that above 860° the sulfur molecule consists of two atoms, S_2. More recently by boiling point and freezing point methods the molecule of sulfur in solution has been found to contain eight atoms, S_8, and it has been inferred that the same molecule exists in sulfur vapor just above its boiling point. In the *Berichte* of the German Chemical Society, Biltz goes over the whole ground, especially examining the density of the vapor under diminished pressure at the boiling point. The greatest density he could obtain corresponded to the molecule S_7, but this was not found to be a constant point. The conclusion he draws is that two molecules only of sulfur exist, one S_8 and the other S_2, and that at the boiling point the molecule with eight atoms begins to decompose into molecules of two atoms. This decomposition is progressive, until at 850° it is complete, the gas at this temperature consisting wholly of the molecules S_2.

A PATENT has recently been taken out by the Clayton Aniline Company, limited, of Manchester, for the continuous concentration of sulfuric acid, which involves the use of cast-iron vessels in the place of platinum. The dilute acid is allowed to flow in a continuous stream on to the surface of a large mass of hot concentrated acid contained in a large cast-iron pan. The concentrated acid must be of a strength not less than ninety to ninety-three per cent. From the bottom of the pan the concentrated acid is drawn off at such a rate as to keep the level of the acid in the pan constant. The great advantages claimed for the process are the simplicity and the cheapness of the plant, and it has already been shown that for most uses the acid concentrated in iron pans is satisfactory.

ABOUT a year ago an article appeared in the *Comptes Rendus* by Gautier, in which the position was taken that arsenic in minute quantities is a normal constituent of the human body. By a new and very delicate method the author found and determined quantitatively arsenic in numerous organs of the body, notably in the pancreas, brain, thymus gland and skin. Since, after digestion of the pancreas with pepsin, the arsenic remained in the nuclein residue, the existence of an arsenic-nuclein was assumed. In the last number of the *Zeitschrift für Physiologische Chemie* there is a paper by Hödlmoser, combating Gautier in every point. In eighteen cases the pancreas and liver were examined by Gautier's method, and in fifteen other cases the same organs were examined by a method, pronounced by the author even more delicate, and in no case was any trace of arsenic found. Numerous other experiments were carried out, carefully following the work of Gautier, but always with negative results. No explanation is offered of the great discrepancy between the author's results and those of Gautier, but one is promised.

THE subject of the toxic action of boric acid is brought up anew by a description in the *Therapeutic Gazette*, by Dr. J. F. Rinehart, of two cases, occurring in his practice, of poisoning by boric acid. Each was after the administration of the acid in five-grain doses every four hours. The symptoms of poisoning appeared after several days and consisted chiefly of an erythematous eruption over the body, accompanied by extreme weakness. The patients recovered slowly on ceasing to administer the drug. The conclusion drawn by Dr. Rinehart is that "any use of boric acid as a preservative of foods should be prohibited by law, as the poisonous effect of any quantity sufficient to preserve food would appear to be proven." This conclusion would, however, seem to be somewhat overdrawn, as it is hardly probable that any such quantities of the acid as were administered in the above cases would ever be ingested from foods in which it was used as a preservative. The chief danger to be apprehended from the indiscriminate use of boric acid in foods, as was recently noticed in this column, is in the case of young children, where they are fed on milk preserved by borax. Here danger may well be apprehended. In any case food preserved by boric acid should be distinctly so labeled.

J. L. H.

CURRENT NOTES ON PHYSIOGRAPHY.

THE RIVER SYSTEM OF CONNECTICUT.

THE discovery of numerous parallel faults arranged in several systems in the small Triassic area of the Pomperaug valley in western Connecticut, and the coincidence of many streams with lines parallel to one or another of these fault systems has led Hobbs to infer a very general dependence of stream courses on fault lines or on faulted troughs ('The River System of Connecticut,' *Journ. Geol.*, IX., 1901, 469–485). He notes that the modern school of physiographers attach 'little importance to geological structure planes as a factor in determining the position and the orientation of water courses'; and if it is joint and fault planes that are meant by 'structure planes' this comment is probably deserved as far as explicit mention of such controls is concerned. Nevertheless, the value of faulting in initiating surface inequalities, and hence in determining the course of consequent streams at the time of faulting, as well as in producing planes of structural weakness, and hence in determining the later development of subsequent streams, has not been altogether overlooked. But it is under the interaction of many controls that modern physiography finds explanation for river courses, and it is the want of consideration of other controls than faults that leaves Hobbs' paper unconvincing.

The author extends the systems of fault lines from the small Pomperaug basin all over Connecticut, preserving them rigidly straight and parallel throughout. He then compares these lines with the stream courses as shown on the topographic map of the State, and where a fair coincidence is found he concludes that there is a relation of cause and effect, thus explaining 'the definite orientation of water courses.' There are serious difficulties in the way of accepting this conclusion.

It is inherently improbable that the Pomperaug fault lines possess an extension all over the State in systems so rigid as are here postulated. Some one of the infinite varieties of curvature is much more probable than the highly specialized case of straight paths. Strict parallelism is also improbable as compared to the many possible patterns of more or less distinct divergence. The possibility of accidental coincidence between eight systems of lines, seven of which run between S. 48° W. and S. 44° E., and the river courses of a region whose slope is southerly and whose structural features (independent of faults) frequently have a similar trend, is not given sufficient consideration. Moreover, the branchwork pattern of the Connecticut valleys has little resemblance to the network pattern of valleys that have been worn along ancient fault lines in a well-faulted area: the Stockholm district of Sweden, for example. This typical district shows a most characteristic oblique reticulation in the arrangement of its valleys, such as would be expected in a maturely dissected upland, obliquely criss-crossed by many fault lines; and it has numerous isolated lozenge-shaped uplands occupying the meshes in the network of fault-line depressions. In Connecticut the valleys have not a reticulated pattern, and the uplands as a rule are not lozenge-shaped, but give forth spurs between ramifying valleys. Well defined as is the fault-line network in the Stockholm district, its lines are neither straight nor in groups of parallels; they exhibit just such irregularities of curvature and divergence as might be expected in a geological instead of in a geometrical design.

While faulted troughs (*Graben*) might have guided many Connecticut streams for a time after the Triassic deformation, it is highly improbable that such courses could persist during the deep denudation that the region as a whole has since suffered, in the course of which many streams would presumably desert their original courses in the process of adjustment to new-found structures. While the brecciated belts of fault planes might during the denudation of the region frequently gain the patronage of subsequent streams, all other belts of weak structures would be active competitors for such patronage; yet no account is taken of such competition, although it must have been common. The northward course of the Farmington, for example, follows the weak beds of the lower Trias, and is oblique to the known faults of its district. Many of the existing streams in the lowlands have courses consequent upon the form of the glacial drift; such is the case with the Quinnipiac below Meriden; and if some of these streams have now cut down here and there to bed rock, it is only by the chance of superposition that the rock is found, as in the Connecticut above Hartford. The possibility that the lower courses of the Connecticut and Housatonic have gained their southeast trends by superposition from a now vanished cover of Cretaceous strata is rejected because fault planes 'would, in the opinion of the writer, afford the simpler explanation.' But while simplicity is a strong recommendation in artificial mechanism, it cannot be logically employed as a means of choice between two theories of river development; if that were so, no rival could be found for the Gordian method of locating the Susquehanna and other Appalachian rivers by antecedence. Fault breccias, where they occur, may certainly exert much influence on the development of river courses in Connecticut; but until their occurrence in the central and eastern part of the State is proved by something more trustworthy than the graphic extension of systematic lines from the western part, this explanation of stream orientation may be regarded as standing in an interrogative rather than in a demonstrative attitude.

LAKE WINNIPEG.

Lake Winnipeg, 260 miles long, with an area of nearly 10,000 square miles or a little less than that of Lake Erie, is a member of the series of lakes that occupies an inner lowland of the ancient coastal plain, marginal to the great Laurentian highland of eastern Canada. Reports by Dowling and Tyrrell give a number of physiographic details concerning the Winnipeg basin ('Report on the Geology of the West Shores and Islands of Lake Winnipeg,' Geol. Surv. Canada, XI., 1901, F. 'Report on the east shore of Lake Winnipeg. . . .' Ibid, G.). The lake is 710 feet above sea level, with a general depth of from 40 to 60 feet. Its eastern border is relatively straight, although minutely irregular in the smaller view. The rock floor here is of Archean gneisses and granites, with a few schists, all reduced to a surface of small relief, over which post-glacial lacustrine clays have been spread to an altitude of 150 feet over the lake. The clay plain is forested, but if cleared and drained it may become 'rich agricultural land.' Further eastward, the generally even but minutely rugged Archean rises above the clays, first in isolated knobs, then in larger patches, finally occupying all the surface; it is severely glaciated, bearing little drift, but with many small lakes in its hollows. The east shore of the lake is frequently bordered by low clay cliffs; but rocks appear in low points and islands, beyond which there are many shoals. The west shore of the lake is very irregular, a frayed outline of Cambro-Silurian strata; cross-bedded standstones below, and even-bedded limestones (Trenton) above. These rocks frequently form bluffs, back from which the country is generally level, but rising slightly further westward. Over this upland is a mantle of boulder clay, showing faint lines of stratification as if deposited in a body of water. The boulder clay frequently assumes the form of drumlins, and many of these are noted along the lake shore and on islands, where they are cut back into cliffs, while curved beaches are strung along between them, as on the southeastern coast of Lake Ontario.

The outline of the western shore strongly suggests an effective glacial erosion, by which the Trenton border has been shaped, somewhat as has been described by Chamberlin for similar outcrops in southern Wisconsin. The similarity of Winnipeg and its fellows to Onega and Ladoga of northern Russia has often been remarked, and seems to be increased as new details are gathered.

A PIEDMONT LAKE IN BAVARIA.

Würm or Starnberger Lake, 15 miles southwest of Munich, is one of several water-bodies piedmont to the Alps on the upland of southern Bavaria. It has recently been monographed by W. Ule ('Der Würmsee (Starnbergersee) in Oberbayern, eine limnologische Studie.' *Wiss. Veroffentl. Ver. f. Erdkunke, Leipzig*, V., 1901, 211 p., 15 figs., 5 pl., atlas of 8 sheets). The lake has an area of 57.1 sq. kil.; an altitude of 584 met., and a maximum depth of 123 met. It lies in the Deckenschotter, or oldest glacial gravels, occupying part of a valley that was primarily the result of stream erosion between the first and second glacial epochs; but the valley has been much modified by deposits of drift from branches of the Isar glacier during the second and third glacial advances. Glacial erosion is given small value in this distal portion of the glaciated area. A slight deformation, producing a depression along the mountain base, is thought to have had some small share in aiding the formation of a lake basin here as elsewhere along the piedmont belt; but the evidence of this is in chief part borrowed from the district of Lake Zurich, and that evidence has been somewhat discredited, as far as lake-making is concerned, in recent years. A chapter is given to the systematic relations of the lake; the element of time, or stage of development, is given too small a share in the proposed classification. Neither the interglacial valley in the Deckenschotter nor the later glacial advances are described in terms of youth, maturity or old age. Temperature, color, transparence, waves, currents, changes of level, and composition are all duly considered. The monograph as a whole is very clearly written; its chapters are closed with concise summaries, and it has current page headings and an excellent index; advantages that do not always accompany scientific publications.

W. M. DAVIS.

THERMODYNAMICS OF THE GAS-ENGINE.

THE second report of the Gas-Engine Committee of the Institution of Mechanical Engineers of Great Britain was presented on the 18th of October by Professor Burstall, of Birmingham University, and the results of experiments, preparations for which were described in the first report (*Proceedings*, 1898) were given. They involve some important details of a novel character and throw some light upon previously obscure points in the theory of that now important prime mover.

Illuminating gas was employed having a mean heating value of about 4.8 calories per liter. A new form of igniting apparatus permitted the ignition of even very weak charges with completeness and certainty, the current being obtained from four cells of the storage battery, with a low voltage and a comparatively heavy current, insuring a 'short and thick' spark.

Varying compression was adopted to determine the effect of such variation upon the efficiency of the motor, and, with each compression, varying mixtures of air and gas, changing about one per cent. at each new series of tests, supplied data for ascertaining the relative values of these mixtures.

For the first time, so far as the writer is aware, the theory of the gas-engine as here applied was constructed with the assumption of a variation of specific heats with temperature, following MM. Mallard and Le Chatelier. The following are Professor Burstall's formulas:

$$K_v = a + sT; \qquad K_p = b + sT;$$

$$K_p - K_v = \text{const.} = b - a = R.$$

$$H_v = (w_1 + w_2)\int_{T_1}^{T_2} (a + sT)\,\delta T;$$

$$= (w_1 + w_2)\,[a(T_2 - T_1) + s/2\cdot(T_2^2 - T_1^2)].$$

$$H_p = (w_1 + w_2)\int_{T_2}^{T_3} (b + sT)\,\delta T;$$

$$= (w_1 + w_2)\,[b\,(T_3 - T_2) + s/2\cdot(T_3^2 - T_2^2)];$$

where H_v and H_p are the quantities of heat added during the periods of constant volume and constant pressure, respectively; w_1 and w_2 are the weight of air and gas, and the weight of residual products from the previous stroke in the clearance spaces.

The equation of the adiabatic also differs from that for constant values of specific heats, thus:

$$\delta q = K_v\left(\frac{dT}{dp}\right)\delta p + K_p\left(\frac{dT}{dv}\right)\delta v;$$

$$dT/dp = v/R;\ dT/dv = p/R;$$

$$\delta q = K_v v/R\cdot\delta p + K_p p/R\cdot\delta v = 0.$$

$$(a + sT)vdp + (b + sT)pdv = 0.$$

$$(b - a)\log_e v + a\log_e(pv) + spv/R = \text{const.}$$

$$p^a v^b e^{s}\frac{pv}{R} = \text{constant.}$$

The correspondence of the actual expansion lines of the indicator diagram with the adiabatic for variable specific heats was found much closer than for the usual assumption of constant values with varying temperatures. In the computations of the heat-balance the usual method would give results about fifteen per cent. lower than with variable specific heats.

The entropy equation becomes, in the latter case,

$$\phi = a\log_e\frac{T}{T_0} + R\log_e\frac{V}{V_0} + S(T - T_0);$$

where V and V_0 are the volumes at temperatures T and T_0, respectively.