drilled to $\frac{1}{2}$ ", after which the edges of holes were examined under the microscope.

In no one of the large quantity of plates of steel examined of different hardness (from 0.1 to 0.6 c.) have I found cracks or flaws. In the drilled holes the edges under the microscope are also clean enough. In the punched holes only the top side is clean, showing a rounded edge, while the bottom side presented a sharp edge, in some places broken away, and drawn out with deep cavities discovering the crystalline structure of the metal. In short, under the microscope we see a clear picture of the rough destruction caused by the punching.

The inside of the holes is smooth for one-third of the length, with visible traces of the friction of the punch; the remaining two-thirds is of larger diameter, with two or three cracks broken off.

Instead of the microscopical crevices which I looked for, I discovered another interesting phenomenon, which, as far as I know, has not yet been described.

On the smooth polished surface of my plates, around the punched holes, appeared clearly visible to the eye (without a glass) a design composed of curved lines, disposed like bundles or sheets, more or less tangential to the circumference of the hole, and crossing each other.

These lines, shown on Figs. 2, 3, and 4, presenting correct printing in lithographs from photographs 5, 6, 7, and 8, do not appear around the drilled holes, but around the punched and the after-drilled holes they appear with the same clearness as around the holes punched to the full diameter.

In puddled iron plates I have not observed those lines. Remarked in the softest ingot metal, they were less visible in steel containing 0.5% of carbon, and finally with 0.6% carbon they could not be remarked.

With the increased thickness of the plates the number and clearness of the lines increased, as is seen by comparing Figs. 2, 3, and 4 (thickness $\frac{1}{2}$ ") with photographs 5 and 6 (thickness 1").

The shape of the holes, as is seen in the photographs, has also some influence on the disposition and dimension of the lines.

On all the small plates, 5" x 3", the lines appeared as very small but still visible indentations. On the largespecimen, 10" x 10" the lines were convex, gradually lowering to the end of the rays (different lines), and imperceptibly flowing together with the surface of the plate.

In the small specimens (3"), lines reaching the edge were terminated with a plain surface; whereas in the specimens with unplanned edges, such as fish plates, the most developed lines were visible beyond the edge of the specimen, and after crossing the lines projected in some cases on the opposite side of the plate.

In all the samples the lines around the top of the hole were less developed, thinner, and shorter, being sometimes disposed in small ripples and sometimes quite absent, changing into a characteristic dull-colored metal around the hole.

After heating and cooling, the lines did not disappear; they were, however, less distinct.

In order to determine how far from the hole the lines develop, a mild steel plate 10" x 10" thick was prepared with polished surfaces, and in the middle of it a hole of 1" was punched.

Around the hole we obtained a very clear design, shown in Fig. 9 from the top and in Fig. 10 from the bottom, the lines being convexed, so that they could be felt with the finger.

After copying the design, the surface of the plate was corroded with acid, after which appeared a notable quantity of bubbles, as shown in Fig. 11, taken from another plate.

After the action of the acid all the convex lines disappeared, being eaten away by the corrosion.

In order to see if the punching of the hole or the lines have an influence on the resistance of the metal, and how far this influence acts, the plate was cut (on a shaping machine) in 8 bars, 4 from each side of the hole, the bars tested gave the following results:

From the left side (extreme end) breaking strain:			
No. 1	"	26.98 tons, elongation	22.7 per cent.
No. 2	"	25.46 "	19.0 "
No. 3	"	27.20 "	19.0 "
No. 4	"	close to the hole	27.43 "
From the right side, near the hole:			
No. 5	"	27.66 tons, elongation	20.4 "
No. 6	"	27.67 "	26.8 "
No. 7	"	25.64 "	19.54 "
From the right side extreme end:			
No. 8	"	28.22 tons, elongation	19.09 "

On examining the broken bars, we remarked that the fracture corresponds with the blow holes or bubbles, that the difference in the resistance and elongation is influenced by the same cause, and that such defects in the ingot are much more serious than the influence of the punching. Further, we remarked that the surface of the broken bar, which was before smooth, appeared covered with convex lines, or small ribs, which could be felt with the finger.

Putting the broken bars together in the same order they occupied in the plate (they were numbered before cutting) as shown in photograph 12, it appeared that the separate lines gave the same design as on the plate before the corrosion with acid, viz., the same lines reappeared at the same places, but were more developed, and accompanied by other lines which were not seen before.

In order to test this fact, another similar plate was prepared from the same sheet, and cut into eight bars, but without punching before the hole. After fracture the eight bars still showed the same smooth surface, without the slightest line.

This test clearly shows that the lines on the plates, on being annulled by pressing out, and reappearing after the tension of the bars, depend upon the strain in the metal caused by the punching of holes in the sheet. This reappearance of the prominent lines after rupture of the bars shows that the metal evidently expanded more between the lines than in those parts of the bars which were covered with lines before the punching out, viz., that in the places covered with lines the metal became harder and less elastic, which is the reason that these parts projected more than the other parts, which had expanded more.

The appearance of fresh lines on the broken bars beside those observed on the plate before it was punched can be explained either by the lines having previously existed, but in the form of prominences invisible to the eye, or that they did not exist, and that the expansion

was only caused by the punching of holes, which expansion occasioned the formation of the lines described, but to a very slight degree insufficient for their apparent formation—a formation obtained only after considerable tension of the softer parts of the metal between the invisible lines of compression.

In completing this description, I must state that I consider the experiments made by me far insufficient for an exact scientific explanation of the causes and laws of the results I have observed.

To my regret I have to discontinue any further experiment, owing to the want of time, and not wishing to take advantage of the kindness of the administration of the Pontiloff Works. However, judging by the results of the experiments made, I consider that the cause of the lines observed by me can be accounted for by the displacement of the molecules of metal (in connection with its crystalline formation and the degree of its hardness), caused by the compression of the same under the punch and its distribution from under the punch into the surrounding mass.

Barba states that the compression of metal when punched can temper the ring round the punched hole much more than it would be by putting into water a red-hot ring turned out of the punched circle; and another authority, Treska, describes the process of distribution of metals.

It is possible that, in continuing my experiments, I might have arrived at quite a different conclusion, but the fact that the punching of holes causes a very important forcing power is evident to me by the two following facts: (a.) The sides of rectangular plates expand, as shown in Fig. 13 (taken from nature) after a hole being punched in the center—the bottom part of the plate expanding more than the upper. (b.) If two holes are bored in a plate on two perpendicular lines, and at the point of contact of the lines a large hole is punched at an equal distance from the hole bored, as shown in Fig. 14, then the bored holes will be trans-

used as fuel. A new charge is then introduced from the top of the tub, after which it is well closed and the distillation is again commenced.

To supply the water into the pan, it is better introduced from the top of the tub, before the charge is taken out; by this means the water in passing down through a heated layer of the wood becomes itself heated, and thus shortens the time of heating in the pan.

As the distillation begins, a semi-solid mixture of the camphor and oil generally accumulates between the partitions in the trough, floating above the condensed water. The camphor and oil thus accumulated in the trough are taken out after several charges, usually 5 to 10 days. The quantity of the yield varies greatly in different seasons. The solid camphor is obtained much more in winter than in summer, while the amount of oil is just reverse. In summer time, from one charge consisting of 120 kilos, of the wood, 24 kilos of the camphor are obtained in one day, while in winter from the same amount, 3 kilos of solid camphor can be obtained in the same time. In summer, from the semi-solid mixture obtained during 10 days, 18.04 liters of the oil are obtained, while in winter only 5 to 7 liters are obtained.

The oil, which contains in solution a considerable quantity of camphor, was formerly regarded as useless, but three years ago a method was devised which consists in distilling the oil and cooling the distillate. The arrangement of the apparatus is as shown in the figure.

The crude oil is introduced into iron kettles, a, a. Each of them is provided with a stopper having two holes; one is for inserting the delivery tube, and the other is for introducing the crude oil during the operation. The vapor passing through spiral tubes made of brass, and kept cool by water, is condensed and the oil is received into suitable vessels, which when full are taken away and cooled by surrounding with a fresh quantity of cold water. By this means the camphor separates out as a semi-solid mass, and in order to sepa-

SUGGESTIONS IN ARCHITECTURE.—A VERANDA.

formed from circles into a flat and elliptical shape, whereby the flattening on the top will be much less than the bottom of the hole, and more in the length of the fiber than across it.

A VERANDA.

OUR illustration of architectural ironwork is from the *Building News*.

ON JAPANESE CAMPHOR OIL.

BY H. OISHI.

LAURUS CAMPHORA, or Kusu-no-Ki, grows in Japan, mainly in those provinces in the islands Shikoku and Kiushiu which have the southern sea coast. It also grows in Kishiu.

The amount of camphor varies according to the age of the tree. That of a hundred years old is pretty rich in camphor.

In order to extract this, such a kind of the tree is selected, and its trunk, stems, etc., are cut into small pieces and introduced into a wooden tub, A, having a false bottom. This tub stands over an iron pan containing water, which is heated by a furnace, C, below, as represented in the figure. The steam arising from the pan passes into the tub, where it meets with the cut pieces of the wood, and carries the vapors of camphor and oil together into a condenser, a, by means of a bamboo pipe. Here all the camphor and oil, together with steam, are condensed, while the uncondensed portion of steam escapes into the air through a pipe attached to the corner of the condenser. The latter is made of a wooden trough which is surrounded by another one, b, filled with cold water. In order to expose a large surface to perfect condensation of the vapors, the condensing trough is fitted internally with a number of vertical partitions which are open at alternate ends, so that the vapors may travel along the partitions in the trough from one end to the other.

The continual supply of water is made by a pipe from which it flows into a wooden trough, c, placed just over the condenser. From the upper trough the water flows into the lower one, b, thus keeping the condenser cool all the time.

One operation requires about 20 hours. After that time the contents of the tub are withdrawn, dried, and

rate the solid camphor from the oil, the liquid is filtered or squeezed out through a cloth bag. The oil thus separated still contains a certain quantity of solid camphor. In order to remove this, it is again mixed with a fresh quantity of the oil and distilled as before. In this way 173 kilos. of the crude oil yields 36 to 45 kilos. of solid camphor; thereby the volume of the original oil becomes about a half. The purified oil, or that which is freed from the camphor, is used as a lighting material by the lower people of the province.

The purified camphor oil is a colorless liquid, and burns with a bright smoky flame; the general properties resemble very much those of the solid camphor. Crude oil has specific gravity 0.959, and the purified oil has 0.895 at 15° C. By oxidation in the air, or by nitric acid or by oxygen, a change in the composition occurs, and it produces ordinary camphor, together with certain higher oxyhydrocarbons, and the oil gradually becomes yellow. The oil dissolves many resins, such as gum-mastic, gum elemi, colophonium, etc.; it dissolves asphaltum, sulphur, and many other things.

Reactions with acids:

Hydrochloric acid separates the oil into two layers, the upper one being transparent; the lower one is turbid. Nitric acid separates the oil also into two layers, the upper being yellow and the lower being colorless, but on heating it becomes a reddish liquid, which after some time again separates into two layers, but the oil suffers oxidation. When sulphuric acid is added, the oil is dehydrated, leaving a liquid smelling like terpene; when added in a large quantity, the oil is charred.

When chlorine is passed slowly into the oil, it is absorbed with elevation of temperature and evolution of hydrochloric acid fumes; the oil is thus changed into a yellow liquid. When excess of chlorine is passed, the oil becomes viscous. This semi-solid substance does not smell like camphor oil. With bromine the same reactions are produced, and when excess of bromine is added a red amorphous substance is formed. The oil dissolves a large quantity of iodine, and when heated becomes dark red. This dark red liquid when cooled below 0° C. becomes a semi-solid mass.

The specific rotatory power of the oil was examined by Solié's saccharimeter, and was found to be 68.96°, while the calculated value for [α]_D is 68.29°.

To separate the oils of different boiling-points, the original camphor oil was subjected to fractional distilla-

tion. The following is the result of distillation, using 200 c. c. of the oil:

Temp. of Distil.	Vols.
35 to 150° C.....	12'0 c. c.
150 to 155.....	5'5
155 to 160.....	3'6
160 to 162.....	9'0
162 to 164.....	7'3
164 to 166.....	6'0
166 to 168.....	6'9
168 to 170.....	10'0
170 to 172.....	13'6
172 to 174.....	14'5
174 to 176.....	21'8
176 to 178.....	12'7
178 to 180.....	12'7
180 to 182.....	9'0
182 to 184.....	11'8
184 to 186.....	5'0
186 to 188.....	4'0
188 to 190.....	3'6
190 to 198.....	4'5
Residue.....	25'0
Total.....	188'5
Loss.....	1'5

All the distillates afford nearly the same reaction with the reagents.

The analysis of the distillate between 180° to 185° gave following result:

C.....	78.87
H.....	10.73
O.....	10.40 by difference.

The composition thus nearly agrees with that of ordinary camphor.

After repeated distillations he gave the following analysis of the fraction between (178 to 180)*:

$$C=86.95 \text{ and } H=12.28.$$

Thus it is a hydrocarbon.
(Exponent 3 means that the distillation was done three times.) The vapor density of the hydrocarbon was found to be 5.7; its molecular weight is therefore 164.4. We have then the necessary data to ascertain its molecular formula:

$$\frac{164.4 \times 12.28}{100} = 20.18 = H_{20}$$

$$\frac{164.4 \times 86.95}{100} = 11.91 = C_{12}$$

The formula is therefore $C_{12}H_{20}$; thus it is a hydrocarbon of the terebene series, having the general formula C_nH_{2n-4} .

The appended table will show clearly the nature of different distillates and resemblance of the oil to the ordinary camphor.

From these experiments it appears that the camphor oil is a complicated mixture consisting of hydrocarbons of terpene series, oxyhydrocarbon isomeric with camphor, and other oxidized hydrocarbons.

The distinguishing property of the camphor oil, that it dissolves many resins and mixes with drying oils, finds its new application as solvent for varnish. He tried in various ways with different resins and drying oils, and obtained rather a satisfactory result.

1. When colophonium, liquid balsam, gum elemi, or gum mastic is respectively melted in a porcelain dish and mixed with camphor oil, stirring all the time, each of them completely dissolves, and, when cooled, a heavy liquid is obtained, which may be used as a varnish. In applying this as a varnish it should be slightly warmed. This varnish, when spread over foreign paper and slightly warmed, makes the paper very transparent. Japanese paper soaked in the same also becomes very bright and transparent.

2. When a little turpentine oil is mixed with the resin solution in the oil, the varnish dries much more quickly, and assumes a brighter surface. The turpentine oil should be added after the resin is dissolved in the oil.

After various trials, the following mixture was found to be the best:

Camphor oil.....	10 grms.
Turpentine oil.....	3'3 "
Resin.....	8'0 "

3. When mixed with linseed oil, the same result as above is obtained, but this varnish does not dry so quickly as the second one, so that the varnished object requires slight warming in order to dry it completely.

4. Since the camphor oil dissolves dragon's blood, gamboge, the varnish may be colored red or yellow. Little alcoholic solution of aniline-red, purple, and blue were respectively mixed with the resin solution and coated on paper, and on drying in sunshine the first two colors disappeared, but the last remained as a fine blue.

5. When camphor oil is added to melted asphaltum, stirring all the time, a good varnish is obtained, which, when coated upon metallic surface and dried, produces very fine bright surface just like Japanese urushi. The best proportion is 22 grms. of oil to 5 grms. of the asphaltum.

6. The mixture of camphor oil with linseed oil or rapeseed oil produces a kind of varnish which when coated upon paper makes it water-proof. The best water-proof paper is obtained by using the solution of aluminum palmitate in camphor oil.

First, the paper was coated with a thin solution of the palmitate; this, after being dried, is again coated with more concentrated solution, and dried; when the third coating is done the paper becomes stronger, and capable of resisting the action of water for more than thirty-five hours.

Soot has somewhat an extensive application, being used for making inks, paintings, and coloring walls, etc. The soot obtained from the camphor oil is one of the best qualities, and is used for making the best kind of our solid ink. It is therefore important to see how much soot can be obtained from a certain definite quantity of the oil, and whether it can be got profitably or not. The first method consisted simply in burning the oil and putting a cold metallic plate over the flame, and collecting the soot deposited; by this means 7.5 grms. were obtained from 100 c. c. of the oil. When presenting this black to a certain dealer, the author was informed that the soot under question is next to the best quality, and that its price may be 35 cents per 375

Fractions.	Alcohol required to dissolve 1 part of the Oil.	Specific Gravity at 15° C.	[α] of the Chloroform Sol. containing 25 p.c. of the Oil.	Vapor Density.	Percentage composition.	Formula deduced.
45 to 156° C.	10'0 0'8655	66'02	—	—	—	—
156 160	9'0 0'8397	—	—	—	—	—
160 162	8'0 0'8400	66'02	5'29	—	—	$C_{11}H_{18}$ (?)
162 164	8'0 0'8580	—	—	—	—	—
164 166	7'4 0'8575	—	—	—	—	—
166 168	6'9 0'8525	—	—	—	—	—
168 170	6'1 0'8556	66'66	—	—	—	—
170 172	5'4 0'8615	—	—	—	—	—
172 174	4'4 0'8586	—	—	—	—	—
174 176	3'9 0'8636	—	—	—	—	—
176 178	2'8 0'8650	66'02	—	—	—	—
178 180	0'8 0'8745	72'51	5'70	—	—	$C_{12}H_{20}$
180 185	0'5 0'9260	—	—	—	—	$C_{10}H_{18}O$
220 230	—	—	—	—	—	—
250 260	—	—	—	—	—	—

grms.; the quantity of the oil required to produce it is 5 liters, calculated from the experimental result, and the price of 5 liters of the oil is 27.8 cents.

In the second experiment the oil was burnt in the

FIG. 1.

One charge consists of 32 grammes = 120 kilos.
Boiler, 3 shaku in diameter. Wooden tub, 2.8 shaku in lower diameter and 1.5 in the upper, and 4 shaku in height.

same way, but within a metallic cylinder, whose bottom has many holes for admission of air. From 100 c. c. of the oil 13 grms. were obtained; therefore, only 3 liters of the oil are necessary to obtain 375 grms.

Three liters of the oil cost 16.7 cents, and produce 375 grms., cost ng 35 cents; thus there is an excess of 18

FIG. 2.

cents over the cost of the oil required. From this it may be said that the soot can be profitably prepared from the camphor oil.

The following is the report on the amount of annual production in Tosa:

10th Year of Meiji (1877).	
Amount of camphor produced ...	504,000 kins.
The total cost	65,520 yens.
11th Year of Meiji (1878).	
Amount of camphor produced ...	519,000 kins.
The total cost	72,660 yens.
12th Year of Meiji (1879).	
Amount of camphor produced ...	292,890 kins.
The total cost	74,481 yens.
13th Year of Meiji (1880).	
Amount of camphor produced ...	192,837 kins.
The total cost	58,302 yens.

—Chemical News.

THE WORLD'S FIRST MERIDIAN.

By RICHARD A. PROCTOR.

DESPITE the opposition of the French, Brazilian, and Haytian astronomers (a rather singular combination), the meridian of Greenwich has been adopted as the astronomical and geographical reference meridian for the world, and hereafter we may expect uniformity to prevail in maps and charts, in nautical almanacs, and in tables of reference alike for terrestrial and celestial computations. Of course, there will be no noteworthy change in the ordinary measurement of time in different countries or cities. At New York and Washington, for instance, where when it is noon in England it is only about seven in the morning, and only seven in the evening when it is midnight in England, they will not, because of the adoption of the Greenwich meridian, call it noon or midnight when the sun gives them so different a time of day. Ordinary or civil time will

always be reckoned pretty nearly by the sun—not exactly, of course, for the simple reason that in that case every journey east or west would involve a change of clock time. Just as Ireland has a different time from England, not because of any native cantankerousness on either side of St. George's Channel, but because the sun gives different hours, so in the United States they must have their clocks and watches agreeing tolerably well with the sun, and so must have different local time from ours. In different sections of the States they will have, also, times differing by a full hour—earlier and earlier for more and more westward sections—an arrangement by which no place will have time much more than half an hour different from sun time. Half an hour is not a matter of any great importance, as we may know by the fact that no one in the business of life recognizes the circumstance that sun time changes by more than half an hour in the course of each year in every part of the world. If we set a perfect clock or watch—that is, one steadily recording day after day 24 true hours of mean time, so that at the end of a hundred years or more it would be as near sun time as at the beginning—to show 12 noon when the sun was exactly south in February, then, tested by the sun, that clock would seem half an hour wrong at solar noon after about half a year had passed, which would seem to show that in a year it would be an hour wrong, and in six years would show six o'clock at 12, and in twelve years would show 12 noon for 12 midnight. Yet the discrepancy would be entirely due to a want of uniformity in the sun's motion, to which none except astronomers pay the slightest attention. In like manner, in the United States there are places where, judged by the sun (even when he is with the clock at Greenwich), the clocks seem half an hour too fast or too slow on the average all the time; yet business goes on undisturbed. The same arrangements will continue, now that the meridian of Greenwich is adopted as the reference meridian, which were in vogue before, except that possibly the American hour system may be brought into correspondence with Greenwich time instead of Washington time—so that, for instance, a traveler from England to New York, or Washington, would find his watch *exactly* instead of *nearly* five hours fast by New York or Washington time. In this way the whole world may one day be divided into hour zones, so that every change of time for a voyager traveling westward would be made by putting back his watch exactly an hour, and every change for a voyager traveling eastward would be made by putting his watch forward one hour exactly. Though, even then, at sea, the present system would have probably to be retained, by which each noon the approximate local noon is adopted.

In what, then, it may be asked, does the importance of the recent change consist? The astronomer and the geographer do not need to ask the question, knowing as they do the multitudinous inconveniences which arise from the use, in the astronomical computations, and the geographical charts made in different countries, of the longitudes of Greenwich, Vienna, Berlin, Paris, Washington, and so forth. I take up, for example, in the old time of the controversy about the transit of Venus, a treatise or paper written by Puiseux at Paris, or by Newcomb at Washington, and I find that before I can compare properly the results deduced or discussed by the French or American astronomer with my own, or with others dealt with by English astronomers, I must translate the French or American longitudes and times into Greenwich longitudes and times. Even in the case of a single treatise, the time thus wasted (there is no other word for it) is considerable; but when a great number of such works, on different astronomical subjects, pass through an astronomer's hands weekly or monthly, as is the case with me, the nuisance becomes quite serious; and when we remember that this is so in the case of one person alone, we see how large the total waste of time and trouble thus arising must necessarily be.

The geographer is similarly annoyed. In comparing French, German, or American maps with English maps, or geographical statements by geographers of other countries with similar ones made in England, the geographer finds that every detail depending on longitude has to be corrected or translated before the full significance of the foreign charts or statements can be appreciated.

In fact, this question of a meridian of reference may be regarded as affecting our view of the earth from without, as it were, more importantly than the view we take of the earth as residents in this or that part of her surface. It is the earth as a rotating planet which has now been definitely marked for reference, so that all astronomers and all geographers measure from one and the same mark, not each set from a mark of their own. Just as astronomers use a fixed meridional marking on Mars by which to time the rotations of the planet, so in future will astronomers and geographers act with regard to the earth. Strange that they should have assigned a fixed meridian to a planet many millions of miles away, many years before they assigned a fixed meridian to their own planetary home!

It may be asked whether the adoption of a fixed meridian for the whole earth will affect the question many find so perplexing, as to what day of the week it is at particular places, and at particular times. Here it is to be noticed that the usage of astronomers and the usage of business folk must of necessity differ. To the astronomer there will now be, what hitherto there has not been, a definite series of days, the same all over the world. What people in England call, for instance, November 17, viz., the interval of time between midnight and midnight on either side of that day whose middle is noon November 17, has been for the English astronomer, and will hereafter be for the astronomers of all countries, divisible into the last twelve hours of November 16 (which ends for the astronomer at noon November 17) and the first twelve hours of November 17, whose remaining twelve hours, numbered from 13 to 24, end at noon November 18, civil time. So, all round the year—December 25, for instance, in astronomical time, will include for all astronomers, the twenty-four hours from December 25, 12 noon Greenwich mean time, to 12 noon Greenwich mean time, December 26.

But as to what day of the week it is at any particular place and time, the difficulty, which many imagine to exist only along the meridian half way round the earth, west or east of Greenwich, has always existed, and will