fraud as that which takes $4,000,000 per annum from honest citizens to pay for water mixed with milk, should not be tolerated. Yet if the milkmen will put clean pure water in their milk, we suffer no injury except to our pockets. In truth the excess of water is the least disagreeable distinction between the milk delivered at our doors and that enjoyed by the rural swain. The hot jolt over stony roads, exposed to the sun's direct rays, as it wends its way to the station, where it waits a few hours for the night milk train, to say nothing of the trip on the rail, enable it to reach us just before it begins to sour, but in a fit state to undergo that change at once on taking it from the ice box. It has spent from 12 to 18 hours in a can none too clean at the start, and soon begins to reproduce for us the well known odor of a dirty milk can. The empty can is returned unwashed on the following day to the honest farmer, whose industrious wife finds it impossible, by careful scalding and scouring, to make it perfectly clean and sweet before it must start off again, and probably consolos herself with the thought that it is "good enough for New Yorkers." To our minds and palates, the filth and stench introduced into it in other ways, including the food of the cow, etc., are far more objectionable and dangerous than the water about which so much stir is being made just now. There is a simple mode of escape from all these by the practice of a little self-denial, by learning to drink black coffee and clear tea. Or, if this task prove too difficult, three or four condensed milk companies stand ready to furnish us and our babies with a pure article of acknowledged healthfulness.

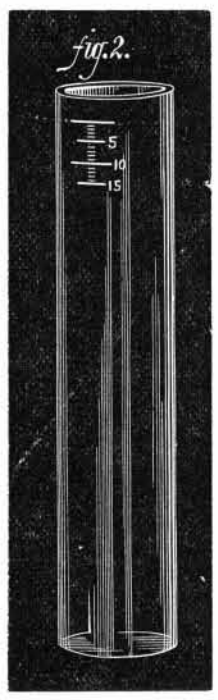
But what are the difficulties in the way of detecting watered milk? Milk is itself a dilute aqueous solution of milk sugar, caseine, and small quantities of mineral salts, and holds in suspension a quantity of fat in a fine state of division. Its composition, when taken from the cow, varies considerably, being richer in the morning than at night, that which is drawn last from the udder, called strippings, being richer than that drawn previously. The same cow yields richer milk when well fed than when poorly fed; and town-fed milk differs from country-fed milk. It is likewise affected by the age of the calf, breed of the cow, etc. The amount of water in unadulterated milk varies from 81·47 to 90·7 per cent, the average according to Letheby being 86·0 per cent. The amount of fat or butter globules varies even more, ranging from 1·79 to 9·88 per cent, both of these figures representing extreme and very uncommon cases. Caseine varies less, from 2·43 to 5·37; sugar, from 3·29 to 6·56; salts, 0·50 to 1·15. Two of the leading English chemists put the average composition of pure milk as follows:

	Letheby.	Wanklyn. Town.	Wanklyn. Country.
Water	86·00	85.94	87·55
Fat	3·90	4·00	3·08
Caseine	4·10	5·02	4·04
Milk sugar	5·20	4·31	4·62
Ash	0·80	0·73	0·71
	100·00	100·00	100·00

It will be evident that, if a complete analysis of a given sample of milk be made, it will tell us neither how much water has been added nor how much cream has been removed. The dairyman must have the benefit of the doubt, and the law should permit him to furnish as poor milk as the poorest cows will give on fair food, and hence he is permitted and encouraged to dilute his best milk down to this standard, no matter what method of testing be employed.

A word about testing milk may not be out of place here. The most satisfactory test is, of course, complete chemical analysis; but unfortunately, the time required precludes its use, except to prove a point already indicated by some more rapid method. If it were possible to erect a huge chemical laboratory at every railroad depot, and employ an army of skilled chemists to analyze a specimen from every can of milk, the time required would be such that most of the milk would sour before it reached the consumers' hands. Beside, it is probably not the farmers but the middlemen who dilute it. The course of analysis is briefly this: A weighed quantity of milk is evaporated to dryness on a water bath, dried at 212°, and weighed; the loss represents the water, and should not exceed 88 per cent. This residue is treated with ether (which dissolves out the fat), is filtered, the filtrate evaporated to dryness, and weighed; the result equals the butter. The total residue, *minus* the butter, is a tolerably constant quantity, and should be about 9 per cent. The caseine in cow's milk (not in breast milk) may be coagulated and determined thus, and the salts are determined by burning off the combustible portion of the solid residue after extracting the butter.

The lactometer, about which we hear so much said, is simply a very delicate hydrometer (Fig. 1), so arranged that it floats in pure water at the zero point of the scale. The depth to which it sinks in milk or other liquid having a specific gravity of 1·029 at 60° Fah. is marked 100°. It is not claimed for this instrument that it is able to do more than show the specific gravity of the liquid. This form of instrument was devised by Dinocourt, and was employed for a long time in Paris and London, where its imperfections and careless use brought severe censure upon it. The difficulty in judging of the quality of milk when we know its density consists in this: Milk contains two different kinds of ingredients, salt and sugar, each of which increases its specific gravity; and butter or cream, which lowers its specific gravity. Hence the apparent paradox that you may lower the specific gravity of the milk by adding either water or cream, and increase its density by removing the cream. Although cream is lighter than milk, it is heavier than water; and hence the addition of cream has much less effect than an equal amount of water; so that although this lactometer does not detect skimmed milk, it does detect the admixture of any considerable amount of water. It was necessary to put the standard of pure milk as low as that of the poorest pure milk to avoid injustice to honest dealers; and for this purpose many hundred samples of pure milk, direct from the cow, were tested, and none being found lower than 1·029, this was taken as the 100° mark for pure milk. Milk that has a greater density may have been skimmed or even slightly watered; if the density is less than that, it is due to one of two things, either water or cream has been added; as no man will add the latter, it is a safe supposition that it is due to the former. Granting the possibility of a farmer or dairyman owning one cow, whose milk is so unusually rich that it falls below 100° on account of cream, he is not likely to send her milk to market or if he does, when mixed, as it must be, with other milk, it will be lifted to the standard at least. So that while the lactometer does not decide the absolute value of the milk, it serves to indicate any considerable amount of dilution; and whether followed up by a complete analysis or not, it will not injure the seller, although affording partial protection to the buyer. The fact that its use by the Board of Health has seriously interfered with the dishonest profits of the milkmen is quite evident from their vigorous efforts to prevent its use. It is not, however, true, as many seem to think, that all milk which stands above 100° is allowed to pass by the sanitary police. Should the milk be wanting in cream, as is easily told by the appearance of the lactometer when it is lifted from the milk, a sample is taken and carefully analyzed to determine the amount of cream removed, a point which, as we have seen, the lactometer does not settle. Several other tests have been suggested for determining the relative value of milk. Each of these is open to one of two objections: they either require delicate balances and skilled fingers, or give very rough approximations. A very simple instrument, which may be used in connection with a lactometer, is known as the creamometer, Fig. 2. It is a straight tube, closed at the bottom and graduated



in hundredths, although the graduation need extend but a little way from the top down. The milk is poured in and allowed to stand and throw up its cream; the volume is then read. Pure milk yields about 10 per cent of cream, but is subject to great variation, so that, while this instrument determines the richness of the milk with some accuracy, and would at once detect skimmed milk, it is unable to decide how much water has been added, because unwatered milk may still be poor in cream, and watered milk throws up its cream more rapidly than pure. John Horsley, F.C.S., modifies this test as follows: One tablespoonful or half an ounce of milk is poured into a tube 11 inches long and ¾ of an inch in diameter, graduated from 10 inches down into hundredths. An equal bulk of ether is next poured in, and the tube closed and shaken for five minutes. An equal measure of alcohol is then added, and again shaken for another five minutes. On placing it upright, the oily matter rises to the surface. Each line of oil corresponds to 4·15 grains of solid butter, and milk with 10 per cent of cream will show two lines of oil, or 8·3 grains for 250 grains of milk.

Sacc's method, which is similar to Horsley's, consists in mixing the milk with an equal volume of alcohol (70° Tr.), and shaking. In good milk the coagulum should occupy the same volume as the milk did. If the coagulum remains suspended in the liquid instead of rising quickly to the surface, it is a proof that water has been added.

Still another method has been devised, depending on the opacity imparted by the butter globules, but space forbids our entering into a minute description of it.

The butter and caseine may best be determined by coagulating the milk with a few drops of acetic acid, boiling, washing the precipitate with water, and finally separating the butter with ether, leaving the caseine pure. On evaporating the ether, the butter extracted by it is left and may also be weighed. No chemist would, of course, attempt to deduce the weight of this coagulum from its bulk, which depends entirely on its compactness, and, although apparently simple, is actually a very fallacious test.

Boussingault has shown (Dingler's *Polytechnisches Journal*, CCV., 65) that the microscope readily distinguishes good milk from skimmed or watered milk; but the microscope, like the balance, is a costly piece of apparatus and reliable only in skilled hands.

TO THE FRIENDS AND PATRONS OF THE SCIENTIFIC AMERICAN.

At no period since the commencement of the publication of this paper—thirty years ago—has its regular weekly circulation been so great as it is at present. This fact is gratifying to us, and not less so, we are sure, to our advertising patrons. Notwithstanding the hard times, scarcity of money, and depression in most kinds of manufacturing business, our old subscribers have never renewed their subscriptions more promptly; and never before have so many new names been enrolled in our subscription books as have come in since the commencement of the new volume. The success of the SCIENTIFIC AMERICAN SUPPLEMENT has exceeded our expectations; and, although but three months old, it has obtained, we believe, a larger circulation than that of any similar publication in this country or Europe, while that of the regular edition of the SCIENTIFIC AMERICAN is undoubtedly greater than the *combined* circulation of all the papers of its kind published both in this country and Europe.

These papers go into most of the manufacturing establishments and machine and workshops of this country, and are on file in the principal libraries and reading rooms in the United States and Europe, thereby affording an unequaled medium for manufacturers of all kinds of machinery, and vendors of any new mechanical articles, new inventions, patents, etc., to advertise their wares. Through no other source can they reach the class of persons most likely to become their patrons.

Every established business firm knows the necessity of advertising; therefore a hint to them is not needed. But upon persons establishing a new business, or having for sale a new article, or wishing to sell a patent, or to find a manufacturer to work it—upon this class we would impress the importance of advertising; and we believe there is no other source from which the advertiser can get as speedy returns as from the columns of the SCIENTIFIC AMERICAN and its SUPPLEMENT.

We do not make these suggestions merely to increase our advertising patronage, but to direct persons how to increase their own business. All who advertise persistently, and through such mediums as have the largest circulation among the class of persons most likely to be interested in the articles offered, advertise judiciously. That the SCIENTIFIC AMERICAN and the SUPPLEMENT go into the manufacturing establishments, and are taken by persons interested in all kinds of engineering and mechanical enterprises, no one will deny; but what the extent of circulation necessary to reach all these classes of persons is, few stop to realize, and none but the publishers and their advertising patrons, we suppose, care much about it. But the latter are interested in this matter; and for their information we would state that 47,500 copies of the SCIENTIFIC AMERICAN and 15,000 of the SCIENTIFIC AMERICAN SUPPLEMENT are printed every week, making a total aggregate on both editions of 62,500 copies of each issue. Of this large edition, in no single week since the 1st of March have we failed to distribute a less quantity than 60,000 copies to our regular subscribers in this country and abroad, through the mails and newsdealers; and we are happy to say that the demand increases each successive week.

We thank our friends and patrons for their liberal encouragement; and we shall strive to render to all classes of them—subscribers, advertisers, and inventors—a full equivalent for their money.

THE FATHER OF WATERS.

Under this head we recently called attention to the remarkable paper of J. B. Eads, C.E., published in the SCIENTIFIC AMERICAN SUPPLEMENT, No. 11, reviewing the labors of the United States Levee Commission, pointing out a number of most serious errors, as he conceives, in the conclusions reached by the Commission. The area of reclamation was given by us at 70,000 square miles, but should have been given at 30,000 square miles. The area of the valley drained by the Mississippi is estimated to contain an aggregate of 1,200,000 square miles, and to be capable of supporting a population of over 300,000,000. In our SUPPLEMENT for the present week (No. 14) Brevet Brigadier General Abbot criticises Engineer Eads' review, giving diagrams of the soundings of the river, showing the accumulation of sediment on the bottom, resulting from increased river volume, with other facts that look difficult of explanation on the theory of Captain Eads. The discussion is one of interest and importance.

Jay Gould Defeated.

About a year ago, the then Commissioner of Patents ordered a patent to issue to T. A. Edison and G. B. Prescott, for quadruplex telegraph instruments, the latter individual being part assignee. Edison sought, by appeal to the Secretary of Interior, Delano, to set aside the Commissioner's decision and prevent Prescott from obtaining his share in the patent, on the pretence that, before selling to Prescott, he had sold the invention to certain other parties, who were known to be in the interest of the notorious Jay Gould. Delano entertained the appeal, held the papers, and refused to decide the case; subsequently he resigned the office. The new Secretary of the Interior, the Honorable Z. Chandler, has recently decided the matter by dismissing the appeal, which he thinks was unauthorized by law; and he sustains the Patent Office in issuing the patent jointly to Messrs. Prescott and Edison,