HEAT DILATATION OF METALS FROM LOW TEMPERATURES.

By THOMAS ANDREWS, F.R.S.

IT is understood that the coefficients of heat dilatation increase with rise of temperature; but Professor P. G. Tait, in his recent work on *Heat*, page 87, remarks that "we are not aware of any experiments made with a view of deciding whether, as is probable,

tration), and immersed in a freezing mixture of three parts of calcium chloride and two parts of snow, each of these ingredients, previous to mixing, being maintained in separate jacketed freezing tanks at a temperature of -18°C . The vessel, A, containing the bars and the calcium chloride freezing mixture, was further surrounded by another compartment holding a quantity of a freezing mixture of snow and salt at a temperature of -20°C . By this means and by con-

each case, both longitudinal and transverse, was regarded as fairly accurate.

The dimensions of the bars were taken in a similar manner for the temperature from -18°C , substituting in another cold bath, B, a freezing mixture of snow and salt to obtain this temperature, and using powdered ice and snow for the observations at 0°C . The higher temperature observations were obtained by heating the whole of the bars in a large hot water bath for the period necessary to insure that their temperature throughout was as required, and the oil bath was used for the temperature of 300°C . Liability to temperature errors was, as far as possible, carefully guarded against by constant reference and comparison between the bath thermometers and that in the center of the test bar, and by keeping the bars immersed during sufficiently long periods.

The hammered metals under observation were large forgings of the different metals, 7 feet 3 inches long, and 5 inches in diameter, planed perfectly square at the ends and turned and polished bright. The measurements were taken on the total length of the forging, as in the case of the rolled metals, to insure greater accuracy, the experiments being conducted in somewhat similar manner; but owing to the greater length of the forgings, a modification of the method was made. One end of the forging was rigidly secured and the expansion ascertained by measuring the diminishing space between the other end of the forging and a fixed point situated a distance from it. The results are recorded in table II.

GENERAL REMARKS.

It is interesting to notice that the coefficients of dilatation were greater in the case of the soft than the hard steels, a circumstance which may be accounted for by a reference to table I. of the analyses, from which it will be seen that the percentage of combined carbon was much lower in the soft than in the hard steels, the percentage of pure iron was consequently also greater in the soft steels; this caused them to be of a greater specific gravity. The results in table II. appear also to indicate another circumstance of metallurgical interest, viz., that the dilatation was generally rather more in the direction of the length of the metallic cylinders than when measured across the diameter; numerous repeated experiments confirmed this. The result appears more marked in the large round forgings of hammered steels and wrought iron than in the case of the rolled bars. It would therefore seem probable that the crystalline particles of the metals suffer slight permanent alteration of form in the direction of their length during the process of rolling or drawing out, sufficient to very slightly affect their relative longitudinal and transverse dilatations. Furthermore, the observations of this memoir, conducted at these very low temperatures, experimentally confirm the suggestion of Professor Tait, inasmuch as the coefficients of dilatation were found generally to decrease with the reduced temperature below 0°C . The author also found such to be the case in his observations on the "Heat Dilatation of Pure Ice from Very Low Temperatures." It may be remarked that many tons of the various freezing mixtures, snow, etc., were required for the experiments.

A NEW FORM OF SIEMENS FURNACE.*

By JOHN HEAD.

It would be necessary to write a complete history of the regenerative gas furnace to give any idea of the diversity and difficulty of the problems which Sir William and Mr. Frederick Siemens had to solve before their furnace, now so well known to iron and steel manufacturers, was made available for use in metallurgical operations. Among these problems may be instanced the preliminary heating of the gas as well as of the air, so as to introduce both of them into the heating chamber at a high temperature, the form necessary to be given to the regenerators in order that the heat should be deposited and recuperated in a methodical and rational manner, the arrangements for reversing the direction of the flame and for effecting a uniform diffusion of its heat throughout the heating chamber, all of which, simple as they now appear, involved a large amount of careful consideration on the part of the Messrs. Siemens. Besides these main features that had to be discovered and applied, we are also indebted to them for all the details that constitute the indispensable accessories used in the construction and working of the regenerative gas furnace. By their work the employment of reactions and metallurgical operations, foreshadowed by chemical research, have been rendered possible and practicable, which but for their furnace could have had no practical application, and would therefore be unavailable to manufacturers.

The great economical idea embodied and carried out in the regenerative gas furnace is perhaps best illustrated by comparison with such a meritorious invention as Neilson's hot blast stove. In this case the temperature of the blast was raised by means of fuel separately burned for that purpose, but in the case of the Siemens regenerative gas furnace the heat below the temperature of the work carried on in the furnace is impounded in the regenerators, and applied to heat up the gas and air supporting combustion. In high temperature furnaces the heat below the temperature of the work to be performed therein is by far the largest proportion of the total heat produced, and previously to the introduction of the Siemens furnace this heat had been lost by being allowed to pass away with the waste gases to the chimney. This circumstance was clearly explained by Lord Armstrong at the meeting of the British Association at Birmingham in 1865. By heating the inflowing gas and air, the temperature of the flame in a furnace may be raised to almost any extent; in fact, the heat attainable under these conditions is only limited by the power of resistance of the materials of which the furnace is built, and thus the highest temperatures required in metallurgical operations are obtained with facility by the expenditure of a moderate amount of fuel, especially since the introduction by Mr. Frederick Siemens of the method of heating by radiation, by which means the durability of the furnace has also been much increased. In considering the details of construction of this ingenious apparatus, it occurred to Mr. E. Biedermann and Mr.

* Paper recently read before the South Staffordshire Institute of Iron and Steel Works Managers.

TABLE I.—ANALYSES OF WROUGHT IRON, STEELS, AND CAST METALS EMPLOYED.

Rolled Bars.

Description.	Graphitic Carbon.	Combined Carbon.	Silicon.	Sulphur.	Phosphorus.	Manganese.	Iron (by Difference).	Total.	Specific Gravity.
Wrought iron (Wortley best scrap)	—	None	0.392	0.034	0.27	0.194	99.11	100	7.59
Bessemer steel, soft	—	0.15	0.009	0.112	0.088	0.468	99.173	100	7.853
" hard	—	0.48	0.121	0.096	0.089	0.684	98.530	100	7.838
Siemens-Martin steel, soft	—	0.23	0.014	0.1	0.075	0.698	98.883	100	7.856
" hard	—	0.46	0.107	0.023	0.075	0.972	98.363	100	7.845
Cast steel, soft	—	0.45	0.016	0.027	0.048	0.086	99.373	100	7.863
" hard	0.259	1.19+	0.175	0.063	0.019	0.396	97.898	100	7.805
Cast metal, best	2.78	0.39+	2.34	0.09	0.58	0.45	93.37	100	7.206
" common	2.62	0.67+	1.94	0.09	0.95	0.52	93.21	100	7.134

Hammered Forgings.

Wrought iron (Wortley best scrap)	—	0.038	0.117	0.019	0.246	0.112	99.468	100	—
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* The terms "soft" and "hard" relate only to difference of percentage of combined carbon, and not to any annealing or hardening processes. The metals were so prepared as to obtain a wide difference in the percentage of combined carbon between the soft and hard varieties.
† Combined carbon in these samples was determined by combustion, and in the other samples by the colour test.

TABLE II.

Rolled Bars.

Description.	Coefficients of Linear Dilatation for 1°C between.			1,000 Parts at -45°C became at 300°C .	
	-45°C and 100°C .	-18°C and 100°C .	100°C and 300°C .	Longitudinal.	Across the Diameter.
Wrought iron (Wortley best scrap)	0.0000086	0.0000114	0.0000133	1003.638	1003.588
Bessemer steel, soft	0.0000093	0.0000117	0.0000139	1004.133	1003.944
" hard	0.0000085	0.0000101	0.0000133	1003.746	1004.322
Siemens-Martin steel, soft	0.0000088	0.0000116	0.0000144	1003.807	1003.946
" hard	0.0000079	0.00001	0.0000139	1003.731	1003.57
Cast steel, soft	0.0000086	0.0000112	0.000015	1003.755	1003.502
" hard	0.0000084	0.0000101	0.000013	1003.577	1003.411
Cast metal, best	0.0000088	—	0.0000137	1003.637	1003.621
" common	0.0000088	0.050009	0.0000132	1003.784	1003.579

Large Hammered Forgings.

Description.	Coefficients of Linear Dilatation for 1°C between.			1,000 Parts at 0°C became at 300°C .	
	-45°C and 100°C .	-18°C and 100°C .	100°C and 300°C .	Longitudinal.	Across the Diameter.
Wrought iron (Wortley best scrap)	0.0000096	0.0000117	0.0000131	1003.944	1003.537
" "	0.0000081	0.0000104	0.0000157	1003.79	1003.33
Bessemer steel	0.0000099	0.0000107	0.0000137	1003.829	1003.601
Siemens-Martin steel	0.0000093	0.0000113	0.0000142	1003.953	1003.641

* This was a smaller forging, only 3 inches in diameter and 13 inches long.

Bath A for temperature of -45°C .Bath B for temperature of -18°C .

Ground Plan.

Ground Plan.

Scale, $\frac{3}{4}$ inch = 1 foot.

these coefficients become gradually less as the temperature is lowered below zero (0°C). The following experiments were made to investigate the subject in relation to metals of the iron and steel series. The varieties of modern steels manufactured by recent processes manifest properties sufficiently diverse as almost to constitute them distinct groups of metals, although for practical purposes they are conveniently grouped under the generic name of steel. Some of these modern metals have recently been so largely used for constructive purposes that the author considered it desirable to obtain an approximate quantitative estimation of their dilatation by heat through varied ranges of temperature. The rolled metals under observation in the experiments consisted of round polished bars, 3 inches in diameter and 13 inches long, planed perfectly square at each end; they were carefully manipulated during manufacture, and were selected from the author's standard samples, having the chemical composition given in table I.

The range of temperature chosen for the observations was from 45°C to 300°C . The experiments were conducted as follows: For the measurements commencing at the low temperature of -45°C , the bars (having previously been slowly reduced to the temperature of 0°C , and then gradually cooled to -18°C) were placed upright in the bath A (see illus-

tration), and immersed in a freezing mixture of three parts of calcium chloride and two parts of snow, each of these ingredients, previous to mixing, being maintained in separate jacketed freezing tanks at a temperature of -18°C . The vessel, A, containing the bars and the calcium chloride freezing mixture, was further surrounded by another compartment holding a quantity of a freezing mixture of snow and salt at a temperature of -20°C . By this means and by con-

stantly renewing the calcium chloride and snow mixture during the experiments, a uniform temperature of -45°C , as registered by an alcohol thermometer, was maintained for the experiments in the cold bath, A. Much larger cooling tanks of a snow capacity for each charge of 8 cwt. were used for the large forgings, and a large cast metal oil bath having a capacity of about 70 gallons of oil was used for the highest temperature. The bars remained thus immersed in the freezing bath while their internal temperature was regularly ascertained by another alcohol thermometer placed in a hole in the center of the test bar, C, wherein was also placed a little alcohol. When the bars had reached and remained for some time at the registered temperature of -45°C , each was in turn removed and placed on a suitable wooden frame, and its length instantly and carefully measured by telescopic readings from a delicate micro-vernier gauge (deviations of $\frac{1}{1000}$ of an inch were perceptible), also supported on a suitable rigid stand. The bars were then replaced for a short time in the freezing mixture, and again removed, and their diameter then carefully measured. No perceptible alteration in the temperature of the bars occurred during the very short time occupied in taking the observations, and frequent tests were made to ascertain this. The average of about thirty measurements in

E. W. Harvey, who are on Mr. Frederick Siemens' technical staff, that possibly further economy in fuel might be realized by a rearrangement of some of the parts of the regenerative gas furnace. Their attention was directed to the conversion of solid fuel into the gas in the producer and to the relatively high temperature at which the products of combustion passed from the furnace into the regenerators, as also to the chemical composition of these products, which temperature and gases they thought might be utilized in the gas producer.

As is well known, the production of carbonic oxide in the ordinary gas producer is the result of the decomposition of the carbonic acid formed in the first instance above the grate by incandescent carbon in the upper portion of the producer, according to the equation $\text{CO}_2 + \text{C} = 2\text{CO}$. Carbonic acid at a high temperature is produced with the development of heat in the lower layers of the fuel, which is transformed with the absorption of heat into carbonic oxide in traversing the red hot fuel above, while hydrocarbons are distilled from the coal used, and leave the producer

the cause and source of the economy realized in a new furnace. If oxygen be admitted below the grate of a gas producer filled with incandescent coke (Fig. 6), carbonic acid will be formed in the lower zone and produce a certain quantity of heat. This carbonic acid will be decomposed in the upper zone, and absorb a portion of this heat. From this reaction it is seen that the weight of carbon gasified in the lower zone is equal to that of the carbon gasified in the upper zone, and if we suppress the production of carbonic acid and replace it by superheated carbonic acid from an external source of supply, half the fuel should be saved.

The furnace about to be described is provided with air regenerators only, but must be distinguished from furnaces in which the air alone is heated. Such furnaces are necessarily wasteful, as only a portion of the heat contained in the burnt gases can be theoretically recovered, and such a result is not attainable in practice. In the new furnace, on the contrary, the gases leaving the furnace are partly directed below the grate of the converter producer and partly into an air regenerator, so that the whole of the heat is utilized as

but as in the new furnace a portion only of the products of combustion passes away by the chimney, while the remainder returns to the furnace after passing through the converter producer, the heat necessary for producing draught in the chimney is diminished to the same extent. This represents a further saving in fuel. As there is no gas regenerator in the new furnace, there is no loss of heat by radiation from it, and further economy is thereby also effected. In both furnaces there is reversal of the currents of air and gas so as to produce uniform diffusion of heat through the furnace chamber; in both, too, the air and gas are delivered into the furnace at a very high temperature.

The furnace may be constructed in various forms, the one shown in Figs. 1-5 having been used with success for heating and welding iron. It is a radiation furnace heated by means of a horseshoe flame; this form of flame offers advantages in this as in ordinary regenerative gas furnaces, but its adoption is not obligatory, as the flame may be made to traverse the heating chamber from end to end in the usual manner. The same letters indicate the same parts in all the figures. AA' are reversible regenerators for air, on the top of which is built the gas producer or converter, B, of which FF' are the charging hoppers and NN' the grates. The heating chamber, E, adjoins the producer and rests on the ground, or in some cases a pit may be provided below it. CC' are the flues leading the combustible gas to the furnace chamber, E, the passage of the gas in these flues being controlled by the valves, DD', at the two ends of a rocking beam, so that the outlets are opened and shut alternately to convey the gas to one or other of the ports, GG', of the heating chamber, E. HH' are the air ports of the heating chamber, communicating through the flues, KK', with the regenerators, AA'. II' are steam jets placed in the return flues for directing a portion of the waste products of combustion to the grates of the converter. J is the valve for reversing the direction of the air flowing into the furnace, and of the products of combustion through the regenerators to the chimney flue. OO' are hinged caps for alternately admitting and shutting off the products of combustion from the heating chamber to the converter. These caps are worked automatically by means of connections attached to the rocking beam, the same movement which closes D opening O', and that which closes D' opening O. QQ' are doors for giving access to the grates of the converter for clearing them.

The *modus operandi* of the furnace is as follows: Gas from the converter, B, passes through the flue, C', and the valve, D', to the gas port, G', and into the combustion

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

GENERAL VIEWS OF NEW FURNACE, SHOWING LONGITUDINAL AND TRANSVERSE SECTIONS AND SECTIONAL PLANS.

with the carbonic oxide produced. In the new form of Siemens furnace the gaseous products of combustion from its heating chamber are delivered under the grate of the producer.

These gases consist of carbonic acid, water in the gaseous state, and nitrogen, all in an intensely hot condition. The production of carbonic acid may therefore be dispensed with (as a portion of the hot gaseous products of combustion are already in that state), provided the heat usually developed in its production and necessary for its conversion into carbonic oxide is compensated for by the heat brought in by the products of combustion. A producer so arranged will become a converter, in which the gaseous products of combustion will be reconverted into combustible gases without any diminution of the temperature of the solid fuel. Although such a result may appear at first sight paradoxical and unlikely, it has been proved by experience in the working of several furnaces during the past nine months, and may be explained by the presence in the burnt gases of a proportion of nitrogen large enough to carry the heat necessary for the reaction.

It is possible by a very simple reasoning to explain

in the original Siemens furnace, but in a different manner. The air regenerators perform the same functions as formerly, but the heat which in the old furnaces was deposited in the gas regenerator is now utilized to bring about the conversion of the products of combustion into combustible gases, to distill the volatile material in the coal, and to raise these volatile constituents to a certain temperature before their arrival in the furnace chamber. The economy of the new Siemens furnace over the original form may rise as high as fifty per cent, when coke is the fuel employed. When coal is used the economy will be considerably increased, because the sensible heat of the gases necessarily lost in the original Siemens furnace is saved in this form, and the formation of tar and soot in the flues is avoided.

Figs. 7 and 8 show the relation which exists between the ordinary and the new type of Siemens furnace. In the first case the waste gases are directed through two regenerators, while in the second case the waste gases are partly directed through an air regenerator and partly through a converter producer. In both cases the waste heat from the furnace is entirely utilized, leaving only heat sufficient for chimney draught;

tion chamber, h' g'. Air for combustion passes through the regenerator, A', the air flue, K', and the air port, H', into the combustion chamber, where it meets the gas from the converter, and combustion ensues. The horseshoe flame sweeps round the heating chamber, E, the products of combustion passing away by the second combustion chamber, h g, and going partly through the regenerator, A, and reversing valve, J, into the chimney flue and partly down the flue, G, whence they are drawn by means of the steam jet, I, through the capped inlet under the grates, NN', of the producer, B, there to be converted into combustible gases. From time to time the direction of the flame in the furnace is reversed by manipulating the rocking beam carrying the valves, DD', and the reversing valve, J, in the usual manner of working regenerative gas furnaces. An auxiliary steam jet is provided for the purpose of supplying atmospheric air to start the producer when the furnace is first heated up.

The new form of regenerative gas furnace has been applied in this country to the heating and welding of iron, to which its application is being extended in England and abroad, while furnaces are in course of construction to apply it for puddling iron and for copper and steel melting. Altogether, ten furnaces for these purposes are in course of construction, in addition to ten furnaces already at work for heating iron. The first furnace of this kind was constructed at the Pather Iron and Steel Company's works at Wishaw, for welding iron, and much credit is due to the proprietors for having had the enterprise and public spirit to make the first application of this improved regenerative gas furnace. The working has been eminently satisfactory from the commencement. The success of the first application of the furnace proves the correctness of the principle upon which it is constructed and the means adopted for carrying it out. The results of working during the past nine months have shown an average saving of five per cent, in waste on the weight of the iron heated, and a saving of upward of two-thirds of the weight of coal used, and a greater money saving, owing to the inferior quality of the fuel employed as compared with that used in their other furnaces fired with solid fuel. From the total saving thus realized should, however, be deducted the cost of raising steam, for which purpose the waste heat of the old furnaces is utilized. Allowing for separate boilers, the saving effected by the use of the new system in a furnace heating eight tons of iron per shift is nearly eighteen tons of coal per week, and the money saving in iron and coal exceeds £1,000 per annum.

This new furnace has also been recently applied for heating billets by the United Horse Shoe Company, of London, and in this case the results are quite as satis-

factory or even better than those just given, as is shown by the accompanying table:

Date.	Number of charges per shaft.	Duration of each shaft.	Weight of billets heated (30 in. by 2 1/4 in. by 2 1/4 ft.)	Average time required for heating to welding.
1889.			Minutes.	Tons. Cwts.
Sept. 13..	11	a.m. 5:45 to p.m. 5:25	21	8 16
Sept. 14..	6	6:00 to 12:15	30	4 16
Sept. 16..	11	5:45 to 5:30	21	8 16
Sept. 17..	11	5:45 to 5:30	26	8 16

Continued below.

COAL.		
Weight used.	Used per ton of billets.	Quality.
Cwts.	Cwts.	
a 17 1/2	1 9	Newcastle small.
b 8	1 7	Newcastle cobbles.
c 17 3/4	2 0 1/2	Newcastle small.
d 18 1/4	2 0 8	London screenings.

It will be noticed from these results that in this furnace eleven charges are made in less than twelve hours, each weighing about 16 cwt., and yielding in the finished state as horse shoe iron 15 cwt. per charge, or 8.25 tons in the day. The amount of small coal used was about 18 cwt. per shift. This is equivalent to 2 cwt. per ton of iron heated, which, it will be admitted, is a most satisfactory result; in one case the consumption of coal was even reduced to 1.7 cwt. per ton, each billet coming out at a full welding heat and rolling into a sound bar. The coal used each day is indicated in the table.

The following are analyses of gas made in the converters at Pather and in London respectively:

PATHER CO.	UNITED HORSE SHOE CO.
From Wishaw coal (nuts).	Newcastle cobbles.
CO ₂ 4.6	CO ₂ 4.5
•..... nil	O..... nil
CO..... 23.0	CO..... 22.5
H total..... 17.4	H..... 16.3
C vapor..... 1.5	CH ₄ 2.6
N..... 53.5	N..... 54.1
100 0	100 0

From these analyses it will be seen that the proportion of CO₂ in the gas made in the converters is not greater than that made in the ordinary Siemens producer.

Besides the advantages in the saving of fuel and metal, it is desirable to call attention to the simplicity of design of the new furnace, owing to which its cost of construction is not much greater than that of a solid fuel furnace, while its cost of maintenance is very much less.

Its cost of construction is found to be about two-fifths of that of the old form of regenerative gas furnace, of the same productive capacity, with separate gas producers and gas regenerators, and the space occupied below ground is also considerably reduced. A saving of labor attends the employment of the new furnace, as, owing to the producer being connected with the furnace, the same men can attend to both, and the labor of firing is reduced in proportion to the reduced consumption of fuel.

In conclusion, the following advantages may be claimed for the new furnace as compared with solid fuel furnaces used for heating and welding iron, viz.: (1) A saving in fuel amounting to, say, two-thirds in weight, and after allowing for raising steam in separate boilers, this saving is fully equal to 5 cwt. of coal per ton of iron heated; (2) a reduction in the waste of iron equal to 5 per cent. upon the weight of metal heated; (3) a saving in labor and repairs which will probably compensate for the extra cost of the new furnace.

Taking a furnace to heat ten tons of iron per shift, or 110 tons per week, the following calculation gives the money saving realized by the adoption of the new furnace:

110 tons iron at 5 cwt. per ton = 27 1/2	
coals saved at 6s.....	£8 5 0
110 tons iron at 5 per cent. = 5 1/2 tons	
iron at £4.....	22 0 0

Being.....£30 5 0

per week, or say £1,500 per annum.

[NATURE.]

NOTES ON A RECENT VOLCANIC ISLAND IN THE PACIFIC.

IN 1867, H.M.S. Falcon reported a shoal in a position in about 20° 20' S. and 175° 20' W., or thirty miles west of Namuka Island of the Friendly or Tonga Group.

In 1877 smoke was reported by H.M.S. Sappho to be rising from the sea at this spot.

In 1885 a volcanic island rose from the sea during a submarine eruption on October 14, which was first reported by the Janet Nichols, a passing steamer, to be two miles long and about 250 feet high.

The U. S.S. Mohican passed it in 1885, and from calculation founded on observations in passing, gave its length as 1 1/2 miles, height 165 feet. The crater was on the eastern end, and dense columns of smoke were rising from it.

In 1887 the French man-of-war Decres reported its height to be 290 feet.

In the same year an English yacht, the Sybil, passed it, and a sketch was made by the owner, H. Tufnell, Esq., which is here produced.

The island has now been thoroughly examined and mapped, and the surrounding sea sounded by H. M. surveying ship Egeria, Commander Oldham.

It is now 1 1/2 mile long and 3/8 of a mile wide, of the shape given in the accompanying plan. The southern portion is high, and faced by cliffs on the south, the summit of which is 153 feet above the sea. A long flat stretches to the north from the foot of the hill.

The island is apparently entirely formed of ashes and cinders, and a few blocks and volcanic bombs here and there, especially on the verge of the hill.

Under the action of the waves, raised by the almost constant southeast winds, this loose material is being rapidly removed; continual landslips take place, and Commander Oldham is of opinion that the original summit was some 200 or 300 yards southward of the present highest cliff, and that the shallow bank stretching to the south represents the original extension of the island.

As far as can be judged from Mr. Tufnell's sketch from the northwest and that of the Egeria from the south-southeast, considerable changes have taken place in two years, the different summits shown in

bable that its existence as an island will be short unless a hard core is yet revealed.

The soundings between Falcon Island and Namuka show that they are separated by a valley 6,000 feet deep.

Metis Island, 73 miles north-northeast of Falcon Island, is another volcanic cone that appeared a few years before the latter, but has not yet been examined.

W. J. L. WHARTON.

HIGH ALTITUDES OF SOUTHERN CALIFORNIA.

By WALTER LINDLEY, M.D.

AUGUST 26, 1888, in company with a friend, I left Los Angeles for the San Jacinto mountains. A four hours' ride by rail took us to the town of San Jacinto, where we were met by a patient of mine whom I had considered to be at death's door from phthisis. He was

By H. Tufnell, Esq., 1887, bearing S.E. about 2 miles.

By "Egeria," 1889, bearing E. 1 1/2 mile.

By "Egeria," 1889, bearing N.N.W. 1/2 W. 1 mile.

the former having disappeared as the sea has eaten away the cliffs.

The flat to the north seems to be partly due to redistribution under the lee of the island of the material removed from the southern face. It is crossed by curved ridges from 3 to 12 feet high, which Commander Oldham considers to have been formed as high beaches during spring tides and strong winds, the flat ground between them, almost at the level of the water, being deposited under normal conditions of weather.

The island is thus gaining on one side while losing on the other, but when the high part is gone, this partial recovery will probably cease.

A little steam issuing from cracks in the southern cliffs was the sole sign of activity, but a pool of water at a temperature of from 91° to 113° F., water which rose in a hole dug in the flat of a temperature of 128° F., and a temperature of 100° F. in a hole dug half way up the slope, also show that the island still retains heat near the surface. The water is sea water that has filtered through the loose ashes, and it rose and fell with the tide.

It appears by the condition of the flat that the island has neither risen nor subsided during the past two or three years.

It will be interesting to watch the ultimate fate of this last addition to the Pacific isles, but it seems pro-

a post office clerk in Kansas City, and came to me nearly four years ago with daily rise of temperature to 103°, night sweats, hard cough, purulent expectoration, marked emaciation, dullness in left apex, rales quite general over both lungs. He remained quite close to the coast for a year, but lost ground, and suddenly determined to go to San Jacinto, where he "took up" a piece of government land. There was a steady improvement almost from the first. He has this season worked in the hay field. While he is by no means a well man, yet the change for the better has been wonderful. San Jacinto has an altitude of about 1,400 feet. It is too warm for comfort in the summer, yet numerous consumptives claim they gain most during the hot season. Here we hired two horses and a buggy for \$3.50 per day, and drove ten miles to the east, to what is called "the foot of the grade," where we stayed over night. The accommodations would have been real good but for the fact that the beds were all engaged. The consequence was we had to sleep on a straw pile in the barn, but the food was good, and, like the straw, was clean.

At 5 o'clock A.M. the next day we started up the grade. The rise is said to be about thirty-three feet in a hundred. A six-mule team has all it can do to haul 800 pounds up this steep road. The grade is two and a half miles long, and it usually takes at least three