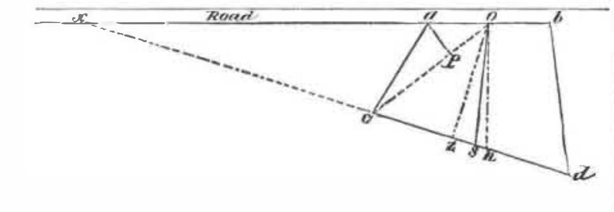
Correspondence.

Working Surveyor's Problems.

To the Editor of the Scientific American:

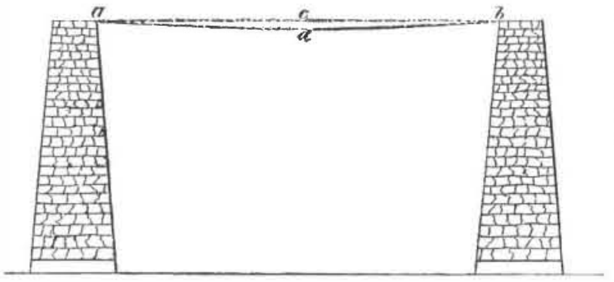
Being recently called to survey a field, the problem was to bisect a quadrilateral from a point given on one side. Robinson solves this by prolonging the sides *a b* and *c d* to their intersection at *x*, thence by similar triangles. Loomis and Davis give a "cut and try" method, as in the figure, set a trial stake at *n*, compute *c a o n*, then add or subtract by triangle. The first method goes outside the figure, and for proof by literal measurement would carry the chain over too many fields to the point *x*. To guess at a point, as by trial stake at *n*, necessitates a long computation. The method given is very simple, and would suggest itself to many minds, and yet I have not seen it published. It is a positive method without a trial stake, and does not lead outside the figure.

The circumstances were: Two men had purchased twenty acres in partnership; on dissolution, the land was divided, leaving each an equal front on the road. In *a b d c* sides, and angles at *c a b d* given, to draw a line to *c d*,



from the point *o*, bisecting the figure. Draw and compute *c o* and *a P*, let fall from *a*, perpendicular on *c o*; then compute *c a o*, and subtract it from ten acres, leaving area of *c o s*. Draw and compute *o z*, let fall from *o*, perpendicular on *c s*, then area of *c o s* divided by one-half *o z* gives *c s* and the point *s*. Join *o s*, and it will be the line which bisects *a b d c* from the point *o*.

Being called to measure accurately an air line across a chasm of 126 feet for an iron bridge, and being without a steel tape the first day, I placed two new steel squares end to end along a wooden rod for sixteen feet with a microscope, and with this measured a steel wire laid and stretched straight on a level surface of boards, then stretching the wire across from *a* to *b*. I was at a loss to know how much to allow for the shortening of the wire caused by the sagging at *d*. Returning to the level surface, I stretched and measured the wire again, marking the position of the ends on the surface. Then releasing one end and allowing the wire to hang slack, I stretched it unsupported along its course at the side of the board surface, and found that when taut, and



with a depression of two inches at the middle, the shortening was less than one-quarter of an inch for the entire length. Equal tension in stretching was tested by the pitch of the taut wire. On obtaining a 100 foot steel tape immediately by express, the steel squares and pole had given a result with a total error of less than one inch for the entire length.

On accepting the work I had asked and obtained permission for a possible error of two inches until I should obtain more accurate instruments.

I would like to hear from others on these or other similar problems. What is the method used in obtaining air line distances, as at the piers of the cantilever bridge at Niagara, and with what result?

E. D. VANCE.

Kinsman, Ohio, May, 1884.

Summer Diet.

Two good rules in diet, good in summer or winter, and at all times—apparently trite, because so often repeated, but still alive and useful while men live and have stomachs—may be thus stated: Rule first is, as the *Ledger* has often repeated, "The rule of not *too much.*" In the languor of summer one is tempted to the use of stimulants more or less hurtful, but all to be included under the general term of "irritants." These create a factitious appetite, which demands an oversupply of food, and leaves the eater no better off, so far as comfort is considered, than he was before eating. If you don't wish to eat, take care to eat but little, and that of the most digestible food, till the desire comes naturally. Just take enough to support nature, and good digestion will provide an appetite for the coming meal times.

Rule second is, the rule of not too *mixed.* Everybody has smiled at the story of the innocent young person to whom a seltzer powder was prescribed, and who dissolved the separate components in separate glasses and swallowed first one and then the other. Astonishment and rebellion arose in his stomach at the entrance of two such uncongenial visitors. The truth is, however, that this experiment is very often unconsciously repeated in still more unpleasant and even dangerous form. People swallow, without thinking, and often without knowing, incompatible and warring articles of food or of refreshment at the same meal, and thus turn their stomachs into chemical laboratories or fermenting tanks. Such experiments are sure to make disturbance and various internal commotions, disagreeable and perilous in their very nature. It should need no chemical analysis to tell us this; experience should be enough.—*Phil Ledger.*

Boiler Efficiency.

When leading men speak of the steam engine wasting nine-tenths of the heat energy supplied to it, they should guard against misconception by admitting from the first that a steam engine cannot be said to waste that heat which it must give up in consequence not of its own defects, but in consequence of inherent defects in steam considered as a gas. Again, it is necessary to be more exact when dealing with this question as far as it relates to the boiler as a heat engine. The examples wherewithal to point a diatribe on the performances of a well tried apparatus should be from its best work and not from a general average, which includes the very bad performance of the indifferently constructed examples of that apparatus. For instance, it is not true that at the very outset of our operations toward the use of heat in a steam engine we throw away twice as much heat as we succeed in utilizing in the steam engine. There are what we call losses which are as inevitable as is the loss of energy due to the necessity for using, say, a lever or a wheelbarrow which has weight, because one without it does not exist, and a steam engine or a boiler works under these abstract disadvantages; they cannot be called practical disadvantages; because the practice cannot be realized under other conditions; nor theoretical disadvantages, because real theory takes into consideration all practical conditions.

We may see what a moderately good boiler does with a pound of coal. The heat of combustion of 1 pound of pure carbon burned to carbonic acid is 14.544 units, and will require for its combustion 2·666 pounds of oxygen. As we are not dealing with calorimeter experiments, we will assume that the oxygen is obtained from atmospheric air. Of this 12·2 pounds will provide the oxygen required. We shall then have 12·2+1=13·2 pounds of gases heated by the 14,544 units, and shall therefore have as the highest possible temperature with air at 60 deg., and having a specific heat of

$$0\cdot238, \text{ of } T=(460+60)+\frac{14{,}544}{13\cdot2\times0\cdot238}=5150 \text{ deg.}$$

Now, if we assume that the heat of the escaping gases could be so far utilized as to fall to that of the feed water, or say 100 deg. or 560 absolute, we should then have as the greatest possible proportion of available heat, or heat which could under the most favorable and hitherto impracticable conditions be realized, only

$$\frac{5150-560}{5150}=0\cdot891;$$

that is to say, with an absolutely perfect boiler, burning pure carbon for carbonic acid, with air at 60 deg. Fah., and only enough to provide the oxygen necessary for chemical combination, there must be a loss of 11 per cent. But this is not waste. Now to follow this up, to see how far a good steam boiler deserves the character for wastefulness which it is so common to ascribe to it, we must take more numerical values. We must make out the worst case for the boiler, and so must credit the fuel with all it possesses in the form of heat. We have supposed the air to be at 60 deg. Fah., and must take the same temperature for the 1 pound of carbon, or an absolute temperature of 520 deg. The specific heat of carbon being 0·25, it must be credited with $1\times0\cdot25\times520=130$ units; the air must be credited with $12\cdot2\times0\cdot238\times520=1{,}485$ units, and these quantities with the heat developed in combustion = 16,159 units, from which, however, must be deducted 32 units as the equivalent of the work done in displacing atmospheric air by products of combustion raised from 60 deg. to 100 deg., at which they are supposed to escape, or increased in volume from 149·8 cubic feet to 161·3 cubic feet, which leaves us 16,127 units as the total quantity of heat available. This is sufficient to evaporate 16·69 pounds of water from and at 212 deg., but as the greatest possible quantity of the total heat realizable is 0·891, as above shown, the greatest possible evaporation from and at 212 deg. by 1 pound of carbon, the heat required to evaporate 1 pound of water at this temperature being 966 units, is

$$\frac{16{,}159\times0\cdot891-32}{966}=14\cdot87 \text{ pounds.}$$

Now what do we get, as compared with this, from a good boiler? Following Mr. W. Anderson's excellent lecture, delivered before the Institution of Civil Engineers last December, we may refer to the results obtained in the portable engine trials made under the Royal Agricultural Society, at Cardiff, in 1872, with a portable engine boiler, nominally of 8 horse power. To begin with, the coal used was not, of course, all carbon. It was a smokeless Welsh coal, containing 0·8497 pound of carbon per pound; but it contained 0·0426 pound of hydrogen, and as the heat developed in the combustion of 1 pound of hydrogen is 4·265 times as much as by 1 pound of carbon, we have to take this into our calculation; and inasmuch as the coal also contained 0·035 pound of oxygen in combination with hydrogen, in the form of water, and will abstract its combining equivalent of hydrogen from the fuel, one-eighth of the weight of the hydrogen must be deducted. Thus, as the 14,544 units developed in the combustion of 1 pound of carbon are equivalent to 15·06 pounds of water evaporated at 212 deg., we have, for 1 pound of the above coal, the heat expressed in pounds of water evaporated

$$=15\cdot06\left\{0\cdot8497+4\cdot26\left(0\cdot0426=\frac{0\cdot035}{8}\right)\right\}=15\cdot24$$

pounds of water from and at 212 deg., equivalent to 14,727 units of heat.

The conditions of combustion in the furnace of a steam boiler being so different from those in a calorimeter, the quantity of air used vastly exceeds that used in the laboratory as represented by oxygen; and in the boiler we are now dealing with, 50 per cent more air was admitted than would be necessary to supply theoretically the oxygen required for perfect combustion. This makes 18 pounds—about 24 pounds is more commonly used—of air per pound of coal, and consequently 19 pounds of gases would have to be heated by the 14,727 units available, and hence the maximum temperature obtainable above that of the atmosphere would be

$$\frac{14{,}727}{19\times0\cdot238}=3{,}257 \text{ deg., or } 3{,}777 \text{ absolute.}$$

The temperature of the smoke from this boiler was 849 deg. absolute, and hence the maximum duty of the obtainable heat would be

$$\frac{3{,}777 \text{ deg.}-849 \text{ deg.}}{3{,}749 \text{ deg.}}=0\cdot7752.$$

The specific heat of coal is about the same as that of gases at constant pressure, or as above given, and hence, the temperature of the air being 60 deg., the 18 pounds of air and 1 pound of coal took to the furnace 19 pounds $\times$ $520\times0\cdot238=2{,}350$ units, which, with the heat of combustion = 14,727 units, gives a total of 17,078 units, from which must be deducted 422 units for the heat expended in displacing atmosphere, or 151 cubic feet, which leaves us, as the total available energy of the 1 pound of coal, 16,656 units. The greatest possible quantity of work to be obtained from such a boiler would, then, be

$$\frac{17{,}078\times\left(\frac{3{,}777-849}{3{,}777}\right)-422}{966}=13\cdot27 \text{ pounds of water evapo-}$$

rated from and at 212 deg., or equal to 12,819 units. Now, the boiler actually evaporated 11·83 pounds of water per pound of coal, and hence the efficiency of this boiler was

$$\frac{11\cdot83}{13\cdot27}=0\cdot892,$$

or less than 11 per cent below the greatest possible efficiency under perfect conditions.

The portable engine or locomotive type of steam boiler is thus very far from being the inefficient thing which on incomplete bases of calculation it is often said to be, and there is not after all a great deal of room for that increase in efficiency to which it is sometimes asserted we ought in some way to attain. It may certainly be said that the reproaches referred to by our correspondent are not deserved by good boilers, nor are the results obtainable by their use so very miserable. It may be necessary to remark that we are referring to good and not to cheap and bad boilers.—*The Engineer.*

A Mountain of Alum.

Mr. G. M. Shaw, of this city, has just returned from a month's trip to the Gila River country in the southwestern portion of Socorro County, where he went with Messrs. Brown and Bergen to survey and report on the recent alum discoveries there, which have been located by a company of Socorro citizens.

Mr. Shaw reports almost a solid mountain of alum over a mile square, some of the cliffs of which rise to an elevation of 700 feet above the river bed. Most of the alum is in an impure state and tasting very strongly of sulphuric acid, but of which there seems to be an inexhaustible quantity. Some of the cliffs, however, show immense quantities of almost pure marketable alum. This alum find, Mr. Shaw tells us, is on the Gila River about two miles below the fork of the Little Gila and four miles below the Gila hot springs.

Mr. Shaw reports numerous hot springs in that section, most of them gushing out of the rocks that form the river banks, some of them hot enough to cook in, and most of them too hot to hold the hand in. The main hot springs referred to above are reported to have effected wonderful rheumatic and other cures. The country is abundantly watered and wooded, and is covered with the finest of grass. The Gila is full of trout and other fish. Game, while still moderately plentiful, has been mostly scared away from the region of the hot springs by professional and other hunters, as well as ranchmen, who are beginning to locate in this difficult-to-get-at section of the Gila. At present the only way to get into this section is with pack animals over a precipitous trail of several miles, wagons having to be abandoned in the gorge of the Little Gila on the North Star Road, about two miles from the hot springs and about seven miles from the alum find, going from Socorro or from the Black range. By the way of Silver City and Georgetown wagons are abandoned on "Sapio" Creek, with about eighteen miles of pack animal trail to the hot springs.

Mr. Shaw being an amateur photographer, also, invariably carries his "outfit" along on his surveying trips, combining pleasure with business, and bringing back with him photographs of all objects and scenes of interest that he meets with on the way. He brings back from this trip over sixty photographs of the Gila country, among which are a number of exterior and interior photographs of some interesting cliff-dwellers' ruins he encountered in a cave about four miles west from the hot springs.—*Socorro Bullion.*