THE EFFECT OF HEAT ON THE STRENGTH OF MATERIALS.

The effect of low temperatures on the mechanical properties of iron and steel appears to have received rather more attention than those of high temperatures. On February 10th, 1880, a paper was read by Mr. John James Webster, before the Institution of Civil Engineers, on "Iron and Steel at Low Temperatures," in which, before recounting his own experiences, the author gives a brief account of the work done by previous investigators in the same direction.

The most elaborate and careful experiments of this kind on record are those by Mr. Knut Styffe, Director of the Royal Technological Institute at Stockholm, carried out in 1865, for the information of a Swedish Government committee. The following conclusions were arrived at by Mr. Styffe:—

(1) "That the absolute strength of iron and steel is not diminished by cold, but that even at the lowest temperature which ever occurs in Sweden it is at least as great as at the ordinary temperature (about 60 deg. Fahr.)"

(2) "That at temperatures between 212 deg. and 392 deg. Fahr. the absolute strength of steel is nearly the same as at the ordinary temperature, but in soft iron it is always greater"

(3) "That neither in steel nor in iron is the extensibility less in severe cold than at the ordinary temperature; but that from 266 deg. to 230 deg. Fahr. it is generally diminished, not to any great extent, indeed, in steel, but considerably in iron."

(4) "That the limit of elasticity in both steel and iron lies higher in severe cold; but that at about 284 deg. Fahr. it is lower at least in iron, than at the ordinary temperature."

(5) "That the modulus of elasticity in both steel and iron is increased on reduction of temperature, and diminished on elevation of temperature; but that these variations never exceed 0.05 per cent. for a change of temperature of 1.8 deg. Fahr. and therefore such variations, at least for ordinary purposes, are of no special importance.

Mr. C. P. Sandberg, from whose translation of Mr. Styffe's report the above is quoted, made in 1867 a number of tests of iron rails at various temperatures by means of a falling weight, since he was of opinion that, although Mr. Styffe's conclusions were perfectly correct as regards tensile strength, they might not apply to resistance of iron to impact at low temperatures. Mr. Sandberg convinced himself that "the breaking strain" of iron such as was usually employed for rails, "as tested by sudden blows or shocks, is considerably influenced by cold: such iron exhibiting at 10 deg. Fahr. only from one-third to one-fourth of the strength which it possesses at 84 deg. Fahr." Mr. Webster, however, in the paper to which we have previously referred, gives reasons for doubting the accuracy of Mr. Sandberg's deductions, since the tests at the lower temperature were nearly all made with 21 ft. lengths of rail, while those at the higher temperatures were made with short lengths, the supports in every case being the same distance apart.

We now come to Mr. Webster's own researches in this field. The material tested were wrought-iron, cast-iron, Bessemer steel, best cast steel, and malleable cast-iron. Three series of experiments were directed to ascertain, respectively, the tensile strengths, transverse strengths, and resistance to impact of the material at temperatures of 50 deg. and 5 deg. Fahr. The transverse test were confined to cast-iron. The results of the tensile tests on wrought-iron and steel agree generally with those observed by Mr. Styffe, and show clearly "that severe cold does not affect the tensile strength of the materials, but that it increases the ductility of each of them" to the extent of 1 per cent. in iron and 3 per cent. in steel.

Mr. Webster found, further—(1) "that when bars of cast-iron are submitted to a transverse strain at a low temperature, their strength is diminished about 3 per cent. and their flexibility about 16 per cent."; (2) that "when bars of wrought-iron, malleable cast-iron, steel and ordinary cast-iron are subjected to a force of impact at a temperature of 5 deg. Fahr., the force required to break them and the extent of their flexibility are reduced as follows, viz.:

	Reduction of Force of Impact.	Reduction of Flexibility.
Wrought-iron	About 3 %	About 18%
Steel (best cast-steel)..	" 1 %	" 17%
Malleable cast-iron....	" 4½ %	" 15%
Cast-Iron	" 21 %	not taken.

The Bessemer steel tested by Mr. Webster was of a harder quality than that used in the German experiments which we have described, the former having a breaking strength of about 46 tons per square inch, with an elongation of at most 18.8 per cent. in 6¾ in., while the hardest quality of the latter had an ultimate stretch of about 30.5 tons per square inch, and an elongation of over 26 per cent. in a length of about 8 in. (equivalent to rather more in 6¾ in.)

The experience of railway engineers in Russia, Canada, and other countries where the winter is severe is that the breakages of rails and tires are far more numerous in the cold weather than in summer. On this account a softer class of steel is employed in Russia, and, we believe, in Sweden, for rails, than is usual in more temperate climates.

The evidence extant in relation to this matter leaves no doubt that the capability of wrought-iron or steel to resist impact is reduced by cold. On the other hand, what, for the sake of convenient distinction, may be termed its *static strength*, is not impaired by low temperatures. The former fact is chiefly of importance in connection with railway material, the latter is reassuring as regards the safety of all structures not liable to sudden shocks. There is obviously scope for further scientific investigation, both as to the effect of cold and heat on materials of construction; more especially, it seems to us, would more precise information be welcome on the manner in which the behavior of steel at different temperatures varies according to its quality. We are glad to learn that it is the intention of the German technical societies, named at the outset, to continue the researches, of which we have noticed the first instalment.

It seems extremely probable that some connection will be found to exist between the phenomena to which we have just referred and those observed by M. Osmond, and described in his paper on "The Critical Points of Iron and Steel," read before the Iron and Steel Institute on May 7th, 1890, (see *Industries*, Vol. VIII, page 446.) M. Osmond, it may be remembered, found that at certain temperatures sudden alterations taking place in the physical properties of iron and steel are indicated by changes in the rate of cooling (or heating). That such changes must correspond to modifications in the strength and elasticity of the materials is a very plausible hypothesis, the confirmation of which would add another contribution to the ever accumulating mass of evidence showing the intimate relationship existing between different branches of science, and more especially between physical and chemical science.—*Industries.*

A somewhat novel and at the same time very interesting method of construction is employed in connection with the building being erected on William street near the Brooklyn bridge approach to New York City. It is designed to accommodate manufacturing establishments using power, and is regarded as a decided advance in its line. The structure is to be 14 stories high, each stories to be a loft of 210 feet long and from 50 to 55 feet wide. It fronts 50 feet on William and Rose streets, and will tower nearly 200 feet in the air. In this building the main consideration being strength, both steel and brick are utilized. While the steel skeleton work is somewhat similar to that designated as "Chicago construction," W. Wheeler Smith, the architect, has made use of massive brick walls, so combining them with the interior steel as to give the greatest solidity and utilized both sources of support to the fullest extent. The steel uprights on the outer edges of the building are inclosed at intervals by solid brick piers 8x4 feet in size, while the girders and flooring are so contrived as to receive this masonry support as well as the support of the steel uprights. Another advantage of this combined construction is that no interior brick walls appear, thus giving an open span of 210 feet. It is stated that with the heaviest machinery in motion on every floor at the same time, no tremor will be perceptible, even in the top story. It will be made as nearly fire-proof as possible, only brick, cement and steel being used in the construction. One of the interesting features is the number of windows, which are close together on every floor, so that the facade towards the bridge exhibits a greater surface of glass than brick. The projectors regard this building as making a new era in construction for manufacturing purposes. — *Carpentry and Building.*

MUNICIPAL DEPARTMENT.

THE SMOKE TEST.

At a recent meeting of the Sanitary Association of Scotland, the following question was asked and answered, among a list of questions for sanitary certificates.

Question 6.— Describe the various methods for testing drains, the difficulties to be met with in smoke and other vapor tests, the means necessary to overcome them, the method you would prefer and the reason why.

Answer.—(1.) *Smoke Test.* Smoke generated by waste oil, sulphur, turpentine or other pungent material, and forced up the drain by fanners, steam or water pressure; (2) rockets exploded in the drains; (3) water pressure; (4) paraffin, peppermint and artificial discoloration.

Presuming the difficulties referred to are those in connection with the circumstance, and not the apparatus employed at the test, as might be also inferred from the words used, they may be stated as consisting principally as (*a*) currents of air counteracting that of the smoke; (*b*) density of the atmosphere; (*c*) untrapped drainage allowing the smoke or vapor to escape into adjoining sections of drainage or to the main sewer; (*d*) escapes travelling along outside of pipes and up linings of walls; (*e*) difficulty in getting termination of pipes thoroughly closed; (*f*) tenants using the pipes during the test.

The remedies are: (*a*) close the whole pipes except the one entering on the far side from the machine, and thereafter apply the test from that point; (*b*) there is no remedy for density other than extra pressure, but care must be exercised lest the pressure blows the smoke through the traps; (*c*) open up the drains and block off at the junctions with suitable India rubber bladders; (*d*) cases have been known in which defects were in the basement flats; but the smoke, through travelling in the way described, was found only in the top flat of the building; it is essential, therefore, to strip off coverings where practicable, and generally to be satisfied on this point by inspection; (*e*) clay makes a fairly good plug, but a considerable number of plumbers and others use with success India rubber bladders; (*f*) the only remedy is to warn the occupants that the test is being applied, and not to run water from the sinks, water-closets, etc., during the short time required. In general they are only too willing to comply with such a request if made in a polite manner.

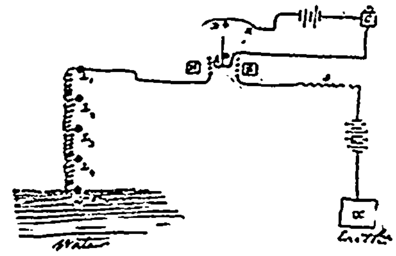
There are a few minor difficulties met with, such as open windows, chimneys, etc., carrying the vapor out of apartments, but these are easily met by an intelligent and experienced operator.

As already stated, the smoke test is to be preferred over any other method. The rocket, paraffin and peppermint are uncertain. The rocket is liable to be extinguished on the exclusion of air, and the paraffin and peppermint are slow. By the smoke both smell and sight are proof of defects, whereas in the two former there is only the smell, which sometimes may be adhering to the operator himself. The water pressure test is suitable in ordinary cases for horizontal drains, and especially those of new construction, but it is not so convenient or handy as the smoke test

AUTOMATIC-ELECTRIC WARNING AGAINST FLOODS.

A valuable device to automatically notify the inhabitants along river banks and low districts of an increase in the water-course of the regions higher up, and to warn in time against inundation has been constructed by Mr. Morais Otto, of Saint Raphael (Var), France. It is thus described in a communication to *La Nature:*

In any public building, say the mayor's office, or a schoolhouse, in each commune, he places a galvanometer so arranged as to indicate automatically at every moment, day and night, the water-level as it exists in the upper district, say at a distance of 30 miles (or more, if necessary) The galvanometer he uses is an ordinary Mariel Duperz with magnet. Referring to the sketch below, the moveable needle, A B, runs around a sector whose divisions correspond to the various heights of the waters. The frame of the galvanometer, represented in section on the sketch, between the two poles of the magnet N, and S, is inclined sufficiently so as to allow a wider play for the movements of the needle. On the glass face of the apparatus is another moveable needle, DE, which may be placed at any division required of the graduated sector. As the level of the the water rises, so soon as the indicator-needle, AB, strikes against the end (bent at a right angle) of the needle DE, so soon does it close the circuit of a local pile which has a bell inserted at C, and this begins to ring. This takes place only in case of extreme dangner. A resistance is arranged at S in the general circuit which is intended to regulate or check the amplitude of the deviations in the galvanometer from the effects of lightning, the inventor has arranged a lightning rod of fusible wire with points.



The next arrangement is one that enables anybody to read constantly the height of the water in a river or torrent situated at a distance from the observer. A hollow iron post is placed upright in the bed of the river or stream; and the line wire ends on an insulator at the top of this post. At intervals of about four inches from the bottom of the post, the latter has small metallic plates, properly insulated, L1, L2, L3, etc., and these are connected by means of bobbins of about 10 ohms resistance, placed inside the post. The top post is connected with the galvanometer, and the circuit then contined through a resistance (*s*), a pile, and the earth (*x*). The best pile he has used for the purpose is one composed of several Daniel elements. Now, let us suppose a thaw to occur; the water rises along the post, thus establishing communication between the small metal plates and the iron of the post which is planted in the earth. At every rise of four inches the resistance of the circuit diminishes 10 ohms on account of the very position of the bobbins of resistance. The intensity of the current is, in consequence, increased, and the needle, AB, of the galvanometer runs forward one degree, which corresponds to