, and fit for general use. If care is used not to employ an excess of the solution, the alum, as Mr. Kilmer says, combining with the organic and mineral impurities of the water, is carried down with them. The resulting water is next to distilled water for purity, and can be obtained in no other way so easily.

Mr. Labor, a pharmacist of Jaligny, has recorded that by collecting, melting, and filtering pure snow he has obtained a supply of "distilled water" perfectly insensible to all the tests for impurity, such as nitrate of silver, perchloride of mercury, soluble salts of baryta, alkaline carbonates, and oxalate of ammonia. Melted ice has repeatedly been recommended for the same purpose, but is looked upon with suspicion or disfavor by both medical men and chemists. It should be observed that pure snow can be obtained with certainty only at the closing portion of a storm, after a heavy fall of snow has swept the atmosphere clear of dust, spores, germs, and animalcules of whatever kind, especially in cities and other places of dense population.

DISTILLED WATER.

The methods detailed above will yield a "natural water" which is sufficiently safe and suitable for ordinary purposes, and which will correspond to the requirements of the Pharmacopœia. But for certain purposes, a water must be had which is absolutely free from all fixed or volatile foreign constituents. Such a water can only be obtained by distilling. Distilled water should be used in the preparation of eye waters and the like; and always, too, in making solutions of "corrosive sublimate, silver nitrate, lead acetate and subacetate, potassium permanganate, iron and zinc sulphates, quinine sulphate, cocaine hydrochlorate, morphine sulphate, hydrochlorate and acetate, and in general terms, all of the alkaloids and their salts."

* Helmholtz: Physiologische Optik, 2d ed., p. 259.
† Hooke, cited by Helmholtz, ibid., p. 256.
‡ Prize paper in the Bulletin of Pharmacy contest.

If a water be used for these purposes which is not entirely free from salts, new chemical compounds are formed, which means either discoloration, precipitation, or undesirable change. For the same reasons, distilled water should be used in making medicated waters and diluted acids. It is explicitly demanded in seventy-nine formulas of the Pharmacopœia.

The absence of stills or retorts in the majority of ordinary pharmacies is a reason for the general ignoring of the requirements of the Pharmacopœia in this regard. Those who have attempted its preparation when they have had any distilling apparatus have found the labor of attending to the condensation of the steam, the filling of the still, and the care of the furnace, varied, perhaps, by the necessity of attending to wordy customers, or compounding a complicated prescription, sufficient on one trial to discourage them from a repetition. Apothecaries have eyed these formulas with a sort of despair, and in a majority of cases have quietly obtained their distilled water (sic?) from the "moss-covered bucket that hung in the well," or from the pump, or from the faucet at the sink in their back room, while physicians have had to content themselves as best they could with supplies from the same sources, or to fall back on the aromatic waters.

AN INEXPENSIVE AND AUTOMATIC DISTILLING APPARATUS.

Now the writer desires to describe an inexpensive, effective, and automatic distilling apparatus, which can be used with little or no trouble by any pharmacist. Procure a square copper boiler of say two or three gallons capacity. Have a half-inch pipe inserted in the median line two inches below the upper edge. This pipe should be three inches long, and bent downward, even vertically. By a rubber tube join this pipe to the inner tube of a ten-inch Liebig condenser (costing 85 cents). With the other end of the inner tube of the condenser connect either a rubber tube or a crook-necked glass tube, which let protrude into a gallon bottle. Here, then, are still, condenser, and receiver. Now through the jacket of the condenser water at ordinary temperature must be kept running in order to condense the steam which passes through the inner tube. For this purpose set at some height above the condenser a pail of ordinary tap water. With a rubber tube siphon this water to the lower end of the condenser, regulating the flow by a pinch-cock. To catch the water as it emerges from the upper end of the condenser, place a pail beneath the outlet pipe. The condenser (supported by a clamp or otherwise) will have to be inclined at such an angle that the condensing water will run in at the lower end and out at the upper without any difficulty. The copper boiler (the still) may be placed on an ordinary stove, or, better and more convenient, on the oil stove in the back room. This apparatus set up will work automatically, the only attention required being to refill the pail of condensing water, as, at rare intervals, it becomes emptied. Distilled water made so easily, so cheaply, and so effectively, the pharmacist has no excuse for not using it whenever necessary.

The receiver bottle should, of course, first be rendered as chemically clean as possible, and the tube which conducts the distilled water into it should be packed at the mouth of the bottle with absorbent cotton, closely enough to exclude floating dust, germs, etc., but not tight enough to create pressure. The first tenth of the distillate should be thrown away, as it contains carbonic acid, ammonia, and other volatile impurities, and the last tenth of the water should not be distilled, lest it pass over with an empyreumatic taste.

If water be used which is not very desirable, it would be well to purify it by one of the methods outlined above, and by boiling it a few minutes before subjecting it to distillation. In placing the water in the still previous to starting distillation, do not fill it more than two-thirds full, leaving room in plenty for the steam.

PRESERVATION OF DISTILLED WATER.

But once having distilled water, we must use means of preserving it from chemical accretions through dust, etc., and from bacterial contamination.

Upon the preservation of distilled water it will be sufficient to quote the remarks made by Dr. Edward R. Squibb in closing a discussion of the subject at one of the sessions of the American Pharmaceutical Association. Dr. Squibb said: "This is a broad subject, and it seems useless to mention a plan I have adopted lately, and have recommended once or twice to others as an excellent means of preserving distilled water. Let a bottle be made chemically clean and be fitted with a good clean cork or rubber stopper. Pierce this stopper with two holes for glass tubing of good size. Let one piece of tubing pass through the stopper so as to reach the bottom of the bottle and project half an inch above the stopper, and tie this end over with a double fold of clean muslin. Let another piece of tubing be bent at a right angle, and having passed one end just through the stopper, tie the other end over with a double fold of clean muslin. Then fill the bottle entirely full of distilled water which may have had the least practicable air contact, and put the stopper as above described in place. When the water is needed from time to time it is poured out through the short bent tube, while the air which enters to replace it is filtered and passes in through the straight tube. In this way, if the water be free from the spores of confervæ, as it usually is when freshly distilled with care, it will remain free, since only strained air can get access to it. When the bottle is not in actual use, the neck and tubes are nicely protected from dust by means of an inverted beaker, whose lip rests on the shoulder of the bottle. Distilled water carefully made and then kept in this way will be preserved for a considerable time. Since I adopted the plan I have had no trouble whatever from confervæ or from any other annoyances."

A new coast survey vessel, to be named the "Pathfinder," is now building in the Crescent Ship Yards at Elizabeth, N. J. It is being fitted out with all modern appliances and is especially designed for service in Alaskan waters. Its length over all will be 196 feet, the capacity 1,000 tons, and the steaming radius 7,000 miles. It is expected that it will be launched in December and start on the cruise for Alaska next spring.

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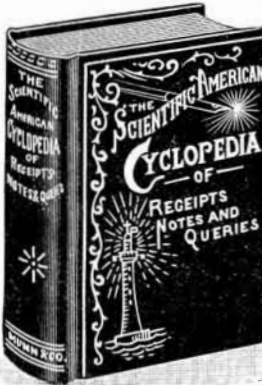
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