poles and various weapons, the sport, if it can be called such, lasting the entire night.

As an eating fish it is there preferred to the salmon, and a French gourmand says of it: "For our part we put it far above salmon. Nothing is comparable to the fresh tunny thrown into a hot frying pan, and sprinkled with vinegar and salt. When properly cooked nothing can be more firm or savory. In short, nothing of the kind can rival or even be compared with the tunny as we find it at Marseilles and Cette."

The large tunnies of our coast are by no means such delicacies, though their cousins, the mackerels, when fresh and broiled—not fried—are equally up to the French ideal.

The Viscosity of Liquids, and its Relation to Chemical Constitution.

The time that it takes a liquid to flow through a capillary tube, under certain conditions, will depend on its viscosity. By comparing different liquids under exactly the same experimental conditions, the difference in tenacity, or their *specific viscosity*, can be determined from this difference in time. Richard Pribram and Al. Handl have been able to prove experimentally that there is an undeniable relation existing between the specific viscosity of homologous liquid substances and their chemical constitution, and that these can be expressed by definite rules for certain substitutions. By means of new and very carefully prepared pure substances, they have recently increased the number and value of their experiments. These have been published in two very exhaustive memoirs presented to the Vienna Academy of Science, and with them the conclusions drawn from all their observations. Omitting the special description of the apparatus employed, and the details of the separate experiments given in the original, the *Naturforscher* gives the following summary of their work.

The first question to be answered by farther experimenting was in regard to the action of isomeric esters (or compound ethers), of which Gueront had asserted that they possessed equal fluidity for equal volumes, the statement being based upon a few observations. It was not found to be strictly correct. It is true that the tenacity (or viscosity) for equal volumes of isomeric esters did not vary a great deal; but these variations ought not to be neglected, and it was found that there was a regularity within these variations which was clearly apparent if the esters were grouped together according to their composition.

If those esters were grouped together, in which the isomerism is due to simple interchange of alcohol radical for an acid radical, the table showed that in those cases where a difference could be seen with certainty, an ester containing a higher alcohol radical would possess greater viscosity, while the one containing a higher acid radical would, of course, have less tenacity, or greater fluidity. In general, these differences of specific viscosity for equal volumes increase as the molecular weight of the alcohol radical increases.

Interesting relations were further apparent in comparing isomeric ethers, in which the isomerism is due to a different arrangement of atoms in the alcohol radical or the acid radical. The compounds of this series which were examined showed that esters containing normally constituted radicals, were more viscous than those isomeric with them, and this was equally the case whether the isomerism was in the alcohol or in the acid radical.

Experiments were then made to ascertain whether similar relations to those last mentioned also existed in the other series. Among the haloid compounds of alcohol radicals, the butylic compounds acted the same in this respect as the esters. With propylic compounds, however, the difference in tenacity for equal *volumes* was very small, while for equal *quantities* the differences were larger; but in an opposite direction, the normal compounds having the smaller viscocity.

The aldehydes, like the ethers, showed greater fluidity in the normal compounds. The isomeric alcohols showed no regularity in the few examples examined, which belong here. A few nitro-derivatives of the fatty series, that can be introduced here, exhibited as little regularity.

"Now, if we take a general survey of the relation of normally constituted substances to the isomeric ones in the different groups, it will be seen that in the majority of cases the normal compounds have the greater viscocity. This rule applies to all the esters, the aldehydes, propylic alcohol (at 50° C.), nitropropane, butyric acid, and butylic iodide; on the contrary, the propylic haloids, butylic alcohol, and nitrobutane, all deviate from the rule."

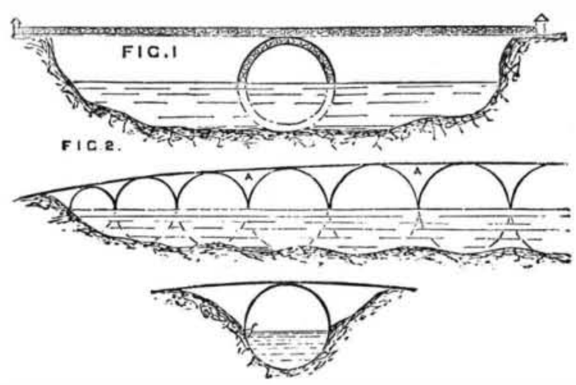
The relation which Brühl has very recently described as existing between the specific refractory power, and the presence or absence of numerous conditions of the atom in the molecule, gave them occasion for observing the specific viscocity in this direction. It was found that when an alcohol passed into an aldehyde or ketone, the fluidity increased. This is considerably greater when two hydrogen atoms go out, and there is a double bond formed between a carbon and an oxygen, than in those cases where the loss of hydrogen is compensated for by a double bond between two atoms of the same kind. This decrease of viscocity, when an alcohol goes into an aldehyde or ketone, is always the same per cent of the whole, whether calculated to volume or to quantity (weight). With increasing molecular weights, however, the absolute difference between homologous alcohols and their corresponding aldehydes or ketones is always greater.

The observations that have been made by this grouping may be embodied in the following general statement: "In homologous series, the increase of viscosity is in general proportional to the increase of molecular weight. The coefficient of increase, however, depends upon the structure of the molecule, and is constant only in those cases where the members of the homologous series, considered as binary compounds, contain one member that is fixed, and the other variable. In the series of halogen derivatives of normally constituted hydrocarbons, the form of the molecule has less influence than the weight of the molecule; with so-called isomeric compounds it is distinctly noticeable."

What was previously ascertained concerning acids was merely confirmed. An exhaustive discussion of the observations made on alcohols, and a comparison with the older results of Rellstab, lead to a surprising result, namely, that the two curves (of tenacity and molecular weight) run parallel only when the two butylic alcohols change places, the isobutylic alcohol being put in the normal series, and the normal alcohol transferred to the isomeric series of alcohols. Finally, the nitro-compounds confirm the law that the viscocity increases nearly in proportion to the increase of molecular weight.

NEW FORM OF BRIDGE SUPPORTS.

The accompanying diagram illustrates designs by Mr. J. F. Smith, Leicester, England. He proposes, says the *Engineer*, that bridges shall consist of iron or steel cylinders of any reasonable diameter, made up with plates riveted to rolled iron or steel ribs, the strength necessary to carry any weight required; they are generally of a circular section, and the lower half of the cylinder, or inverted portion of the arch, supports the upper half, and has a continuous bearing on the ground or bed of the river its whole length; the larger the cylinders the more stable the bridge. These bridges, or cylinders, may be riveted up in dry dock, a portion of the ends covered with movable plates, floated into position and sunk; the only trouble in foundations being in



cases where the bed of the river is rocky and uneven, then it is necessary to level or groove the bottom with "jumpers" from a platform over the line of intended cylinder. For small water-courses under turnpike and other roads, Mr. Smith says these bridges may be riveted up on the spot, rolled in, covered over, and the bridge is made as in Fig. 3, without any piling, diverting watercourse, building foundations and arches, or other trouble and expense usual in the old style of building bridges.

Where railroads are to be formed over frequently flooded or boggy land, a number of these cylinders laid side by side —as in Fig. 2—will, it is claimed, save railway companies the enormous cost of foundations. The cylinders having a continuous bearing the whole width of the railway cannot possibly sink very much, and the rail level would be made good on the top in case of any subsidence.

Light and Color.

BY ALFRED DANIELL, M.A., B.SC.

Light is a form of wave-motion in the all-pervading ether; and it scarcely needs, nor does space allow, a lengthened discussion of the varieties of converging proofs which aid one another in forcing us to this conclusion. If we throw a couple of stones on the surface of water, we find a couple of systems of rings produced, which at their points of crossing present the appearance of engine-turning. Where the crest of one coincides with the crest of the other, there is double upheaval; where the trough of one coincides with the trough of the other, there is double depression. Where, however, the crest of one coincides with the trough of the other, what do we find? Neutralization of effects—no effect, no motion; for the instant a state of rest. This is exactly what happens when two beams of light coming, or appearing to come from two points exceedingly near to one another, are allowed to shine upon the same spot. The phenomena of interference of light are phenomena in which light added to light produces darkness in some places, and extra brightness in others—darkness when the same spot is affected by waves which are in opposite places, and increased brilliancy when the waves are in accord with one another. This is a matter capable of easy explanation when the phenomena of light are considered as due to wave-motion; but under the old corpuscular material theory of light it was very difficult to explain, as indeed it was to understand or believe the explanation offered.

The phenomena of color are again due to waves of different lengths. Each color and shade of color, provided that it is in the spectrum, is due to a special wave-length. The waves of light which produce in our eyes the impression of deep red have a length of about the 37,640th part of an inch; and since the ripples of 192,000 miles of space break upon the eye in a second, we learn that during each second we spend in contemplating the planet Mars, or any red star, the prodigious number of 458,000,000,000,000 break upon the eye; and if the red object we look at be terrestrial, it must be in a state of continued vibration, which enables it during each second to start this enormous number of waves traveling through the ether and striking the eye. The other extreme in color is produced by certain violet rays, which have a wave-length of the 60,000th part of an inch, and of which more than 700,000,000,000,000 strike the eye during every second. But there are still more rapid vibrations, propagated by the ether, to which our eyes are not sensitive, but to which our photographic plates do respond; and there are vibrations, slower than those of the extreme red, to which our eyes are not specially sensitive, but which our skin and general bodily organisms perceive as heat rays. The slower waves are thus the cause of radiant heat, the more rapid ones cause the sensation of light, and the most rapid produce the chemical effects upon which photography depends. Yet there is no broad line of demarkation between these departments of energy-bearing waves. The red rays are felt to be warm by the hand, and seen by the eye to be red; the violent rays are seen by the eye to be violet, and are also found to be active in relation to photographic plates. What lies beyond these we do not know. There is no probable reason, in the nature of things, for such a limitation of vibrations in the ether to one or two octaves; but whether there be or be not any radiations through space which are slower or more rapid than those with which we are acquainted as heat waves, light-waves, or actinic waves, it remains that we do not know anything about them, for we have no senses which perceive them, and we have as yet discovered no instrumental means for their detection. Yet we suspect their existence. Many of the vibrations of luminous bodies are connected with one another in the same way as the harmonics of a low musical note are related; and thus we may, without any material call upon our imagination, suppose ourselves to be in relation to the vibrations of light in much the same position as we can easily suppose a grasshopper to be on listening to the boom of a church organ. The grasshopper can hear sounds which are beyond our hearing, sounds high and keen edged, sounds like those which he himself makes: but it is probable that we in our turn can hear low tones which the grasshopper cannot hear, and that on listening to a full-chorded combination of sounds, the insect would be deaf to the lower notes, and would hear simply a crowd of harmonics, which would seem at first to bear no relation to one another. In the same way, we can suppose ourselves to be blind and devoid of sensation in respect of those long fundamental waves in the ether, of which these light rays and heat rays are some of the harmonics. Too much stress must not be laid on this, however, because our knowledge (though growing) is not yet very great in this regard; and there is not much evidence that there is any material loss of recognizable or perceptible energy in the shape of unrecognizable or imperceptible radiations.

Color in the theory of light resembles pitch in the theory of sound. Both depend upon the length of wave which strikes upon the appropriate organ of sense after traveling through the appropriate medium. Yet though they depend upon the length of wave, the length of wave does not explain the sensations of color or pitch. The theory of light and that of sound are both, in the most rigid sense, sciences of calculation, of applied mathematics, mechanical sciences. They have nothing to do with the emotional effect of the harmony of colors or of sound; or with the relation between beauty of color or of sound, and the admiration which this calls forth from a sensitive mind. They have to deal with vibrations alone, and a transversal vibration in the ether, having a wave-length of the 51,110th of an inch, and falling on the retina of the eye, may or may not rouse the enthusiasm of the mind which is behind the eye that perceives the blue of heaven; but physical science, concerning itself with the vibration as such, and as such only, stops short where physiology and psychology take up the burden of discovery and of explanation.

White light, such as that which comes to us from the sun, is composed of almost all the vibrations within the limits of visibility, simultaneously traveling through space, and simultaneously striking our eyes. When a ray of bright white light strikes the eye, we have no sense of any special color in the mixture, and this is the sensation of white light; the mixed sensation of all colors, of which none preponderates, is the sensation of uncolored or white light. If an orchestra sounded forth every imaginable note within the compass of our hearing, the blinding flare would not produce in our ears the effect of any particular pitch; the result would simply be an indescribable Wagneresque ocean of pitchless sound. So it is, and as wonderful, but that we are more accustomed to it, every time we behold white light; and our object when we endeavor to procure what we call pure white light is to procure light which is due to all possible vibrations, of which no one preponderates over the other so as to impress the aggregate result with its own colored individuality.—*Journal of Gas Lighting.*

The American Association.

The annual meeting of the American Association for the Advancement of Science will take place at Montreal (not Buffalo as stated in our last), on Wednesday, Aug. 23, 1882.