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SCIENCE IN THE COURTS.

As science has advanced, it has become an important aid in the discovery of crime. The experts, so called, whose examinations, investigations, and opinions are made a part of evidence in important legal cases, are called by the prosecution and defence and make their statements, upon the value of which as evidence the jury must decide. Now it most generally happens that the judge, who is a master of civil and criminal law, knows comparatively little of Nature's laws. The counsel, *pro* and *con*, are generally as unscientific as the judge, and the jury, as a rule, know even less of science than of law. To prevent their making mistakes on law points, it is the duty of the court to instruct the jury as to the law and the rules of evidence; and it is the duty of the jury to accept his instructions as correct in every particular, and, applying the rules of evidence to the testimony before them, to give a verdict in accordance with these rules upon the is ues of facts involved in the case.

Experts, so called, are introduced for the purpose of instructing the jury upon matters upon which neither the court nor jury are supposed to be informed. If the experts, so called, differ in opinions and statements, the jury must judge of the weight to be given to each opinion and testimony, and the evidence of experts, like that of other witnesses, must be taken for what it seems to be worth.

This is, we believe, the rule as concerns such evidence in modern courts of law. It certainly works in a very peculiar manner, and, as applied, does, in our opinion, as often defeat as it helps the administration of justice. Besides, its effect is to throw odium upon science and those who are really scientific, as neither judge, counsel, nor jury are qualified to decide from the evidence given—unless very gross ignorance is exhibited—whether the witnesses are really qualified to testify as to the points upon which they presume to pronounce authoritatively.

To establish the qualifications of the witness as an expert, he is generally asked his age, profession, and experience in the matters upon which he is required to testify. If he swears he has been twenty years a professor of chemistry in some public institution, has practiced medicine a certain length of time, or has been an engineer in some industrial establishment for a stated period, he is thenceforward to the jury, an expert chemist, physician, or engineer, as the case may be; and if he is possessed of the *otium cum dignitate*, coupled with a free use of formulated expressions having the sound of profundity and learning to a juryman's ear, he may swear to any absurdity he likes, and the average arbiter of the jury box will gulp it all down as gospel. To be a professor in an institution of learning, ought to, but does not, always indicate professional acquirements. We all, probably, know some physicians of many years' standing, whom we would not invite to "throw physic to the dogs,' if the dogs were *our* dogs. We have many of us met professed engineers who have hardly the qualifications requisite for a boiler tender. It is not what a man ought to know, but what he does know that renders him competent to give an authoritative opinion.

Wo have plenty of examples of the different, and even conflicting, evidence of this class of witnesses. The testimony taken before the coroners' juries in the celebrated *Westfield* case, is one. Truly, the average juryman must have had a good time in trying to reconcile the legion of theories and opinions ventilated in that memorable investigation.

In Albany, quite recently, one set of physicians swore that in death from abortion, certain *post mortem* appearances must inevitably appear. Another set of medical witnesses swore to just the opposite.

In Philadelphia we have had recently the spectacle of a professed chemist and toxicologist making an examination of the body of a man supposed to be poisoned, and carrying his investigations far enough to convince himself of the presence of antimony, and forgetting there was a jury and a public to be convinced as well, appearing on the witness stand without a particle of proof that he found it, except his bare assertion. The prisoner in this case was acquitted, on the evidence of other experts called for the defence.

In Albany, some twenty years since, a man was hung, for poisoning his wife by aconite, on the evidence of a professed chemist, who swore he obtained aconite by a process that never detected it before and never detected it since, and this, notwithstanding that other chemists swore that the process described would, so far from detecting, absolutely prevent the detection of aconite, were it present.

In a recent trademark suit, relating to the manufacture of mustard, Dr. Ogden Doremus, of this city, swore that mustard seeds contained over eleven per cent of starch. To prove it, he used a solution of iodine upon mustard placed on filtering paper, which paper gave, when tested, the characteristic reaction of iodine with starch when no mustard was present. The error in the experiment was pointed out by Professors Seely and Chandler. Dr. Doremus was aided by Dr. Austin Flint, who tried to confirm by the use of a microscope, what Dr. Doremus tried to prove by the iodine test. Dr. Flint swore that he could see the granules of starch by the use of a high power. Professors Seely and Chandler could not see any such granules, but they did see what they thought might have been fragments of the exterior envelopes of the seeds. Dr. Doremus has, in a letter since published, affirmed the presence of starch in mustard seed (he says nothing of the percentage), and attempted to prove it by a test which would give the same results with cellulose as with starch.

Now, in view of such facts as these, is it any wonder that the public is beginning to mistrust the value of this kind of evidence? Such a mistrust is based upon good grounds enough. As now presented to juries, the testimony of the both competent and incompetent witnesses, only serves to muddle their intellects, and to complicate rather than make plain the facts.

If it be necessary to give juries authoritative instruction on points of law, how can it be less necessary that they should be similarly instructed in matters involving scientific knowledge. To bring before them A, who swears to one thing, and swears to the truth, and then bring B, the charlatan, who looks and talks twice as wisely as A, and denies under oath all that A has asserted, is not to instruct but to mystify them. When Counseller X tells the jury in his address that something is law which is not law, the Court quietly corrects the assertion in his charge, and the correction has the weight of authority. The jury believe the judge and discredit Counsellor X. But when Charlatan B tells them something is science that is not science, the true, yet modest A's assertions are no more authoritative to decide the question than B's. The jury must decide, or rather make a guess, as to what is right or wrong; and the average juryman is rather more likely to guess wrong than right in matters of science.

Now there is a plain, simple, and practical remedy for this state of things. In all cases where there are points of law to be decided, there is an arbiter on the bench to perform that office. There should be an equally authoritative tribunal to decide on scientific points, a separate jury of experts, if may be, constituting, for the time, a scientific court, whose charge to the jury should be as authoritative as that of the judge. Would it not be refreshing to hear such a witness as the one mentioned above, who swore to finding aconite, disposed of in the following fashion "It is my duty, gentlemen of the jury, as foreman of the scientific jury in this case, to instruct you that aconite cannot be detected by the process described in the testimony of the witness. However much he may be convinced that he did so, it is contrary to known laws of chemistry to suppose that he so obtained it. You are, therefore, to dismiss from your minds the possibility of such a result, in your deliberations upon this case." Or perhaps this:

"The process sworn to by A will obtain arsenic from the stomach of a person poisoned by that substance. The process sworn to by B will not obtain it. A says that by his process he found no arsenic. B says he found it in a process by which he could not have found it. It remains for you to judge whether, if by an accurate method arsenic could not be found, the testimony of one who swears he found it by an impossible process proves its presence."

Let such a course be pursued, and we soon should have somewhat less of *pseudo* science on the witness stand, and true scientific testimony would become of real value.

BEET SUGAR IN THE UNITED STATES.

As our readers are aware, we have done our utmost to promote the establishment of this industry, and we may therefore, with all the more reason, rejoice at the encouraging statements of the Commissioner of Agriculture in regard to it, published in his monthly report for January. He regards the future of the industry as now mainly dependent upon the comparative profit of beet sugar and cane sugar manufacturing.

The introduction of this business into this country met with many obstacles, notwithstanding the remission of duties on importations of machinery intended for beet sugar making. Perhaps no branch of chemical manufacturing needs to be conducted with greater nicety; and as in the outset we had to depend upon foreign skill—much of it hardly fit to be called skill—there were many failures, and success has come slowly.

The pioneer experiment at Chatsworth, Ill., failed disastrously; yet at Freeport, in the same State, the lessons of that failure are being turned to such good account that success is confidently anticipated. At Black Hawk, Wis., a coöperative beet sugar manufactory is pushed with great vigor, and gives large promise of good results But the most decided success has been met with in California, where two companies are in full operation, the California Beet Sugar Co. at Alvarado having produced over a million pounds of sugar in the second year of its operation. Success is also reported from the Sacramento Valley Beet Sugar Co. A third company is delayed from the difficulty of obtaining seed.

The percentage of sugar obtained from Silesian Beets raised in California is quite extraordinary. The superintendent of the Sacramento Valley Beet Sugar Co., Mr. S. Ehrenstein, states that an average shows a yield of from 13 to 14 per cent, and exceptional instances occur in which 18 per cent is obtained, a much larger yield than ever was obtained in Europe.

It seems from these facts that *the* sugar producing region of the West is to be California, that land of wonderful resources and unprecedented development. Though the beginnings are comparatively small, there is little doubt that they will prove the foundation of a gigantic interest. The struggles of the pioneers in this field have been severe, but those who have held out will be ultimately rewarded.

DRYING SUBSTANCES BY HOT AIR.

Drying by hot air differs very materially from drying either by confined, saturated, or superheated steam, which convey their heat to metal racks, cylinders, or pipes, the latter radiating their heat and thus reaching by it the material to be desiccated. It also differs in principle from that of drying by superheated steam forced into interstices between solid bodies or injected into solutions. The latter, as we have shown in a previous article, acts by its superfluous heat over that of normal, saturated steam, converting more moisture into steam, and itself passing off as saturated steam.

When hot air is injected into a solution, it parts with its heat slowly; decreasing in volume and taking up a portion of watery vapor, it passes off as warm, saturated air, or air loaded with moisture. The use of air in this way would be practically uneconomical, the application of the heated gas would be very imperfect, and could not compare in convenience even to the injection of superheated steam, to say nothing of that most admirable of modern contrivances for evaporating liquids, the steam jacketed pan.

But hot air blown through the interstices, between bodies wetted upon their surfaces, will dry them very rapidly. The general principles of such drying are as follows:

Air always contains a quantity of watery vapor, which quantity varies with the temperature, the formula expressing this variation being that, with every increase of 27° above 32° Fahr., the capacity of air is doubled.

Thus air at 32° holds suspended one 160th part of its weight of water as vapor; at 59° it holds one 80th part; at 86° it holds one 40th part; and at 113° one 20th part; and so on, the temperatures increasing in an arithmetical series, the common difference of which is 27°, and the quantities of vapor suspended increasing in a geometrical series, the first term of which, taking air at 59°, is one 160th of the weight of the air, and the common ratio of which is 2.

Now the specific heat of air under atmospheric pressure, or any constant pressure, does not practically vary between the limits of —22° and 392° Fahr., as proved by Regnault in his elaborate investigations on this subject. That is, the amount of heat necessary to raise the temperature of one pound of air one degree of the Fahrenheit scale, is the same for all temperatures between these limits, and this law holds good for all non-condensible gases, or gases that cannot be liquefied, by cold or pressure or both combined.

It takes $\frac{2375}{10000}$ of a heat unit to raise a pound of air one degree. To raise one pound of air, from say 59° to 113°, would take 12·825 heat units. At 59°, one pound of air holds one 80th of a pound of water, At 113°, it holds one 20th, hence, by the increment of 12·825 heat units, it has been able to absorb one 20th its weight minus one 80th, = three 80ths. Now if we add to it 25·650 more heat units, we shall raise its temperature 54° more, heating it to 167°, whereupon it will suspend one fifth part of its weight of watery vapor,—an increase of three 20ths of its weight, or just four times as much effect as was produced by a rise of temperature, of an equal number of degrees, from 59° to 113°.

In drying by air, then, it is economy to admit the air at as high temperatures as the substance to be dried will sustain without damage; and as fast as the air has taken up its specific load of moisture, to change it.

It is further evident that the temperature of the air should as far as possible be kept from falling during its passage; since if it does this, a portion of the moisture it first seized upon will be deposited before it escapes, and a portion of the due effect will be lost. It should also be allowed to remain in contact with the substance to be dried till it arrives at the point of saturation, for if ejected before this, a portion of the due effect will also be lost.

We have seen that 51·3 heat units absorbed by one pound of air at 59° raises the air to 167°, and imparts to it the power of absorbing fifteen 80ths of a pound more water than it first possessed. To convert fifteen 80ths of a pound of water at 59° into saturated steam, and thus remove it, requires 209·8 heat units, or more than four times as many as required for the removal of the same amount by heated air.