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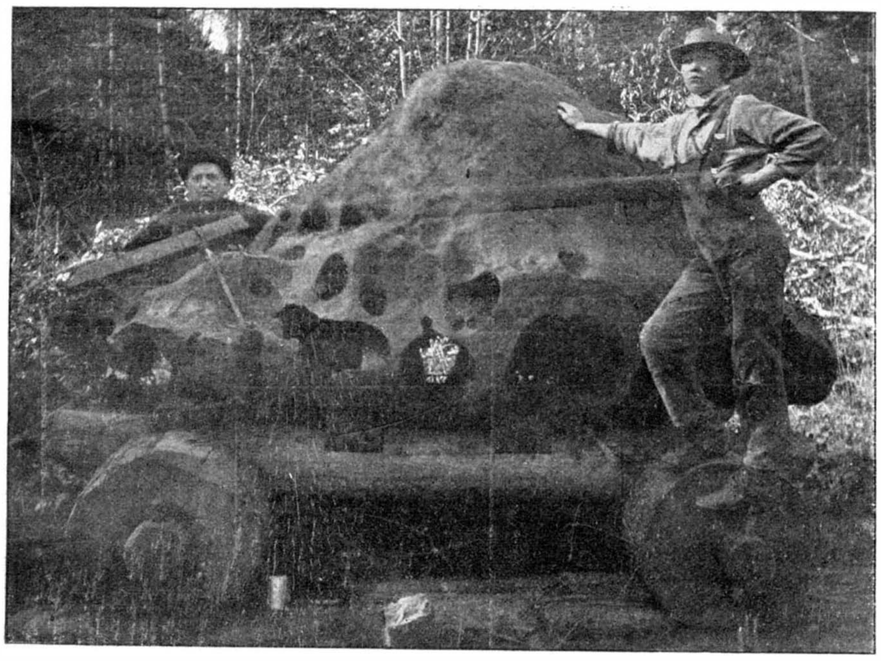
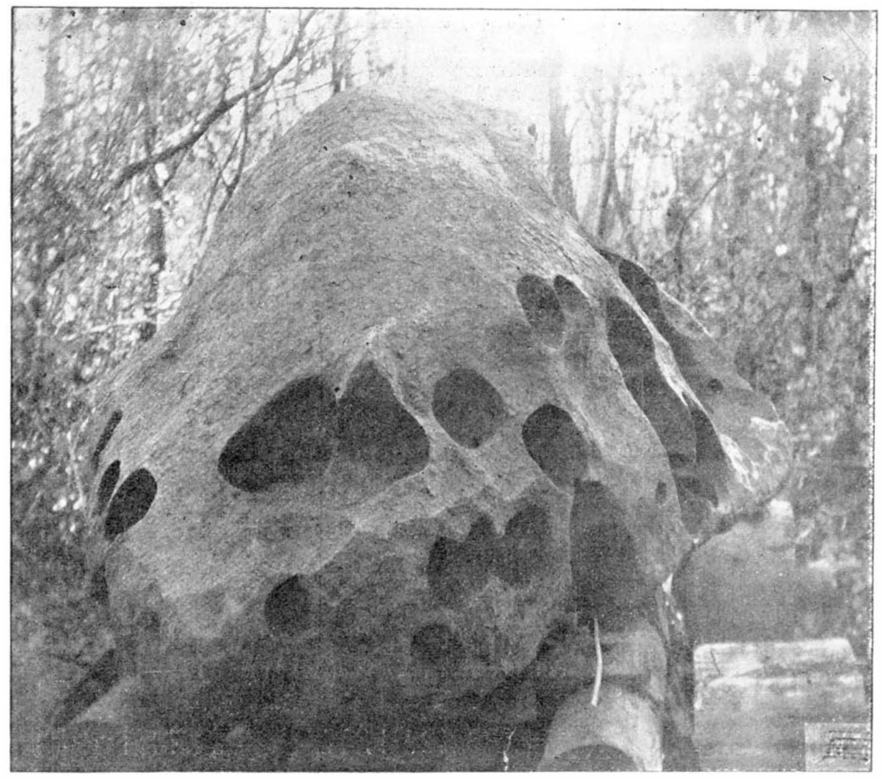
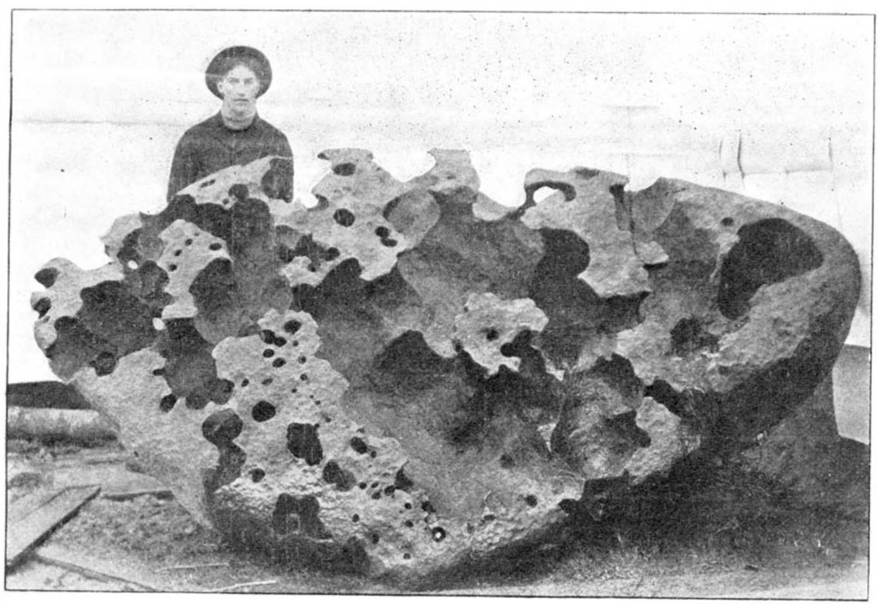


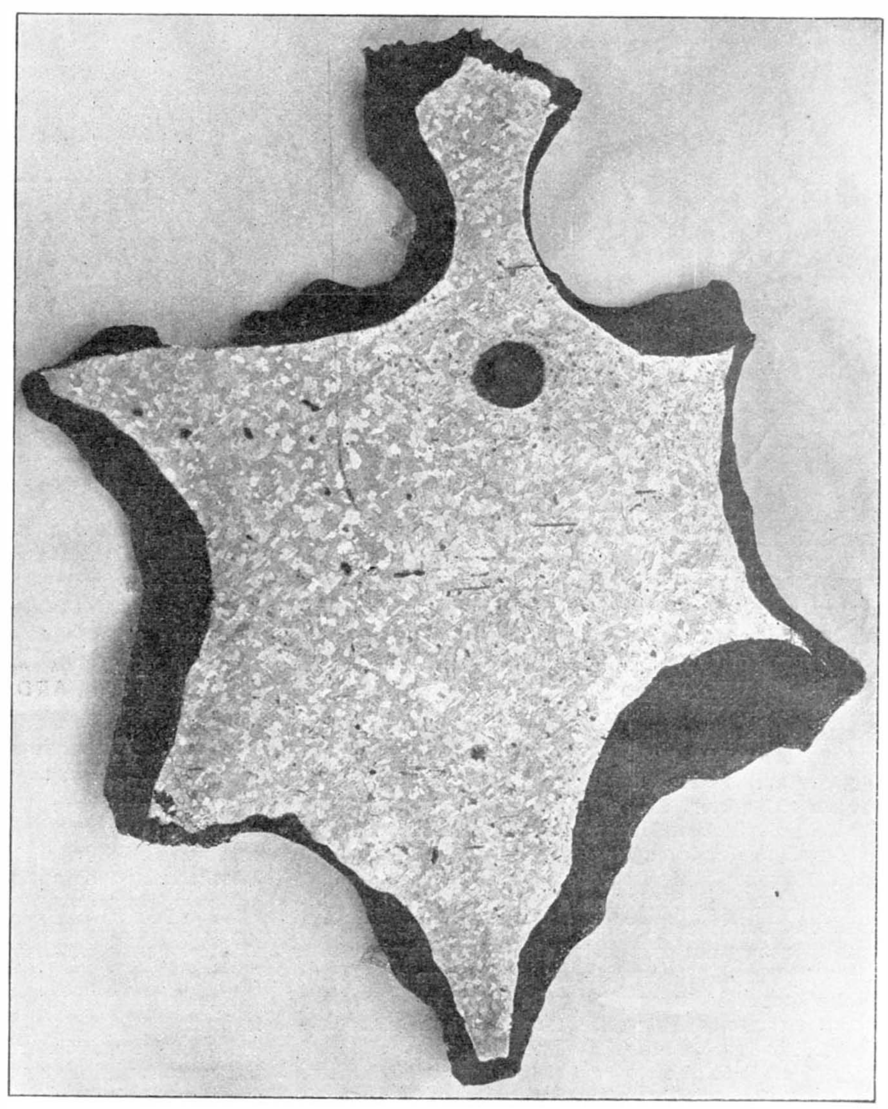
SIDE VIEW, SHOWING HOLE PIERCING THE BASE.



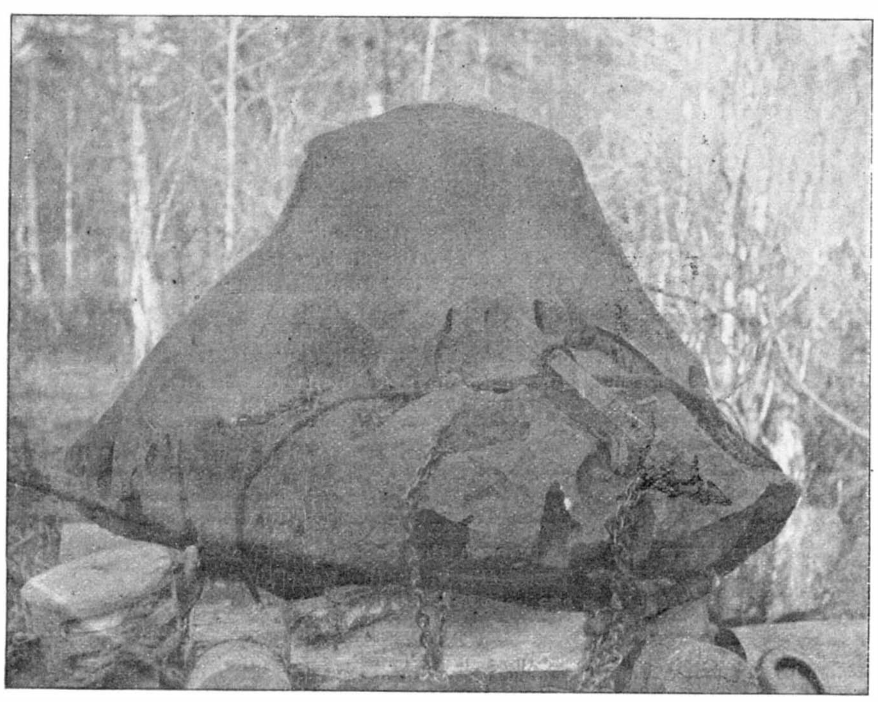
END VIEW, SHOWING ERODED HOLES AND FURROWS.



FULL VIEW, LOWER SIDE OF METEORITE.



ETCHED SECTION, HALF ACTUAL SIZE.



END VIEW OF METEORITE.

WILLAMETTE METEORITE.

THE WILLAMETTE METEORITE.*

By HENRY A. WARD.

THIS most interesting meteorite, noble in size and wonderful in physical features, was found near the border of Clackamas County, Oregon, in the autumn of 1902. At this point in its course the Willamette River, 80 miles south of its junction with the Columbia, runs between high banks of sedimentary rocks. At Oregon City, sixteen miles south of Portland, these banks come as cliffs down close to the river, which on the western side they follow southward for three and one-half miles to the town of Willamette. This meteorite having been found two miles from this town (to northwest) I have given it the name, as above, of Willamette Meteorite. Its exact locality is lat. 45 deg. 22 min. N., long. 122 deg. 35 min. W. The region immediately surrounding is a series of hills, distant foot hills of the Cascade Range, with their steeply sloping sides cut into by streamlets flowing into the Willamette. One of these streams is the Tualitin. On a hillside, three miles above the mouth of the Tualitin, fell, apparently centuries ago, the Willamette siderite, the third largest iron meteorite in the world. The region is a wild one, covered by a primeval forest of pines and birch, little visited and largely inaccessible. Here, on the spur of the hill in a small level area, lay the great iron mass, lightly buried in soil and the carpet of accumulated vegetable *débris*. In the valley, half a mile away, there lives with his family a humble, intelligent Welshman, Mr. Ellis Hughes. He had formerly worked in Australian mines. He had with him in 1902 a prospector named Dale, and together they roamed over the hills seeking minerals. One day a blow on a little rock projecting from the soil showed it to be metal. They dug and found its great dimensions; also that it was iron. It was on land which they learned belonged to a land company. For some months they kept the find a secret, hoping to buy the land on which the "mine" was located. Some months later they ascertained, in some way, that their supposed iron reef, which they had found to be but ten feet long and a yard or more deep, was a meteorite. They became more secretive than ever, and covered their find most carefully.

In August of 1903, Mr. Dale in the meantime having left the country, Mr. Hughes conceived the idea of bringing the great iron mass to his house, a distance of nearly three-fourths of a mile. This seemed an almost impossible task, he having only his son of 15 years and a small horse as motor power. But he was an old miner, full of mechanical resources, and also full of pluck and energy. With infinite pains he fashioned a simple capstan with chain to anchor it, and a long braided wire rope to roll up on it, as his horse traveled around it as a winch. Then he fashioned an ingenious car with log body-timbers and sections of tree trunks as wheels; also some heavy double-sheaved pulleys. By wearisome blocking-up and leverage he succeeded in capsizing the great mass directly upon the car and lashing it securely. Then he stretched out his hundred-foot hauling wire-rope, attached one end of it to the car and the other to his staked-down capstan, and started his horse going round. The sequence of effect to cause followed; so did the meteorite. The great mass moved slowly, for the ground was soft, and, even with boards put under them and constantly changed, the wheels sank deep into the mud. Some days they moved little more than the length of the car (which was that of the mass itself); on others they passed over ten, twenty, or (one day) fifty yards of their toilsome road. At last, after three months of almost incessant toil, the giant meteorite reached Hughes' own land, where it now rests. It was a herculean struggle between man and meteorite, and the man conquered. It is unpleasant to have to record what followed.

The Hughes, father and son, had for these months worked unobserved in the dense forest. Their nearest neighbors, a mile away, do not seem to have been aware of what they were doing. But when the great find was announced, people came trooping up the little valley, first from near-by Willamette, then from Oregon City, and then from Portland, to see the celestial wonder. News soon came to the Portland Land Company, and they promptly claimed the meteorite as having been taken from their land. Hughes refused to give up possession, which latter, he believes, is a strong point in the matter. So a suit at law has commenced, with all prospects of a stoutly-fought legal battle. The suit should come off during the coming summer, but it may likely be delayed. Public opinion is divided as to the probable outcome; but sympathy lies mainly with Hughes, the finder of the mass, and the only man recorded in common life or among scientific collectors as having run away with a 14-ton meteorite.

The newspapers of our country had for several months of the past autumn and winter noted this Oregon meteorite in a desultory manner, but their stories seemed exaggerated, and were not generally credited. In February I decided to visit the distant locality and investigate the matter. A four days' railroad trip put me upon the ground. To make my further description more clear I must say that before my arrival Mr. Hughes had unloaded his car, tipping off the great meteorite over upon its side. Thus three of the cuts in this present article are from photographs which were taken when the meteorite was in its vertical position, still standing upon the car. I have every reason to believe that they were accurate in every way. Notwithstanding every favor extended to me by Mr. Hughes, the fullest scrutiny of the great mass was attended with great difficulties. The weather was wet, a cold rain falling every day that I was there. The mass was in the woods without shelter, and the deep mud and slush around it made kneeling to examine the lower surfaces almost impossible. My first work was to take full measures. These I will give in connection with its general outline as shown in the several cuts which illustrate this paper. One of the cuts presents well the general truncated cone, or dome-like form of the mass. The measures which I took, and which apply to this, are as follows:

The extreme length of the mass, 10 feet 3½ inches.

The extreme breadth across base, 7 feet.

The extreme vertical height from base to summit of dome, 4 feet.

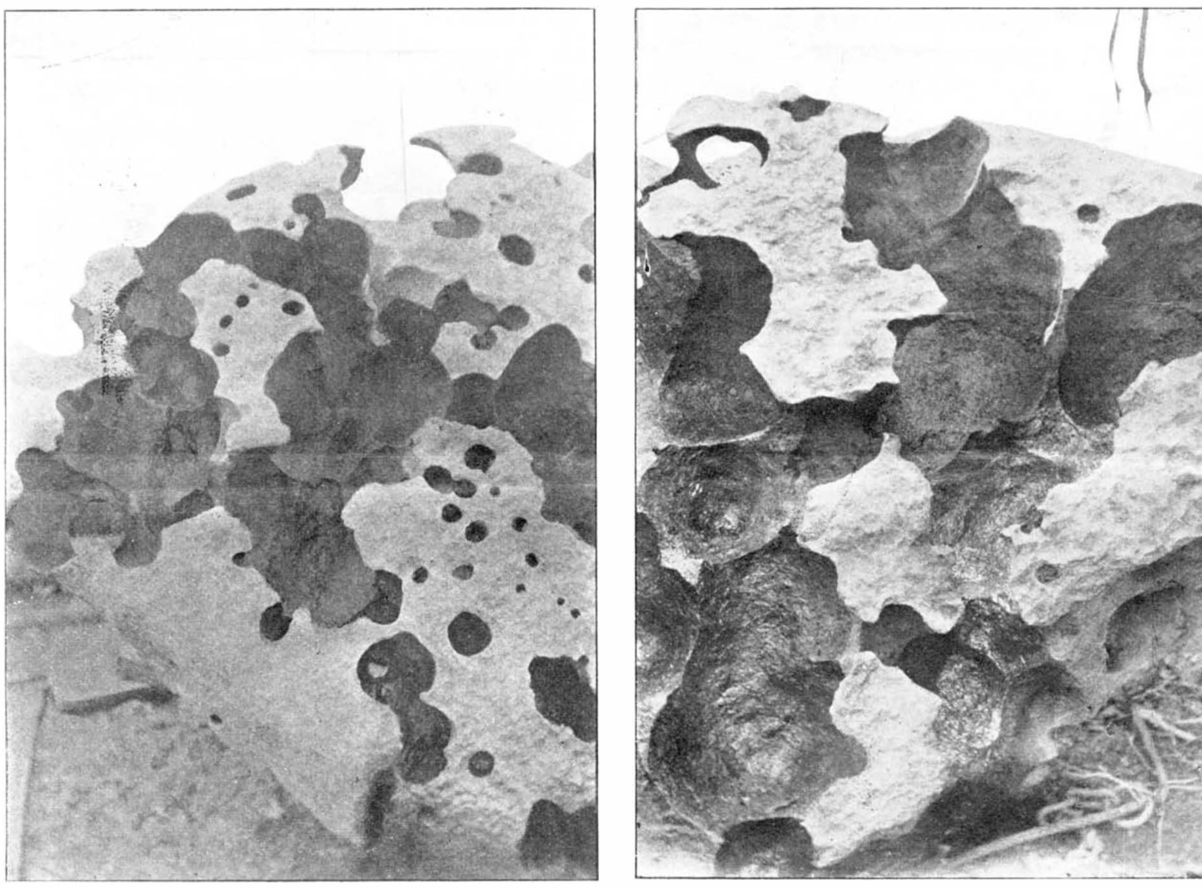
The total circumference of the base is 25 feet 4 inches.

It will be seen that while the upper dome is a circle in its section, this is not true of the lower part, which from mid-height expands before and behind into an oval form. This is observable where the lengthening of the base into an oval becomes quite clear, with the rapid slope of the right-hand end and a more gentle slope of the left. But regarding the mass at a right angle to this, or an end view, the sides of the central dome part are seen to come to the base almost vertically, and with very little enlargement or flaring.

The meteorite has thus the form of a huge abbreviated cone, having its base on two sides so prolonged as to produce an oval, whose long diameter is one-third greater than is its transverse diameter. There are no angular outlines to the mass as a whole; all, whether in vertical or horizontal section, is bounded by broad curves. At this point I may stop to say that as the meteorite lay buried in the ground, its base was uppermost; in other words, the reverse of the position it held upon the car. This position, with the apex of cone buried below, is unquestionably the one which it held as it came through our atmosphere during its immediate fall. That the great mass changed sides as it lay in the ground on the flat area where it fell is not to be conceived for a moment. Its front face in its flight was the apex of the cone. All features of the surface harmonize with this view. The upper half of this apex is devoid of any striæ such as so often occur on the *Brustseite* of a stone meteorite. Nor are there here any well-defined pittings. If these have ever existed, they are now completely effaced. This part of the great mass seems to have undergone but one change since it entered out atmosphere and there met the trials of intense atmospheric friction. The denuding influence of this may well be considered as having induced the generally round and even character of the upper cone, though no fine polish or striation remains. The one effect noticeable on all this area is the presence of little spots or patches from one to three or four centimeters in length, of material which seems more dense, and of a faintly deeper shade of color from that of the main mass. These appear over all the surface in question, sprinkled indiscriminately, without order or allineation. They stand slightly elevated above the surface, and might in loose terms be called scabs. I am disposed to think of these as representing flows of melted matter, which were once more wide-spread or continuous, but now show simply as patches. I will not enlarge upon this appearance, for the conditions under which I saw the mass were most unfavorable.*

Proceeding to examine the lower half of the cone, we have to notice three things: First there is a large border area, a border averaging eighteen or twenty inches wide, entirely around the mass, which is quite covered with the pittings (Pezographs) which are so common a feature on both iron and stone meteorites. These pittings are well defined and continuous, but are shallow. They are usually oval in form, with a greater diameter of from three to eight centimeters. They appear to have no distinct form or allineation; and they meet and merge into each other with but a fuller, slightly pronounced crest between them.

A second feature in this lower half of the great cone is the series of round bore-holes, sprinkled irregularly all around it and more generally near the lower border. These holes, which are so notable a feature on the Cañon Diablo siderite, as also in the Tazewell and in the Youndegin (Australian) masses, are here beautifully sharp and well defined. They are usually nearly circular in section, one to three inches in diameter, and in depth ranging from three or four inches to an undefined depth. These holes, notably those of smaller diameter, are sometimes materially larger in their inner portions than they are at their



AREA OF SOUTH PART OF BASE. AREA OF NORTH PART OF BASE.

WILLAMETTE METEORITE.

* Read before Rochester Academy of Science and republished from its Proceedings.

* I may be permitted to again remind the reader that, as I saw the meteorite after it was tipped off from the car, the cone end was down, and I could study it only while kneeling in the mud, holding an umbrella over my head in a heavy fall of rain and sleet, and with a temperature too cold to comfortably hold a pencil. The day will come when this cone—as indeed the whole meteorite—will be studied under more favorable circumstances.

outer orifice. This feature, observable also in the holes in the Cañon Diablo masses, seems to militate strongly, if not conclusively, against any theory of their existence being caused primarily by the boring action of the air in the meteorite's downward flight. They are undoubtedly due to the former presence of lengthened cylindrical nodules of troilites or some other sulphuret which have subsequently yielded to decomposition, and have generally dropped out. An interesting specimen in the Ward-Coonley meteorite collection is a mass, some 15 inches in diameter, of Cañon Diablo iron, with such a circular hole; its orifice being open, while all the lower part is occupied by the still remaining troilite nodule. In our Willamette iron no less than nine of these holes pierce the mass from its upper surface quite through to the base below.

The third feature of this upper (brustseite) face of the Willamette iron is one which now makes it the most remarkable meteorite known to science. This is the existence of deep, broadly open basins and broad furrows or channels cutting down deeply into the mass. The basins are distributed alike over the lower cone area. The furrows reach vertically quite across this belt to the lower edge or base of the mass, whose border they break with deep channeling. These deep bowl-like cavities and furrows exist more upon one of the sides of the meteorite than upon the other. And, as fate would have it, that was the side upon which the mass, tumbled from the car by Hughes, lay when I visited it. I was able (working from below) to get a view of the somewhat heart-shaped and double cavity. Its length was about 19 inches, its breadth about 14, and its depth about 5 inches at deepest part.

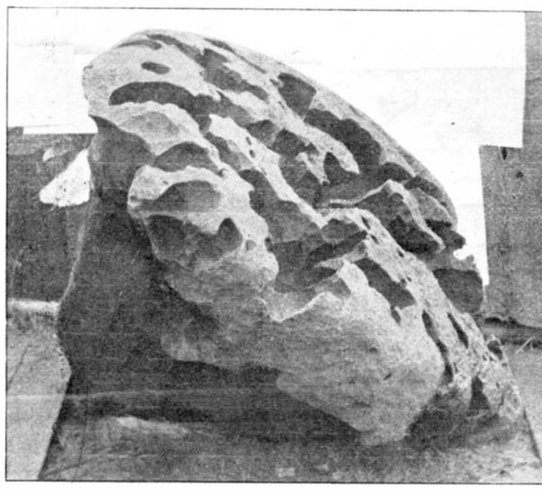
Other cavities (some from their form might be called basins, others caverns) were of various diameter at mouth, 5 to 10 inches, and varied in depth from 4 to 12 inches. In all cases these cavities had their widest expansion or opening toward the apex of the cone, in the line of flight of the meteorite. At the right hand of one of the cuts are visible two huge furrows or channels. One of these, the smaller, I was able to reach as the meteorite now lies, partly by sight, partly by feeling. Its length was 26 inches, its average breadth 5 inches, with a depth increasing from front backward from 3 to 5 inches. The parallelism of these furrows, as well as the allineation of the holes before mentioned, is an observable fact; while equally observable is their pointing from every side of the mass toward the apex of the cone. Nothing can be clearer than that this has been produced by the tremendous friction of the densely compressed air through which the meteorite passed on its way to our earth.

The air, which was compressed in front of the mass to a density comparable to that of some solid substance, has flown back past the apex and the sides of the cone with a friction force almost inconceivable in its intensity. The air crowded in front of a meteorite having a velocity of 60 miles per second has furthermore been shown by physicists to have, by reason of its compression, a heat of over 5,000 degrees Cent. (9,000 deg. Fahr.) a heat calculated to melt away any surface which it enveloped. It is to the melting, rubbing and chiseling effects of this air compression, with its following air-stream, that we may attribute all the glazing, pitting, hollowing, and channeling which we have observed on the front side of the cone and on the flanging base of our great meteorite. That the melting should be more powerful on the upper (forward) part of the cone is easily conceivable. Also it is clear that the boring and channeling power of the air should be most exercised on the basal flanges, on which it more directly impinged. The effects are here colossal, and words would feebly express the emotion induced in seeing the great cone, with its torn, excavated sides. It seems impossible in theory, but the whole is made easily credible in seeing and studying the effect. With it all comes forcibly the thought of how "Reason will lead where Imagination does not dare to follow."

It would be a serious omission not to call attention to the possibility, and even strong probability, that the great mass has contained great nodules or even long cylindrical inclusions of some mineral softer and more easily yielding to attrition than is the iron of which it seems to be wholly composed. We know that inclusions of troilite are frequent in siderites, in some of which, as for instance, Toluca, Youndegin, Cañon Diablo, and Bella Roca, they occur in masses of some volume. We suspect that the Willamette may contain such troilite inclusions, and that they may have both determined the position and have greatly enlarged these excavations. This is particularly true of the long furrows. In these, the upper part of the wall hangs over as a rim, leaving the tube or gutter, as seen from the side, larger within than in its outside exposure. These furrows, as well as one of the holes, gouge deep recesses out of the otherwise continuous border of the mass. As is noticeable, the lower part of the cone rolls smoothly around to join its base.

At this point in our paper we leave the cone or brustseite of our meteorite; repeating here that the three cuts taken before our arrival show the mass upright; nearly the reverse of the way we saw it. Views taken from either end show well the relation of the great meteorite cone to its base. With them is first revealed the second series of wonders of our most wonderful and absolutely unique meteorite.

On the base of the mass we shall see added phenomena. One illustration shows the full surface of the base of the great meteorite—its length, ten feet; its breadth, seven feet. It will be seen that its original surface was slightly crowning; also that this surface was covered with well-developed normal pittings of great similarity of character in all its parts. The remaining areas of this surface are in every case thus covered. Furthermore we observe the striking manner in which the base of our mass was drilled and bored by the clean, round holes which we have already noticed as existing in moderate numbers on the brustseite. Counting only those which are of limited diameter, there are over thirty of them, varying from a half inch to two and one-half inches across, and from

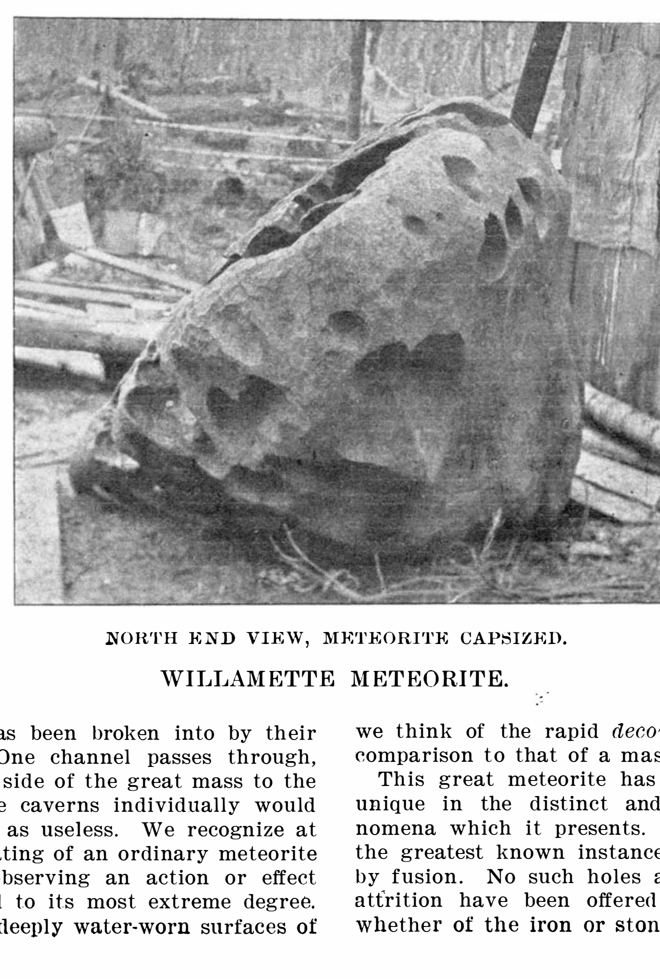


SOUTH END VIEW, METEORITE CAPSIZED.

three or four inches to an unmeasurable depth. Indeed, quite a few of them which are near the periphery, pass completely through the mass, as we noted when describing the other side. One of these perforating vertical holes or drill-holes is seen at the base of the figures; the other two are visible toward the extreme left. The position of these upon the base, the rear side of the meteorite, argues strongly for their origin being due to pre-existent troilite cylindroid nodules. The inner trend of some of these bores is quite irregular, and the surface roughened with sharp, tortuous ridges. Some few of the holes join each other below, anastomosing, as may sometimes be seen in sections of long troilite nodules in the face of a section of siderite. In the frequency of these long round holes and their general distribution over all sides of the mass, our present meteorite quite resembles, though it surpasses in this feature, Cañon Diablo.

But our attention is strongly drawn away from these aerial features, to so call these effects which were created and completed by the attrition and erosion of the mass as it flew through our atmosphere in its fall to our earth. For we have before us a most singular and astonishing group of concavities and caverns. Nothing can exceed the labyrinthine and chaotic outspread of these. They cross the mass from side to side and end to end. Yet they have no regularity of distribution or system of allineation. They make a confusion of kettle-holes; of wash-bowls; of small bath-tubs! One of the latter, crossing the mass diagonally, is three feet long by ten to fifteen inches across, and with an average depth of sixteen inches. Another, nearly circular, is two and one-sixth feet in diameter and eighteen inches in deepest part. This one is quadrifid in its bottom; each of the four areas being a distinct basin, swelling gently up from its center to the sharp crest running between it and its neighbors. Views of either end of the mass show well the depth and the *scooped* appearance of these caverns. The rim of the meteorite on one side has been broken into by their continuation outward. One channel passes through, opening a hole from one side of the great mass to the other. To describe these caverns individually would be impracticable as well as useless. We recognize at once that we are not treating of an ordinary meteorite phenomenon. We are observing an action or effect of *decomposition*, carried to its most extreme degree. We are reminded of the deeply water-worn surfaces of limestone in certain caves; of eroded blocks of gypsum; or, most of all, of the cragged protuberances of old coral rock. *These excavations in our meteorite are clearly due to the action of water.* This has not been an erosion, as have been the deep holes and channels of the other side of the mass. There are here no lines of flow, no connections in the nature or the trend of the depressions. We have to seek a different cause and a different mode of action. This is not difficult to find. It has been seen that this meteorite lay in its original bed, as it fell, with the conical end down, and the flat base upward and quite level; that it lay just below the surface of the ground in a soil highly charged throughout with vegetable matter, the accumulation of centuries under the falling leaves and branches of a primeval forest. Finally we remember that western Oregon is a region marked as a rain belt ever since it has been known at all. Every condition was favorable to the decomposition of this great mass of iron, so situated that its surface was ever soaked with abundant water, and that water was heavily charged with carbonic acid due to vegetable decomposition. Under such conditions the oxidation of the mass would go on rapidly. The depressions would soon be initiated; these would fill with water, and thenceforth the work of dissolution of the mass would go on rapidly and with ever-increasing area of surface and power of action. This is an action in which there has been no intermittence and no minimizing; for while the frosts of the short winter may have for a time yearly lessened the chemical action, the increased mechanical effects of freezing and thawing would have quite compensated in accomplishing the destructive work. It is especially noticeable in studying these caverns how certain portions of the surface of the mass have been left unaffected, holding to-day not only the original superficial level, but also retaining in fullest degree the pittings and all other markings which the mass had when at close of its flight it reached its bed. These areas of original surface stand as islands in the waste depressions of decomposition; and in the majority of cases the decomposition which has made the caverns, has also undermined these intervening areas. These latter thus stand on pedestals or bases which are hour-glass in form, dwindling from top downward and from below up. Thus it occurs that many of the round borings noticed before and which are so prominent a feature in the view of the base of the meteorite now pass quite through with a short passage from the old surface into the latter formed basin or cavern. Incidentally we may mention that the corroding progress of this decomposition has eaten holes, usually quite irregular in shape and often large in diameter, through the walls between the several basins. No less than ten of these, varying from two to eight inches in diameter, may be counted. The most casual view of the sides and bottom of these basins shows the entire difference of surface texture between them and the inside of the great holes and furrows on the brustseite of the meteorite. These basins have a rough, sandy surface, not for a moment to be compared with the rubbed-down, semi-polished inner wall of the air-worked hole. The difference of appearance is as palpable and somewhat similar to that which exists between a glaciated rock and a sawed or ground rock surface. Here is again the occasion to express the opinion that probably this immense and profound caverning of the lower sides of the meteorite has been in some important measure determined and intensified by the presence in the body of the mass of some softer and more easily decomposed material. Such, too, would be, as in the other case, considerable masses of troilite. Before, we invoked its erosive quality; now we think of the rapid *decomposition* of a sulphid in comparison to that of a mass of dense iron.

This great meteorite has shown itself to be quite unique in the distinct and essentially diverse phenomena which it presents. On one side, it offers us the greatest known instance of aerial erosion, helped by fusion. No such holes and furrows due to aerial attrition have been offered by any other meteorite, whether of the iron or stone class. While on the op-



NORTH END VIEW, METEORITE CAPSIZED.

WILLAMETTE METEORITE.

posite side it gives us a case of discrete decomposition of aqueous cause, far beyond anything before registered on these celestial bodies.

It is a truly interesting thing to see these two phenomena, each so potent, yet each so different in nature and in origin, connected with the same mass of matter, acting upon it at two different epochs, yet producing results having such general likeness in appearance. In the presence of these marks of cosmic power, all other features of our meteorite seem to dwindle. Even its great size loses some of its impressiveness. The measures of Willamette which I have given indicate its great size and give it place in this respect with the three largest meteorites known to science, a compeer of Peary's Anighito and of the Bacubirito, although not of the length of the latter nor of the cubic contents of either. It is interesting to note that all the largest meteorites have been irons. It is doubtful whether a mass of stone of such great volume could have come to our earth retaining its cohesion and integrity through the destructive agencies attending its atmospheric passage.

In a study made many years ago by Reichenbach in which some problems of meteorite flights are elaborated, it is shown that a meteorite passing with a lessened velocity of twenty miles per second through our atmosphere, with its computed density at the height of ten miles above our earth, would undergo a pressure of 7,700 pounds upon each cubic inch of its front surface. Only iron would sustain such pressure, and even this, as in the beautiful instance of Cabin Creek, is irresistibly affected.

To the light given forth by the glowing melted surface, with that of the stream of ignited particles flowing away behind the flying mass, must be added the enormously greater light of proambient air, itself heated by the compression mentioned. The light thus given out can be almost as little conceived of, as described. It is well known that the apparent size of any meteorite in its aerial flight is very much greater than is the real diameter of the solid mass. Numerous instances will be readily recalled where a meteorite

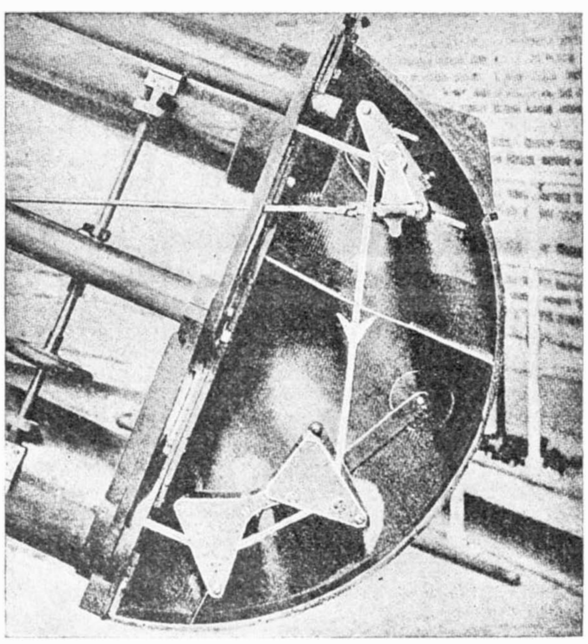


Fig. 1.—Showing the optical arrangement of the Spectroheliograph.

(the part that fell) was but a few inches in diameter, while the same in its passage through the heavens appeared as a globe of several feet in diameter. Thus we have the astonishing light effects in well observed meteorite falls where the whole country for miles on either side of its course is illuminated with the light of midday. The Athens meteor (October 18, 1863) is said to have thus momentarily lighted all Greece. How great and dazzling and wonderful was probably the illumination within a radius of many hundred miles when Willamette fell! With what aerial commotion, explosion and pyrotechnics must this great mass have traversed the atmosphere and screechingly sought its final home, "losing itself in the continuous woods where rolls the Oregon"!

The weight of the mass remains to be determined. Its shape makes its cubing a little difficult; and the difficulty is notably increased by the many and voluminous hollows. Assuming the average depth of these in the base at 10 inches, we may assume the total weight of the mass is probably lessened by fully one-fourth by reason of them. The mean of several careful computations, based upon numerous measures taken around the mass, and with knowledge of the specific gravity of the iron, makes the meteorite weigh about 27,000 pounds or 13½ tons. Before many months have passed we may probably have the great mass on scales, and thus know its exact weight. If our above estimate is correct, Willamette ranks in weight as the fourth among meteorites known to science, the larger of the two masses of Chupaderos weighing about 15½ tons.

An etched section of the Willamette iron shows it to belong to the octahedral group and to that division (No. 56) which is designated as broad octahedrite Og. But this structure is somewhat dimmed by numerous small flakes of a very much brighter and more lustrous iron than are the kamacite blades, and seeming to have no regular or definite form—the largest of them having a diameter of not more than 6 to 7 millimeters. These plates, at least in part, are apparently hexahedral, as some of the larger ones show Neumann lines on their etched surface. The patches of plessite are decidedly small, but occasionally show the alternating layers of kamacite and plessite formerly known as "Lapham markings." The taenite lines are plainly visible along the edges of the kamacite plates. There are numerous small troilite nodules from 1 to 3 millimeters in size scattered promiscuously throughout the section, and a few rod-shaped ones 1 millimeter in width, and in some instances up to 15 millimeters in length. The largest troilite nodule found in several sections was 28 millimeters in diameter. It incased several small patches of the nickeliferous iron. No schreibersite is apparent to the eye, nor would it be expected from the small amount of phosphorus found in the analysis of the iron. The exterior of the mass in our possession is of a dull reddish brown color, much oxidized, with a tendency to scale in small flakes. The fractured surface of this iron is much more coarsely granular in structure than is that of any iron with which I am familiar.

Perhaps more about the inner structure of the iron may be developed as the mass is further sectioned.

The above observations on the structure of the Willamette iron are made by my assistant, Mr. H. L. Preston, who has had my small mass (a few kilogrammes) in hand, in Rochester, for section.

Two analyses of the Willamette iron have been made for me; one by Mr. J. M. Davison, of the University of Rochester; the other by J. J. Whitfield, of Philadelphia. We give these below:

DAVISON.	
Iron	91.65
Nickel	7.88
Cobalt	.21
Phosphorus	.09
WHITFIELD.	
Iron	91.46
Nickel	8.30

The specific gravity of the iron is 7.7.

A NEW EPOCH IN SOLAR PHYSICS.*

UP to the year 1868 those rose colored appendages round the solar limb, the prominences, could only be observed at the times of total eclipses of the sun. The ingenious method for watching these phenomena any time when the sun shines we owe to the labors of Lockyer and Janssen, and the striking of a medal by the French government in honor of this important solar physical advance properly noted an epoch in this branch of astronomy.

By this new device, which was spectroscopic, the positions, forms, structure, and movements of the prominences that encircle the solar disk could be accurately watched and determined, and we owe a debt of gratitude to such men as Respighi, Tacchini, Ricco, Mascari, and others for the great work they have accomplished in taking advantage of this new line of research by recording daily the state of the solar limb in respect to these appendages. It must not be forgotten that all this work has been accomplished by eye observations alone. Sweeping round the solar limb and noting accurately the position, form, etc., of each prominence is not the work of a moment, even if the sky is clear, and it is astonishing what a great amount of valuable information has been gathered by this apparently sluggish method. When it is considered that one sweep of the spectroscopic slit round the solar limb only makes us acquainted with the prominences that exist in a very small section of the solar atmosphere and at only one particular moment of time, it was natural that early attempts were made not only to employ photography as a means of quickly recording these, but of devising, if possible, some method by which prominences on the solar disk itself could be also photographed.

It is not the object of the present article to trace the history of the development of the instrument, the photospectroheliograph, which now affords a means of satisfying these and other unlooked for requirements, but to give an account of the latest form adopted and results obtained by Prof. George E. Hale, of the Yerkes Observatory, to whom belongs a large part of the credit of designing and constructing an instrument capable of giving most successful results.

It may nevertheless be mentioned that Janssen in 1869 conceived the first idea of the method; he was followed by Braun, of Kalocsa, in 1872, and by Lohse, of Potsdam, in 1880. In 1889 Hale commenced work in this direction, and after him came Evershed in England and Deslandres in Paris, who both designed and used instruments which gave excellent results.

From time to time Prof. Hale has published accounts of the design of, and work accomplished by, his former instruments, but in a recent publication† he gives us a very full and detailed description not only of the latest form he has adopted, but of the magnificent photographs which he has secured with it.

To pass then at once to the modern photospectroheliograph, reference may first be made to the principle involved. The feature of the instrument is that it is capable of giving us pictures of the sun in light of one wave-length, or in monochromatic light. The instrument itself differs little in principle from an ordinary spectroscope if the eye-piece be replaced by a (second) slit. If the solar image be thrown by means of a lens on the first slit, then after the solar light has passed through the lenses and prisms of the spectroscope it will fall on the second slit, which will only allow a narrow portion of the spectrum to pass through it corresponding in width to this slit. The position of this second slit is, however, adjustable, and it can be made to coincide with any line in the solar spectrum. Thus any particular line can be completely isolated by this device. If now the solar image falling on the first slit be kept stationary, and the whole spectroscope be moved in a plane at right angles to the axis of the incident solar beam and in a direction at right angles to the length of the first slit, then the light that will pass through the second slit will be a succession of images in monochromatic light corresponding to the strips of the solar image which entered the first slit.

By adjusting the second slit on, say, the K line or calcium, and placing a photographic sensitive plate fixed independently of but nearly in contact with the surface of the second slit, then while the first slit is passing over the solar image, the second is moving over the film of the photographic plate at rest and allowing the monochromatic calcium K light to impress its successive images on the plate. The result is a picture of the sun in "K" light. Isolating different lines by means of the second slit, various monochromatic images of the sun in different "lights" can be secured.

An instrument made on the above principle is the ideal form to be used, but it can only be adopted when sunlight is thrown by means of a heliostat on to the lens which forms the image. It may be mentioned, by the way, that an instrument on this principle has recently been erected at the Solar Physics Observatory, South Kensington.

Prof. Hale wished, however, to employ his spectroheliograph in connection with the great Yerkes refractor of 40 inches aperture, so that he was obliged to adopt another method, because the movement of the spectroheliograph, which is of considerable weight, across the solar image formed at the focus of this large lens would have made the telescope vibrate, and produced in consequence bad solar images.

The method which he eventually adopted was to keep the whole spectroheliograph still in relation to the telescope itself, and to move the solar image uniformly across the first slit by means of a motor which actuated the declination slow motion of the telescope. Another difficulty then arose as regards the movement of the photographic holder, for this had to be made to travel across the second slit at the same uniform speed as the image over the first slit; this was finally

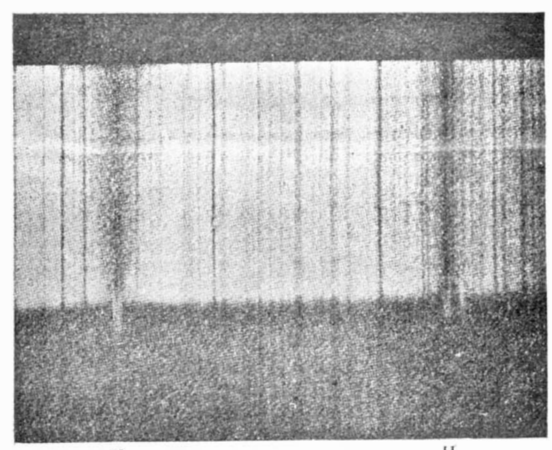


Fig. 2.—Reproduction of a photograph showing the H and K lines of calcium in the solar spectrum when large dispersion is employed.

overcome by connecting the plate holder directly with the declination motor, thus moving them simultaneously.

Although very similar in principle to the ordinary spectroscope, the spectroheliograph is different from it in many important details. In the first place both slits, instead of being straight as is usually the case in spectroscopes, are curved, and curved to a radius which is determined by the material of the prisms employed. Again, it is most convenient if the two tubes, carrying each a slit with its respective objective, and corresponding to the collimator and telescope tubes of the ordinary spectroscope, are arranged parallel to each other. This is accomplished by inserting between the collimator lens and the prisms (two in this case) a plane reflector which can be so adjusted that the light, after being reflected and passing through the prisms, emerges parallel to the beam falling on the reflector or to the collimator's axis.

By the use of the reflector in this position, thus rendering the prisms clear of the optical axis of the collimator, the instrument may be employed for another line of solar research, because when greater dispersion is required, as will be described further on, a grating may be inserted in its place. The optical arrangement, as briefly described above, can be seen from the accompanying illustration (Fig. 1), which shows this portion of the instrument alone. To indicate the path of the beam of light from the collimator objective to the second slit objective a white line has been drawn, the direction being indicated by the arrow head.

For further information regarding the details of the construction of the instrument the reader may be referred to Prof. Hale's account, but a few dimensions may be given here. Since the solar image formed by the forty-inch telescope measures seven inches in diameter, the two slits, both being supplied with the necessary means of adjustment, are eight inches long. The collimator and camera lenses are of the portrait type by Voigtländer, and are of equal aperture (6¼ inches) and focal length. These lenses are really too small for the large solar image dealt with, but Prof. Hale's statement that the considerable cost of lenses of about

* Nature.

† Publications of the Yerkes Observatory, vol. iii. part i.; also the Astrophysical Journal, vol. xix., No. 1, p. 41.

ten inches, the required size, rendered their purchase difficult, explains this defect.

Passing over several important points that are vital to the efficient working of this instrument, which would here take up too much space even to refer to at short length, such as a description of the movable plateholder, the adjustment of the several parts of the

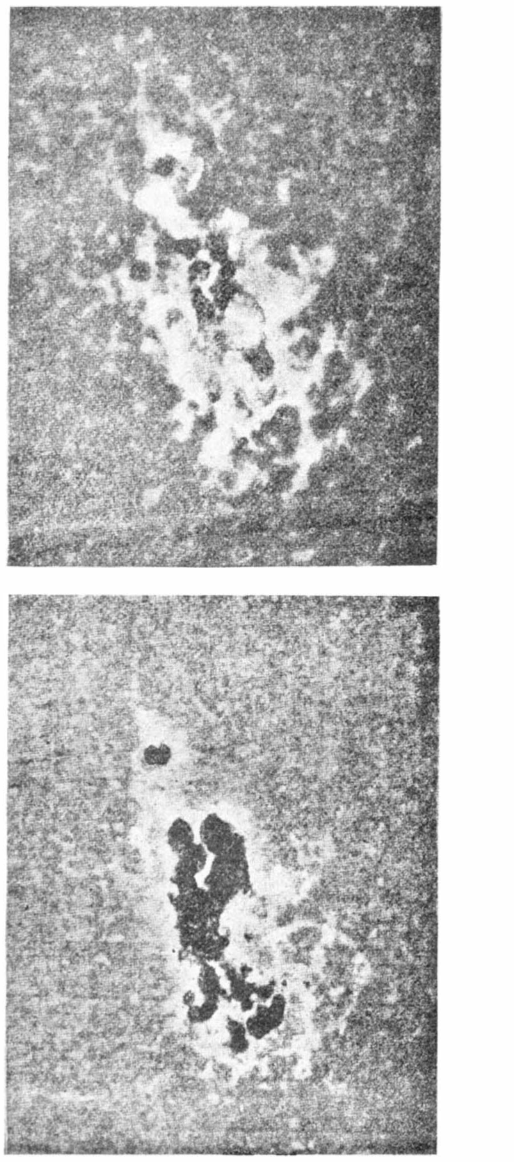


Fig. 3.—Showing that the bright calcium flocculi are more extensive at the H_2 level (upper photograph) than at the H_1 level (lower photograph). Notice that the spot is nearly obliterated at the H_2 level.

spectroheliograph, the value of diaphragms to reduce diffuse and reflected light, the method of setting the second slit on any particular line in the spectrum, etc., we now come to describe some of the results which are the first fruits of this research.

It has been stated above that if a line due to calcium be isolated by the second slit then we shall obtain a picture of the sun in calcium light; if a hydrogen or iron line be used, then a hydrogen or iron solar picture will be obtained. The lines which are the most easy to employ, and which give the best results, are those of H and K due to calcium. These lines in the solar

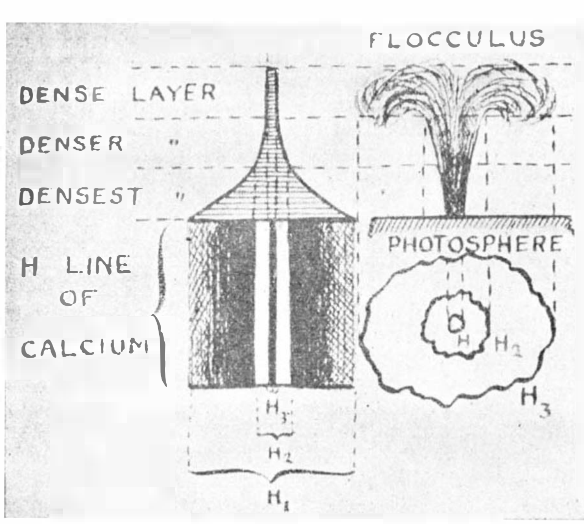


Fig. 4.—Diagram to illustrate the relation between the various portions of the H calcium line, the layers of different density, the resulting extent of the calcium flocculi and the probable appearance of their vertical sections.

spectrum (Fig. 2) are broad, of a composite structure, and are composed of three main parts, (1) a broad, dark band, designated by Prof. Hale as H_1 or K_1, (2) a comparatively narrow, bright line, lying at the center of this band at points on the sun's disk where the slit crosses hot masses of calcium vapor (H_2, K_2), and (3) a very narrow, dark line running through the center of H_2 and K_2 designated H_3 and K_3.

Now according as the second slit is made to isolate any part of either of these lines, so a calcium picture of the sun corresponding to this particular part of the line is obtained.

It may perhaps be mentioned that the name "flocculi" is here employed to designate the clouds of vapor which are photographed with the spectroheliograph. When the calcium line is employed "calcium flocculi" are photographed, or if the hydrogen line be used we obtain "hydrogen flocculi." These flocculi are, according to Prof. Hale, situated at a greater level above the photosphere than the "faculæ," the latter being elevated regions of the photosphere.

As the width of the H and K bands depends on the density of the calcium vapor, and the denser calcium in the sun is below that of less density, the pictures of the sun secured by using different parts of these lines will correspond to different levels. In fact, a means is thus employed of photographing sections of the calcium vapor, or of sounding the solar atmosphere with respect to this element. Thus, if the second slit be set at the extreme edge of H_1 or K_1, the resulting photograph will only show that calcium vapor

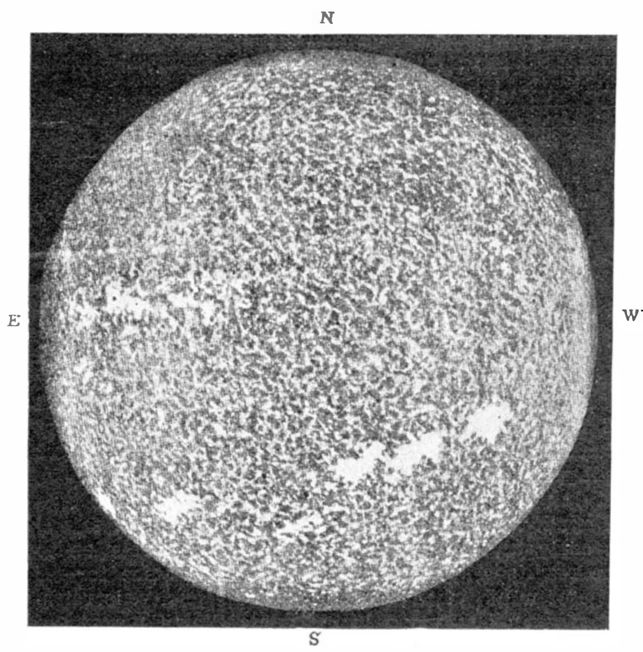


Fig. 5.—The sun in calcium light (H_2 level), showing the bright calcium flocculi, August 12, 1903.

which is dense enough to produce a line of this breadth, in fact, a section across the base of the calcium flocculus will be obtained. If set nearer the center of the line a section of the flocculus corresponding to a higher level will be produced.

Further, this calcium picture in the final positive is always bright on a dark background no matter which parts of the H or K lines are employed. That this is so can be seen from Prof. Hale's pictures taken in the H_1 or H_2, or K_1 or K_2 light; this is an important point to which reference will be made later.

An examination of several photographs has led Hale to deduce that the calcium flocculi when secured with the slit nearer H_3 or H_2, or K_3 or K_2 are more extensive than those taken near the outer edge of H_1 or K_1. It is argued from this that the calcium flocculi are most probably in general composed of a series of columns of vapor expanding as higher levels are

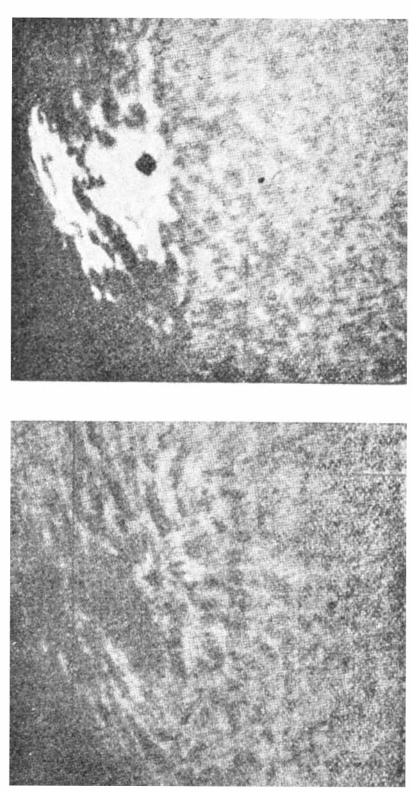


Fig. 6.—Two photographs of the same region of the solar disk taken on the same day, showing that where the bright calcium flocculi are present (upper photograph), the bright hydrogen flocculi (lower photograph) are absent.

reached, and possibly overhanging laterally (Fig. 3).

To explain this point a little more fully perhaps the accompanying diagram (Fig. 4) may prove of service. In the center of the diagram is drawn (on rather an exaggerated scale) the H line of calcium, and below this are lettered the detailed portions of it according to Hale's nomenclature. Above this are drawn three layers to represent three strata of calcium vapor corresponding to the width of the H line, which varies according to the density of the vapor. To investigate the distribution of the densest layer the portion H_1 of the H line is used, H_2 is employed for the less dense layer, and H_3 for the least dense.

At the right-hand side of Fig. 4 is a sketch of a portion of the solar surface taken separately with H_1, H_2, and H_3 lines, and we have therefore the H_1, H_2 and H_3 flocculi. As, according to Hale, the area of the H_3 flocculus is more extensive than that of H_2, and H_2 more extensive than that of H_1, if we project this to gain a mental image of the vertical distribution of this calcium vapor we obtain an object somewhat after that drawn above the three calcium flocculi. In fact, the object will take a form which is very like a tree-like prominence.

It is therefore of great interest to examine the same region of a large spot as photographed at two different levels, as in Fig. 3.

This illustration shows the region of the large spot of October 9, of last year, and the secondary slit was placed at the middle of the calcium H_1 level (lower picture), and at the calcium H_2 level (upper picture); the plates were exposed at 3h. 43m. and 3h. 30m. P. M., so that they may be taken to represent approximately the solar conditions at these two different levels for the same moment of time. The actual spot itself is best seen at the H_1 level, where the flocculi are not so extensive. At the H_2 level the spot is nearly completely covered up by the flocculi, which are here far more pronounced and extensive. At this level the calcium vapor overhangs parts of both the umbra and penumbra of the spot.

The general appearance of the disk of the sun taken in calcium light is shown in the accompanying figure (Fig. 5). Under good atmospheric conditions the whole disk is covered with minute structure resembling somewhat the granulation of the photosphere. Scattered along distinct zones in both hemispheres are large bunches here and there of flocculi.

These masses of flocculi partake of the general movement of rotation of the disk like the spots. Not only do their areas vary very considerably from time to time, but the positions at which they make their first appearance change both as regards latitude and longitude. The enormous extent of these calcium flocculi in relation to the solar disk, and their variation in amount from time to time, a fact also known, suggest that here we have an indication of solar action that has only up to the present time been feebly shown by spots.

It is the investigation of the amount and distribution of these flocculi from day to day and from year to year that makes the spectroheliograph such an important instrument at the present moment, for it is the only means existing of recording these important phenomena.

Not only has Prof. Hale employed the calcium lines in this work, but he has used other lines, notably those of hydrogen. For this investigation the plane reflector used in the optical train of the instrument is replaced by a grating, as larger dispersion of the spectrum has to be obtained. By this means the hydrogen or other lines are rendered somewhat broader, and it then becomes possible to isolate them completely by the second slit, the width of which is adjusted to be less than that of the lines employed, in order to cut out the continuous spectrum on both sides. Numerous photographs were secured with each of the H β, Hγ, and Hδ lines, and comparisons were made with the calcium photographs.

The striking point which this comparison at once showed was that where on the solar disk the calcium flocculi did not exist the hydrogen flocculi were most apparent (Fig. 6), or, as Prof. Hale says, "the hydrogen flocculi are, in general, dark, and that while they have a general resemblance in form to the bright calcium flocculi, the differences are in many cases very striking."

Perhaps a short digression may here be made, as it does not seem quite clear, at any rate to the writer of this article, what Prof. Hale really means by the terms "dark" hydrogen or "dark" calcium flocculi.

The principle of the spectroheliograph is that if a calcium line be chosen to work with, then the resulting solar disk is built up of two kinds of markings, namely, (a) where the calcium exists (bright), and (b) regions where it does not exist (dark). Further, as has already been pointed out, it does not matter which part of the calcium lines is used, as both the dark and bright parts produce bright calcium flocculi on the completed positive. Again, if a hydrogen line be used we have a disk built up of two kinds of markings, (c) where the hydrogen exists (bright), and (d) where no hydrogen exists (dark).

Since the existence of each of these substances on the sun's disk is indicated by bright markings, it is not quite clear why Prof. Hale calls the dark patches dark calcium or dark hydrogen, as in these parts calcium and hydrogen respectively are, according to the very principle of the spectroheliograph, shown to be absent.

It seems preferable to say that the regions where calcium exists correspond to those regions where hydrogen is absent than to say that the bright calcium flocculi resemble in form the dark hydrogen flocculi.

To show the confusion to which such a form of description as the last mentioned can lead one, a good instance is given on Plate viii., Figs. 3 and 4, of Prof. Hale's publication. There are shown two illustrations of the same region of the sun, one taken with the calcium line (K_2), and the other with the hydrogen line (H β). On each of these there is a peculiarly shaped

dark patch, evidently the same region on the solar disk, and the photographs show that in this region neither calcium nor hydrogen is present. According to Prof. Hale's notation, this patch should be called both a "dark calcium" and "dark hydrogen flocculus"! As a matter of fact, the marking might be due to quite another substance altogether, and although it appears dark when analyzed with either the calcium or hydrogen lines, it might appear as a "bright flocculus" if a line in the spectrum of the substance of which it is composed were used. Thus if at the particular levels at which the photographs were secured we knew that helium had been present in this region, then it would have been shown on the photograph as a dark patch if the calcium and hydrogen lines had been employed, and as a bright one if any of the helium lines had been isolated by the secondary slit.

Enough, perhaps, has been said to indicate that what is meant by the "dark hydrogen or calcium" flocculi is not quite clear.

The fact brought out by the beautiful series of photographs of Prof. Hale, that when the bright calcium flocculi are absent the bright hydrogen flocculi are present, raises a number of important points in solar physics which the spectroheliograph alone at the present time can attempt to solve.

Calcium and hydrogen are not, however, the only substances which exist in the solar atmosphere. How are the other materials distributed? The comparative thinness of the lines of these other substances in the solar spectrum makes it more difficult to analyze their distribution over the solar surface, but nevertheless possibly many of the strongest lines may yet be analyzed.

It will thus be seen that the new spectroheliograph in the hands of Prof. Hale and his co-worker, Mr. Ellerman, has opened up a new field of research which apparently has no limit. The facts that the sun is continually changing in activity and that the sky in any particular place is not always clear point out that for the study of the distribution of any particular element on the disk, one spectroheliograph at one station is not sufficient. Just as in the case of sunspots, three stations, widely separated, are required to produce a nearly daily record, so with this new instrument the same number of stations would be required for the study of one element. For the complete study of several elements, it will be seen, numerous instruments will have to be employed if every advantage is to be taken immediately to begin to gather the necessary material.

So important is it that this new instrument for solar research should be employed to tell us of the changes that are taking place in the sun from day to day and from year to year, that no time should be lost in constructing a sufficient number of them, in distributing them where the raw material, sunlight, can be most often procured, and in organizing a homogeneous plan of campaign.

When it is considered that a study of the solar changes is vital for the clear understanding of the numerous terrestrial variations which are so closely associated with our every day life, the necessity of such a programme is obvious.

Just as in the case of the charting of the heavens, so this work should be of an international character, for every country would be able to reap equally the benefits which such an organization would bring.

The Rumford spectroheliograph of the Yerkes Observatory having thus shown the exceptional value of this new method of solar research in the hands of Prof. Hale and Mr. Ellerman, future workers will find their task very much lightened by a study of this magnificent and epoch-making contribution to solar physics. It is satisfactory to note that for this work in particular among other valuable contributions to astronomy by the same author, the Royal Astronomical Society has this year awarded Prof. Hale its gold medal. WILLIAM J. S. LOCKYER.

CONTEMPORARY ELECTRICAL SCIENCE.*

NEW METHOD OF PREPARING ARGON.—H. Moissan and A. Rigaut prepare argon in the following manner: 100 liters of atmospheric nitrogen are prepared by eliminating the oxygen by means of heated copper turnings, and dried by means of sulphuric acid and potash. The gas is then passed through iron tubes containing a mixture of five parts of powdered quick-lime and three parts of magnesium powder free from oil and aluminium. After being in contact with the heated mixture for two hours, the gas is found to have shrunk to one-tenth of its original volume, and it then contains 10 per cent of argon. The gas is collected in a rubber sack, and passed through a heated porcelain tube containing 70 grammes of the mixture of lime and magnesium, a heated glass tube containing 70 grammes of the same, a third tube containing oxide of copper and two drying tubes containing sulphuric acid and potash respectively. After this treatment the gas only contains 5 to 10 per cent of nitrogen. Finally, the gas is circulated over metallic calcium, which absorbs the last traces of nitrogen and hydrogen. The apparatus requires two persons to work it and is capable of turning out 1 liter of argon in 12 hours. The argon obtained shows no traces of nitrogen bands in its spectrum. The new method marks a considerable advance upon its predecessors.—Moissan and Rigaut, Comptes Rendus, November 16, 1903.

MEASUREMENT OF SMALL INDUCTANCES.—W. Stroud and J. H. Oates have devised an apparatus which, though not quite so sensitive for the measurement of small capacities as Prof. Fleming's, is better adapted to the measurement of small inductances. The essential feature of their method consists in the employment of what is substantially an electro-dynamometer with laminated iron cores, or it may be briefly described as a movable coil d'Arsonval galvanometer, in which the permanent magnet is replaced by an electromagnet, with a laminated iron core, actuated by a 100-volt alternating current. The solid iron core inside the moving coil of the ordinary d'Arsonval is in this instrument also replaced by a laminated one. The instrument is used just like an electro-dynamometer when it is arranged for measuring the conductivity of electrolytes. The field magnet is placed across the mains, and the highly-insulated movable coil is used to replace the galvanometer in the bridge. The key must be in the battery circuit, and under no circumstances must it be in the galvanometer circuit. The apparatus may be used for measuring an inductance with certainty to something well under one-tenth of a millihenry. By adopting a specially sensitive arrangement the authors succeeded in reading down to 2 micro-henrys.—Stroud and Oates, Phil, Mag., December, 1903.

* Compiled by E. E. Fournier d'Albe in the Electrician.

THE DISCOVERY OF THE FUTURE.*

By H. G. WELLS.

IT will lead into my subject most conveniently to contrast and separate two divergent types of mind, types which are to be distinguished chiefly by their attitude toward time, and more particularly by the relative importance they attach and the relative amount of thought they give to the future of things.

The first of these two types of mind, and it is, I think, the predominant type, the type of the majority of living people, is that which seems scarcely to think of the future at all, which regards it as a sort of black nonexistence upon which the advancing present will presently write events. The second type, which is, I think, a more modern and much less abundant type of mind, thinks constantly and by preference of things to come, and of present things mainly in relation to the results that must arise from them. The former type of mind, when one gets it in its purity, is retrospective in habit, and it interprets the things of the present, and gives value to this and denies it to that, entirely with relation to the past. The latter type of mind is constructive in habit, it interprets the things of the present and gives value to this or that, entirely in relation to things designed or foreseen. While from that former point of view our life is simply to reap the consequences of the past, from this our life is to prepare the future. The former type one might speak of as the legal or submissive type of mind, because the business, the practice, and the training of a lawyer dispose him toward it; he of all men must most constantly refer to the law made, the right established, the precedent set, and most consistently ignore or condemn the thing that is only seeking to establish itself. The latter type of mind I might for contrast call the legislative, creative, organizing, or masterful type, because it is perpetually attacking and altering the established order of things, perpetually falling away from respect for what the past has given us. It sees the world as one great workshop, and the present is no more than material for the future, for the thing that is yet destined to be. It is in the active mood of thought, while the former is in the passive; it is the mind of youth, it is the mind more manifest among the western nations, while the former is the mind of age, the mind of the oriental.

Things have been, says the legal mind, and so we are here. And the creative mind says we are here because things have yet to be.

Now I do not wish to suggest that the great mass of people belong to either of these two types. Indeed, I speak of them as two distinct and distinguishable types mainly for convenience and in order to accentuate their distinction. There are probably very few people who brood constantly upon the past without any thought of the future at all, and there are probably scarcely any who live and think consistently in relation to the future. The great mass of people occupy an intermediate position between these extremes, they pass daily and hourly from the passive mood to the active, they see this thing in relation to its associations and that thing in relation to its consequences, and they do not even suspect that they are using two distinct methods in their minds.

But for all that they are distinct methods, the method of reference to the past and the method of reference to the future, and their mingling in many of our minds no more abolishes their difference than the existence of piebald horses proves that white is black.

I believe that it is not sufficiently recognized just how different in their consequences these two methods are, and just where their difference and where the failure to appreciate their difference takes one. This present time is a period of quite extraordinary uncertainty and indecision upon endless questions—moral questions, æsthetic questions, religious and political questions—upon which we should all of us be happier to feel assured and settled, and a very large amount of this floating uncertainty about these important matters is due to the fact that with most of us these two insufficiently distinguished ways of looking at things are not only present together, but in actual conflict in our minds, in unsuspected conflict; we pass from one to the other heedlessly without any clear recognition of the fundamental difference in conclusions that exists between the two, and we do this with disastrous results to our confidence and to our consistency in dealing with all sorts of things.

But before pointing out how divergent these two types or habits of mind really are, it is necessary to meet a possible objection to what has been said. I may put that objection in this form: Is not this distinction between a type of mind that thinks of the past and a type of mind that thinks of the future a sort of hair-splitting, almost like distinguishing between people who have left hands and people who have right? Everybody believes that the present is entirely determined by the past you say; but then everybody believes also that the present determines the future. Are we simply separating and contrasting two sides of everybody's opinion? To which one replies that we are not discussing what we know and believe about the relations of past, present, and future, or of the relation of cause and effect to each other in time. We all know the present depends for its causes on the past, and the future depends for its causes upon the present. But this discussion concerns the way in which we approach things upon this common ground of knowledge and belief. We may all know there is an east and a west, but if some of us always approach and look at things from the west, if some of us always approach and look at things from the east, and if others again wander about with a pretty disregard of direction, looking at things as chance determines, some of us will get to a westward conclusion of this journey, and some of us will get to an eastward conclusion, and some of us will get to no definite conclusion at all about all sorts of important matters. And yet those who are traveling east, and those who are traveling west, and those who are wandering haphazard, may be all upon the same ground of belief and statement and amid the same assembly of proven facts. Precisely the same thing will happen if you always approach things from the point of view of their causes, or if you approach them always with a view to their probable effects. And in several very important groups of human affairs it is possible to show quite clearly just how widely apart the two methods, pursued each in its purity, take those who follow them.

I suppose that three hundred years ago all people who thought at all about moral questions, about questions of right and wrong, deduced their rules of conduct absolutely and unreservedly from the past, from some dogmatic injunction, some finally settled decree. The great mass of people do so to-day. It is written, they say. Thou shalt not steal, for example—that is the sole, complete, sufficient reason why you should not steal, and even to-day there is a strong aversion to admit that there is any relation between the actual consequences of acts and the imperatives of right and wrong. Our lives are to reap the fruits of determinate things, and it is still a fundamental presumption of the established morality that one must do right though the heavens fall. But there are people coming into this world who would refuse to call it right if it brought the heavens about our heads, however authoritative its sources and sanctions, and this new disposition is, I believe, a growing one. I suppose in all ages people in a timid, hesitating, guilty way have tempered the austerity of a dogmatic moral code by small infractions to secure obviously kindly ends, but it was, I am told, the Jesuits who first deliberately sought to qualify the moral interpretation of acts by a consideration of their results. To-day there are few people who have not more or less clearly discovered the future as a more or less important factor in moral considerations. To-day there is a certain small proportion of people who frankly regard morality as a means to an end, as an overriding of immediate and personal considerations out of regard to something to be attained in the future, and who break away altogether from the idea of a code dogmatically established forever. Most of us are not so definite as that, but most of us are deeply tinged with the spirit of compromise between the past and the future; we profess an unbounded allegiance to the prescriptions of the past, and we practise a general observance of its injunctions, but we qualify to a vague, variable extent with considerations of expediency. We hold, for example, that we must respect our promises. But suppose we find unexpectedly that for one of us to keep a promise, which has been sealed and sworn in the most sacred fashion, must lead to the great suffering of some other human being, must lead, in fact, to practical evil? Would a man do right or wrong if he broke such a promise? The practical decision most modern people would make would be to break the promise. Most would say that they did evil to avoid a greater evil. But suppose it was not such very great suffering we were going to inflict, but only some suffering? And suppose it was a rather important promise? With most of us it would then come to be a matter of weighing the promise, the thing of the past, against this unexpected bad consequence, the thing of the future. And the smaller the overplus of evil consequences the more most of us would vacillate. But neither of the two types of mind we are contrasting would vacillate at all. The legal type of mind would obey the past unhesitatingly, the creative would unhesitatingly sacrifice it to the future. The legal mind would say, "they who break the law at any point break it altogether," while the creative mind would say, "let the dead past bury its dead." It is convenient to take my illustration from the sphere of promises, but it is in the realm of sexual morality that the two methods are most acutely in conflict.

And I would like to suggest that until you have definitely determined either to obey the real or imaginary imperatives of the past, or to set yourself toward the demands of some ideal of the future, until

* A discourse delivered at the Royal Institution.

you have made up your mind to adhere to one or other of these two types of mental action in these matters, you are not even within hope of a sustained consistency in the thought that underlies your acts, that in every issue of principle that comes upon you, you will be entirely at the mercy of the intellectual mood that happens to be ascendant at that particular moment in your mind.

In the sphere of public affairs also these two ways of looking at things work out into equally divergent and incompatible consequences. The legal mind insists upon treaties, constitutions, legitimacies, and charters; the legislative incessantly assails these. Whenever some period of stress sets in, some great conflict between institutions and the forces in things, there comes a sorting between these two types of mind. The legal mind becomes glorified and transfigured in the form of hopeless loyalty, the creative mind inspires revolutions and reconstructions. And particularly is this difference of attitude accentuated in the disputes that arise out of wars. In most modern wars there is no doubt quite traceable on one side or the other a distinct creative idea, a distinct regard for some future consequence; but the main dispute even in most modern wars and the sole dispute in most mediæval wars will be found to be a reference, not to the future, but to the past; to turn upon a question of fact and right. The wars of Plantagenet and Lancastrian England with France, for example, were based entirely upon a dummy claim, supported by obscure legal arguments, upon the crown of France. And the arguments that centered about the late war in South Africa ignored any ideal of a great united South African state almost entirely, and quibbled this way and that about who began the fighting and what was or was not written in some obscure revision of a treaty a score of years ago; yet beneath the legal issues the broad creative idea has been apparent in the public mind during this war. It will be found more or less definitely formulated beneath almost all the great wars of the past century, and a comparison of the wars of the nineteenth century with the wars of the middle ages will show, I think, that in this field also there has been a discovery of the future, an increasing disposition to shift the reference and values from things accomplished to things to come.

Yet though foresight creeps into our politics and a reference to consequence into our morality, it is still the past that dominates our lives. But why? Why are we so bound to it? It is into the future we go, tomorrow is the eventful thing for us. There lies all that remains to be felt by us and our children and all those that are dear to us. Yet we marshal and order men into classes entirely with regard to the past; we draw shame and honor out of the past; against the rights of property, the vested interests, the agreements and establishments of the past the future has no rights. Literature is for the most part history or history at one remove, and what is culture but a mold of interpretation into which new things are thrust, a collection of standards, a sort of bed of King Og, to which all new expressions must be lopped or stretched? Our conveniences, like our thoughts, are all retrospective. We travel on roads so narrow that they suffocate our traffic; we live in uncomfortable, inconvenient, life-wasting houses out of a love of familiar shapes and familiar customs and a dread of strangeness; all our public affairs are cramped by local boundaries impossibly restricted and small. Our clothing, our habits of speech, our spelling, our weights and measures, our coinage, our religious and political theories, all witness to the binding power of the past upon our minds. Yet we do not serve the past as the Chinese have done. There are degrees. We do not worship our ancestors or prescribe a rigid local costume; we venture to enlarge our stock of knowledge, and we qualify the classics with occasional adventures into original thought. Compared with the Chinese we are distinctly aware of the future. But compared with what we might be, the past is all our world.

The reason why the retrospective habit, the legal habit, is so dominant, and always has been so predominant, is of course a perfectly obvious one. We follow the fundamental human principle and take what we can get. All people believe the past is certain, defined, and knowable, and only a few people believe that it is possible to know anything about the future. Man has acquired the habit of going to the past because it was the line of least resistance for his mind. While a certain variable portion of the past is serviceable matter for knowledge in the case of everyone, the future is, to a mind without an imagination trained in scientific habits of thought, nonexistent. All our minds are made of memories. In our memories each of us has something that without any special training whatever will go back into the past and grip firmly and convincingly all sorts of workable facts, sometimes more convincingly than firmly. But the imagination, unless it is strengthened by a very sound training in the laws of causation, wanders like a lost child in the blackness of things to come and returns empty.

Many people believe, therefore, that there can be no sort of certainty about the future. You can know no more about the future, I was recently assured by a friend, than you can know which way a kitten will jump next. And to all who hold that view, who regard the future as a perpetual source of convulsive surprises, as an impenetrable, incurable, perpetual blackness, it is right and reasonable to derive such values as it is necessary to attach to things from the events that have certainly happened with regard to them. It is our ignorance of the future and our persuasion that that ignorance is absolutely incurable that alone gives the past its enormous predominance in our thoughts. But through the ages, the long unbroken succession of fortune tellers—and they flourish still—witnesses to the perpetually smoldering feeling that after all there may be a better sort of knowledge—a more serviceable sort of knowledge than that we now possess.

On the whole there is something sympathetic for the dupe of the fortune-teller in the spirit of modern science; it is one of the persuasions that come into one's mind, as one assimilates the broad conception of science, that the adequacy of causation is universal; that in absolute fact, if not in that little bubble of relative fact, which constitutes the individual life, in absolute fact the future is just as fixed and determinate, just as settled and inevitable, just as possible a matter of knowledge as the past. Our personal memory gives us an impression of the superior reality and trustworthiness of things in the past, as of things that have finally committed themselves and said their say, but the more clearly we master the leading conceptions of science the better we understand that this impression is one of the results of the peculiar conditions of our lives, and not an absolute truth. The man of science comes to believe at last that the events of the year A. D. 4000 are as fixed, settled, and unchangeable as the events of the year 1600. Only about the latter he has some material for belief and about the former practically none. And the question arises how far this absolute ignorance of the future is a fixed and necessary condition of human life, and how far some application of intellectual methods may not attenuate even if it does not absolutely set aside the veil between ourselves and things to come. And I am venturing to suggest to you that along certain lines and with certain qualifications and limitations a working knowledge of things in the future is a possible and practicable thing. And in order to support this suggestion I would call your attention to certain facts about our knowledge of the past, and more particularly I would insist upon this, that about the past our range of absolute certainty is very limited indeed. About the past I would suggest we are inclined to overestimate our certainty, just as I think we are inclined to underestimate the certainties of the future. And such a knowledge of the past as we have is not all of the same sort or derived from the same sources. Let us consider just what an educated man of to-day knows of the past. First of all he has the realest of all knowledge—the knowledge of his own personal experiences, his memory. Uneducated people believe their memories absolutely, and most educated people believe them with a few reservations. Some of us take up a critical attitude even toward our own memories; we know that they not only sometimes drop things out, but that sometimes a sort of dreaming or a strong suggestion will put things in. But for all that, memory remains vivid and real as no other knowledge can be, and to have seen and heard and felt is to be nearest to absolute conviction. Yet our memory of direct impressions is only the smallest part of what we know. Outside that bright area comes knowledge of a different order—the knowledge brought to us by other people. Outside our immediate personal memory there comes this wider area of facts or quasi facts told us by more or less trustworthy people, told us by word of mouth or by the written word of living and of dead writers. This is the past of report, rumor, tradition, and history—the second sort of knowledge of the past. The nearer knowledge of this sort is abundant and clear and detailed, remoter it becomes vaguer, still more remotely in time and space it dies down to brief, imperfect inscriptions and enigmatical traditions, and at last dies away, so far as the records and traditions of humanity go, into a doubt and darkness as black, just as black, as futurity. And now let me remind you that this second zone of knowledge outside the bright area of what we have felt and witnessed and handled for ourselves—this zone of hearsay and history and tradition—completed the whole knowledge of the past that was accessible to Shakespeare, for example. To these limits man's knowledge of the past was absolutely confined save for some inklings and guesses, save for some small, almost negligible beginnings, until the nineteenth century began. Besides the correct knowledge in this scheme of hearsay and history a man had a certain amount of legend and error that rounded off the picture in a very satisfactory and misleading way, according to Bishop Ussher, just exactly 4004 years B. C. And that was man's universal history—that was his all—until the scientific epoch began. And beyond those limits—? Well, I suppose the educated man of the sixteenth century was as certain of the nonexistence of anything before the creation of the world as he was, and as most of us are still, of the practical nonexistence of the future, or at any rate he was as satisfied of the impossibility of knowledge in the one direction as in the other.

But modern science, that is to say the relentless systematic criticism of phenomena, has in the past hundred years absolutely destroyed the conception of a finitely distant beginning of things; has abolished such limits to the past as a dated creation set, and added an enormous vista to that limited sixteenth century outlook. And what I would insist upon is that this further knowledge is a new kind of knowledge, obtained in a new kind of way. We know to-day, quite as confidently and in many respects more intimately than we know Sargon or Zenobia or Caractacus, the form and the habits of creatures that no living being has ever met, that no human eye has ever regarded, and the character of scenery that no man has ever seen or can ever possibly see; we picture to ourselves the labyrinthodon raising its clumsy head above the waters of the carboniferous swamps in which he lived, and we figure the pterodactyls, those great bird lizards, flapping their way athwart the forests of the Mesozoic age with exactly the same certainty as that with which we picture the rhinoceros or the vulture. I doubt no more about the facts in this further picture than I do about those in the nearest. I believe in the megatherium which I have never seen as confidently as I believe in the hippopotamus that has engulfed buns from my hand. A vast amount of detail in that further picture is now fixed and finite for all time. And a countless number of investigators are persistently and confidently enlarging, amplifying, correcting, and pushing further and further back the boundaries of this greater past—this prehuman past—that the scientific criticism of existing phenomena has discovered and restored and brought for the first time into the world of human thought. We have become possessed of a new and once unsuspected history of the world—of which all the history that was known, for example, to Dr. Johnson is only the brief concluding chapter; and even that concluding chapter has been greatly enlarged and corrected by the exploring archæologists working strictly upon the lines of the new method—that is to say, the comparison and criticism of suggestive facts.

I want particularly to insist upon this, that all this outer past—this nonhistorical past—is the product of a new and keener habit of inquiry, and no sort of revelation. It is simply due to a new and more critical way of looking at things. Our knowledge of the geological past, clear and definite as it has become, is of a different and lower order than the knowledge of our memory, and yet of a quite practicable and trustworthy order—a knowledge good enough to go upon; and if one were to speak of the private memory as the personal past, of the next wider area of knowledge as the traditional or historical past, then one might call all that great and inspiring background of remoter geological time the inductive past.

And this great discovery of the inductive past was got by the discussion and rediscussion and effective criticism of a number of existing facts, odd-shaped lumps of stone, streaks and bandings in quarries and cliffs, anatomical and developmental detail that had always been about in the world, that had been lying at the feet of mankind so long as mankind had existed, but that no one had ever dreamed before could supply any information at all, much more reveal such astounding and enlightening vistas. Looked at in a new way they became sources of dazzling and penetrating light. The remoter past lit up and became a picture. Considered as effects, compared and criticised, they yielded a clairvoyant vision of the history of interminable years.

And now, if it has been possible for men by picking out a number of suggestive and significant looking things in the present, by comparing them, criticising them, and discussing them, with a perpetual insistence upon "Why?" without any guiding tradition, and indeed in the teeth of established beliefs, to construct this amazing searchlight of inference into the remoter past, is it really, after all, such an extravagant and hopeless thing to suggest that, by seeking for operating causes instead of for fossils, and by criticising them as persistently and thoroughly as the geological record has been criticised, it may be possible to throw a searchlight of inference forward instead of backward, and to attain to a knowledge of coming things as clear, as universally convincing, and infinitely more important to mankind than the clear vision of the past that geology has opened to us during the nineteenth century?

Let us grant that anything to correspond with the memory, anything having the same relation to the future that memory has to the past, is out of the question. We cannot imagine, of course, that we can ever know any personal future to correspond with our personal past, or any traditional future to correspond with our traditional past; but the possibility of an inductive future to correspond with that great inductive past of geology and archæology is an altogether different thing.

(To be continued.)

EFFECT OF N-RAYS UPON THE EYE.—R. Blondlot has made another remarkable discovery in connection with N-rays. He happened to have his eyes fixed on a small feebly-illuminated band of paper at a distance of about 1 meter. A brick, which had been exposed to sunlight, was brought near his face from one side, with the exposed surface toward him. He at once saw the band of paper brighten up. The effect disappeared on removing the brick, or on turning its unexposed side toward his face. But it was not affected by inclosing the brick in a box closed with black paper. A simple experiment is to darken the room until the face of a clock on the wall is only feebly visible. On bringing a solarized brick or pebble near the eye, the face of the clock becomes sharper in outline, and possibly the hands are seen. This was surprising considering that N-rays are known to be absorbed by moisture, and could therefore not affect the retina through the humors of the eye. But the author has found that saline solutions do not absorb the rays, and that a freshly prepared ox's eye transmits them freely in all directions. Moreover, saline solutions, especially of hyposulphite of soda, store

up the rays, and may be used as sources of N-rays in the place of a Nernst lamp. The author supposes that the rays play a hitherto unknown part in the economy of animal and vegetable life.—R. Blondlot, Comptes Rendus, November 23, 1903.

ON THE GLACIAL POTHOLE IN THE NATIONAL MUSEUM.*

By GEORGE P. MERRILL.

FOR several years the department of geology of the National Museum was on the lookout for a desirable object of the nature indicated by the above title and of such dimensions and so situated as to allow its removal and installation in the National Museum. In the summer of 1884 the one finally obtained was "located," but it was not until 1892 that conditions favored the attempt to remove it. The supervision of the work was intrusted to Dr. O. C. Farrington, to whom I am indebted for the account of its extraction given below. The rock in which the pothole occurs is a gray, white-banded, strongly foliated, micaceous gneiss, standing nearly on edge, with the hole eroded parallel with the foliation. These features are shown in the accompanying illustration. It is scarcely necessary to state that the parallel flutings on the outside of the block were caused by the drills during the process of extraction. Although somewhat shattered by the jar of blasting, as stated by Dr. Farrington, the injury was easily remedied by a little cement, and the specimen as it stands to-day is one of the most striking in the department. The total weight of the specimen is about 4,000 pounds.

Following is a transcript of the label:

GLACIAL POTHOLE.

Riggsville Landing, Georgetown, Maine, 60,-880. Collected for the Museum under the direction of O. C. Farrington. 1893.

"Besides its proper and characteristic rock erosion, a glacier is aided in a singular way by the co-operation of running water. Among the Alps, during the day in summer, much ice is melted, and the water courses over the glaciers in brooks which, as they reach the crevasses, tumble down in rushing waterfalls, and are lost in the depths of the ice. Directed, however, by the form of the ice passage against the rocky floor of the valley, the water descends at a particular spot, carrying with it the sand, mud, and stones which it may have swept away from the surface of the glacier. By means of these materials it erodes deep potholes (moulins), in which the rounded detritus is left as the crevasse is closed or moves up the valley."—Geikie, p. 400.

The pothole here exhibited is assumed to have been formed by a glacial ice stream in the manner described, during the melting of the ice sheet of the Glacial epoch. Similar holes are formed by running streams, but in this case there is now no stream in the near vicinity, nor traces of others than those temporarily formed by the melting ice. This hole was one of several situated on the rocky shore of a cove a few feet above tidewater action. The largest one is described as some 14 feet in depth. It is stated that a smaller hole is always to be found at a distance of a few feet to the southward of each of the large ones.

The inequalities of the interior of the hole are due to the unequal hardness of the material, and perhaps in part to the direction of the current of water. The rock is gneiss, and it will be observed that the hole is cut parallel with the foliation, the gneiss at this point standing nearly vertical.

Holes of this kind are variously called potholes, moulins, giants' kettles, and caldrons, and sometimes Indian ovens, or kettles, from the popular belief that they were excavated by the Indians and used in grinding corn or cooking food.

The following description regarding the work of extraction is taken from Dr. Farrington's notes:

"This pothole was one of a score or more found in the vicinity of Riggsville Landing, Georgetown, Maine. They are variously situated, in different degrees of preservation, and vary in depth from a few inches to fourteen feet. Nearly all were visited with a view to ascertaining which were best adapted for removal, but only one was found which seemed to be at all favorably situated for the purpose. This had a depth of 40 inches, a diameter of 20 inches, and was situated on the edge of a sea-wall which furnished one face of the block which it would be necessary to cut out, and giving room for horizontal drilling without the excavation of a large amount of rock from the front. The bed-rock here also appeared on careful examination to be nearly free from seams or joints, and though a gneiss of contorted structure, quite tough and homogeneous.

"To 'dig up a well,' however, is proverbially an impossible task, and even with so many favoring circumstances the work presented difficulties which made success seem very doubtful.

"So evident were these, especially when the small amount of money available for the work was taken into consideration, that it was some time before a contractor could be found willing to undertake it.

"Finally, however, a Bath firm, Messrs. Liberty & Lake, consented to make the attempt, on condition of being freed from responsibility if the work was a failure.

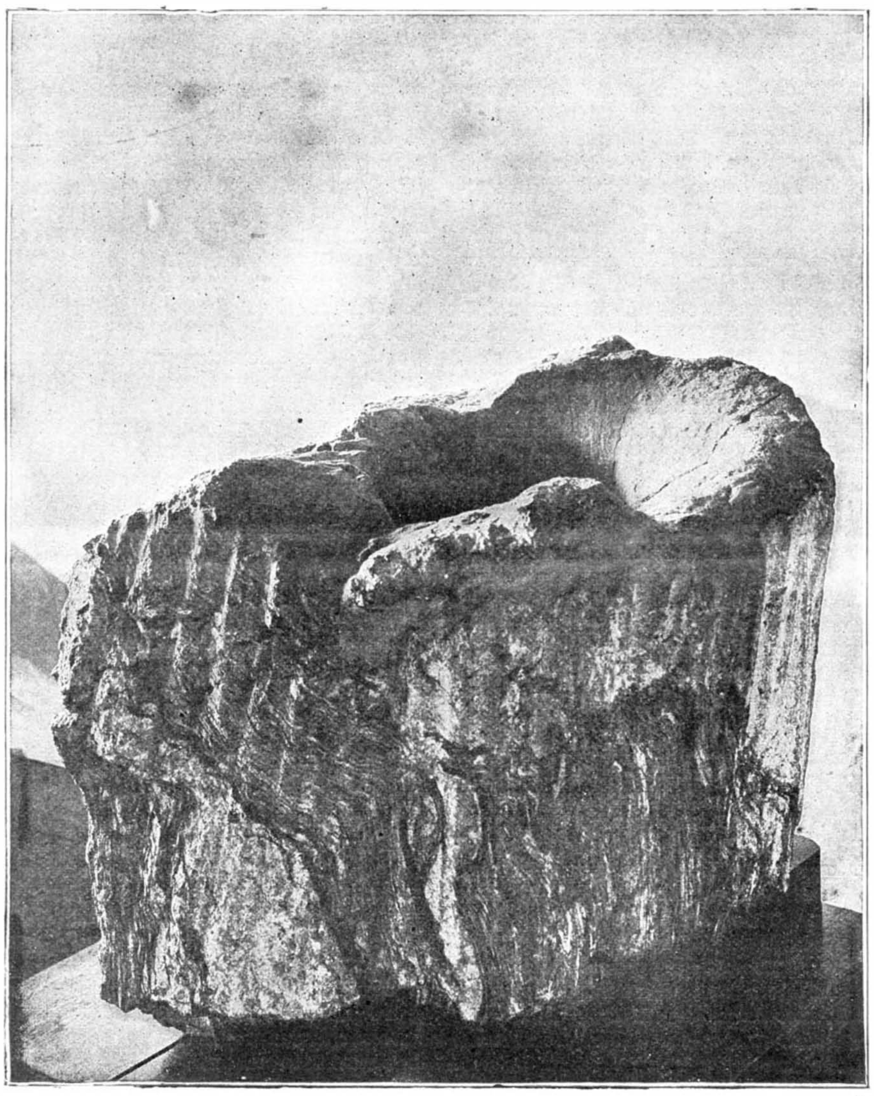
"The task in hand was to drill a solid row of vertical holes four feet deep around three sides of the pothole, then having excavated on the sea-wall side sufficiently to give room for the use of tools, to drill a horizontal row meeting these some inches below the bottom of the pothole and thus cut out a block containing it.

"The first plan was to do the drilling by hand, but as seventy-five holes must be made, each four feet in depth, it was found that this would require the labor of as many men as could be employed for several months and an expense quite beyond the means available. Accordingly a steam drill and scow were procured and work begun with these on April 12. Some large masses of overhanging rock were soon found to interfere with the working of the drill, and as the removal of these by hand would have been very tedious and expensive, it was thought best to employ powder. The result, however, was disastrous to the perfection of the pothole, since the concussion from the explosion shattered the ledge and opened several seams, showing that the rock was by no means the tough, homogeneous mass which it had appeared to be.

"As the work proceeded this weakness became more apparent, as even the jar from the pounding of the drill caused pieces of the interior of the 'well' to loosen and fall away and the seams to open still wider. All devices resorted to for overcoming this, such as keeping the stone wet and lining the interior with plaster and cement, were of little avail. Before the drilling could be completed other masses of rock had to be removed, and as our financial resources would not allow doing this by hand, powder was necessarily employed, to the further injury of the pothole as a specimen. After two weeks of this work the drilling was finished and the cutting by hand of the cores between the drill-holes commenced, a task which occupied about a week. To free the block from its bed, pairs of long iron wedges were inserted in the horizontal holes at the bottom and driven in till the mass was raised a few inches, when it was brought forward and grappled with a chain. It was then hoisted by means of a derrick, transferred to a scow (great care being necessary in this operation lest the block should break apart), and, on May 2, towed to Bath, where it remained for some days before being shipped to Washington.

"For the guidance of those who would undertake similar work it should be noted that sufficient means ought to be provided to perform the task without the use of explosives, since these are certain to shatter the rock to a greater or less extent. The damage might be less to a rock of different structure, such as granite, but in the present instance the disintegrating action of ice and water upon the interior of the pothole for ages has necessarily left it in a brittle condition.

"Acknowledgments are due Mr. G. C. Campbell, owner of the land on which the pothole was situated, for the gift of the stone and for assistance rendered in every way possible to facilitate the work. To Messrs. Liberty & Lake credit is given for their enterprise in undertaking the work and for the ingenuity and skill displayed in overcoming its difficulties."



THE GLACIAL POTHOLE IN THE NATIONAL MUSEUM.

* From Smithsonian Miscellaneous Publications.

A PHILIPPINE CENSUS.

THE census of the Philippine Islands, completed under Brigadier-General J. P. Sanger, shows that our Pacific possessions have a population of 7,635,426, of which 647,740 are classified as wild and uncivilized, although not without some knowledge of the domestic arts.

This is the first accurate and complete enumeration of the Filipinos ever made, those undertaken by the Spanish authorities being largely estimates. It was taken by the Philippine Census Bureau, which was organized by Gen. Sanger.

Gen. Sanger's report gives the population of the Philippines by islands, provinces, municipalities and barrios. It is classified also by tribes and religions.

The tables give separate enumerations for 343 islands which bear names, and many others are grouped together unnamed. The most populous island is Luzon, which contains a total of 3,798,507, of which 223,506 are classified as wild. Panay is next in population with 743,646, of which 14,933 are wild; Cebu, third, with 592,247, all civilized, and Mindanao is fourth, with 499,634, of which 252,940 are wild. Jolo, with 44,718 inhabitants, contains only 1,270 who are civilized, and the province of Cotabato, with 125,875 people, has but 2,313 civilized.

The city of Manila contains 219,028 inhabitants, which includes 15,901 who reside on vessels in the harbor, while 11,460 live in the limits of the city walls.

Gen. Sanger states the aborigines of the Philippines are believed to be the Negritos, of whom 23,000 still remain. They are distributed over many of the different provinces and live in a primitive state, having no fixed habitations or occupations, but wander about in the forests, living on such food as they can find. They are very short in stature, the males averaging only 4 feet 10 inches and the females even less. Their color is black, their hair woolly and bushy, and their toes are remarkably prehensile, they using them almost as well as fingers.

These people probably approach as near to the conception of primitive man as any people thus far discovered. Their origin is shrouded in obscurity, but from the fact that similar types are found in the Malay peninsula and on the islands in the Bay of Bengal, it is concluded they once occupied the entire Malay archipelago.

Of the other wild tribes in the islands the most important are the Igorotes, in northern Luzon, who are divided into several branches, with different names. One of these branches, inhabiting the sub-province of Bontoc, is said to be the most famous of head hunters. Another curious tribe of head hunters is the Ibilao, sometimes called Ilongot, in the province of Isabella, while in Mindanao are seventeen wild tribes, nearly all of which have the beliefs and ceremonial customs of savages. They not only take the heads of vanquished enemies, but their hands and hearts as well, and offer human sacrifices to their deities.

The report divides the civilized Filipinos into eight tribes, the Bicol, Cagayan, Ilocano, Pampangan, Pangasinan, Tagalog, Visayan, and Zambalan, the most numerous of which is the Visayan. While the great mass of the people are Malays, and had common origin, there is a difference in their written and spoken languages, but not much in their customs. For such progress as they had made they are indebted, says the report, somewhat to the Chinese, with whom they came in contact hundreds of years ago, before the arrival of the Spanish, and since then to the religious orders.

which had contributed largely to their civilization and education.

The archipelago was divided into five dioceses and 746 regular parishes, 105 mission parishes, and 116 missions. Notwithstanding the inestimable services rendered by the friars, the report says, they succeeded in exciting the bitter antagonism of the Filipinos, which was beyond question a powerful incentive to the revolution of 1896. Now that the friars' land question has been settled, it is probable, says Gen. Sanger, that the Roman Catholic clergy will substitute a large number of the friars and that all cause of agitation on their account will be removed.

In a chapter on the Bicol tribe, the governor of the province of Ambos Camarines remarks that a very noticeable characteristic of that people is the aggressiveness displayed by the females and their evident superiority to the males in business capacity. Wherever a family had risen from the lower ranks of society to a position of comparative affluence and social importance, it was generally found due to the tact, energy, and close attention to business of the female member of the matrimonial partnership.

The Ilocanos, to quote one of their number, like all nations of the world, have many and varied superstitions, among them one that they do not take a bath, marry, or start on a voyage on Thursdays. The raven they consider a bird of ill omen, and when it croaks it is regarded as a sign of some misfortune. A gambler, if he meets a woman on the way to a gambling house, returns, as he believes it a sign of bad luck.

These superstitions, and others of a more injurious nature, says the report, prevail generally among the ignorant masses, and are not unlike those which afflict many people in the United States and other countries. It was needless to say that they interfered with the daily affairs of life and were the cause of much unnecessary anxiety and suffering, and sometimes of serious crimes. Fortunately, they would disappear as the people became more intelligent and rational and therefore less inclined to believe in bogies of any kind.

THE THYLACINE.

(*Thylacinus cynocephalus.*)

By P. L. SCLATER, F.R.S.

IN the late Sir William Flower's excellent "Introduction to the Study of Mammals" the threefold division of that order, originally proposed by Blainville, into "Ornithodelphia," "Didelphia," and "Monodelphia" is fully maintained, although, for good reasons, Huxley's change of these names into "Prototheria," "Metatheria," and "Eutheria" is adopted, as being "far less open to objection." The Metatheria, as Flower points out, are represented in the present epoch by numerous species which offer considerable diversities in appearance, in structure, and in habits, although they all agree in many anatomical and physiological characters which give them an intermediate position between the Prototheria and the Eutheria. The most important of the latter set of characters is that the young of the Metatheria are brought forth in a rudimentary condition, and are nourished by milk injected into their mouths from the maternal mammæ, to which they are firmly attached for some time after their birth. During this process the young, in nearly all cases, are sheltered in an abdominal pouch or *marsupium*, whence the Metatheria have received the more familiar name of "Marsupials."

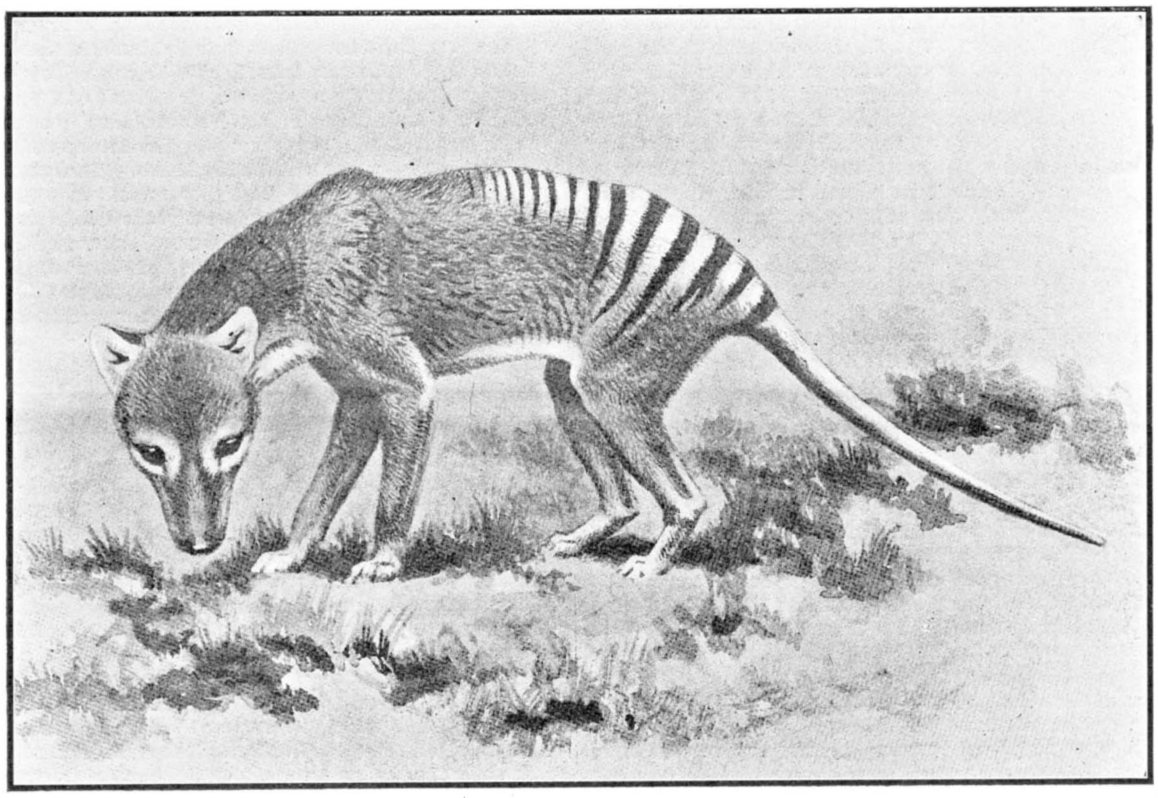
The Marsupials then, as we will call them, are usually divided into two sections, the Diprotodonts and the Polyprotodonts. Of the former of these, which with a few unimportant exceptions are vegetable feeders, the best known are the kangaroos of Australia and the adjacent islands, while of the Polyprotodonts, which are carnivorous and insectivorous, the finest and largest representative now living on the earth's surface is the Thylacine of Tasmania, the animal represented in the accompanying drawing.

On first seeing the Thylacine alive the uninformed spectator would naturally take it for a dog or a wolf. And indeed in general external appearance the Thylacine is excessively like one of these animals, but it is, nevertheless, undoubtedly a Marsupial in every essential part of its structure, and like most other members of the Metatherian group carries its newborn young in an abdominal pouch. It is also at once distinguishable from a wolf by its long, tapering, and thinly-haired tail, as is well shown in our picture, and by the curious transverse stripes on the back, which are very prominent in the living animal.

The Thylacine is a native of Tasmania, and is not found in any other part of the world, although in a former geological epoch an allied form, which has been named *Thylacinus spelæus* by Prof. Owen, existed in the adjacent parts of Australia. In Tasmania the Thylacine is said to be popularly known as the "tiger" or "hyæna," from its rapacious habits, but is also often called, more appropriately, the "Tasmanian wolf."

In former days, when Tasmania was first peopled by Europeans, the Thylacine was common in all the rocky and mountainous districts of the island, and at that time found an abundant supply of food in the native kangaroos and bandicoots. But when sheep were introduced into the colony, and bred in large numbers, the Thylacine soon learned to attack the sheepfolds, and consequently became an object of persecution to the Tasmanian shepherds, whose fierce hostility has now brought it to the verge of extinction. Of late years, indeed, very few living specimens of it have reached Europe, and the Zoological Society is fortunate in having secured the fine young male example now figured, which was obtained by purchase in March, 1902. So far as I know, this is the only specimen of the Thylacine now alive in Europe.

The first living Thylacines ever received by the Zoological Society were a young pair presented by their corresponding member, Mr. Roland Gunn, of Launceston, in 1849. They had been captured in snares on the upper branches of St. Patrick's River, about thirty miles northeast of Launceston, and lived many years in the Regent's Park. The same generous friend, learning that these animals were no longer alive, sent a second pair in 1863, which likewise did well in the society's gardens. Thylacines in captivity are very active in their movements when excited, but somewhat nocturnal in their habits. They are usually fed on mutton.—Knowledge.



THE THYLACINE. (THYLACINUS CYNOCEPHALUS.)

DISCOVERY OF THE MOST ANCIENT TEMPLE AT THEBES.

By M. EDOUARD NAVILLE and MR. H. R. HALL.

THE excavations carried on by the Egypt Exploration Fund from 1893 to 1896, following those of Mariette, in the temple of Deir-el-Bahari at Thebes are well known to every winter visitor to Egypt. After four years of excavation, the beautiful temple which was erected by the Queen Hatshepsu or Hatasu of the XVIIIth dynasty (B.C. 1500) was entirely cleared of the chaotic mounds of rubbish and Coptic walls which almost hid it from view. But after the conclusion of the excavations an unexplored space still remained to the south of the temple, and between it and the southern horn of the semicircle of cliffs which rise at the back of Deir-el-Bahari. This space was also covered by confused mounds of rubbish. During the past winter season of 1903-4 the systematic exploration of this untouched tract has been begun by us, working on behalf of the Egypt Exploration Fund, and has already met with a success which promises well for further work on the same site. The net result of the work of excavation has been the discovery of another temple, side by side with the great building of Hatshepsu; this is the most ancient shrine yet discovered at Thebes, being the funerary temple or mortuary chapel of the King Mentuhetep Neb-kheru-ra, of the XIth dynasty (B.C. 2500). Fragments of architraves, etc., bearing the name of this king had previously been found at Deir-el-Bahari by MM. Mariette, Maspero, and Brugsch Bey, so that it had always been known that an XIth dynasty building had existed hereabout. Also some fragments of octagonal sandstone columns, lying on the rubbish, had been conjectured to belong to this building, and the present excavations have shown this conjecture to be correct. But the precise position and nature of the building itself were unknown until now.

It is in an unexpectedly good state of preservation, and is, as far as yet can be seen, the best preserved of the few Egyptian temples which can show any buildings *in situ* which are older than the time of the XVIIIth dynasty. The remarkable pyramid-temple at Abûsîr, near Cairo, excavated by Dr. Borchardt for the German Oriental Society, is older, dating from the Vth dynasty, but is not so well preserved. Further, the newly-found temple has already yielded results of great importance to our knowledge of Egyptian art and architecture. A large number of the sculptured slabs which once adorned the walls of its pillared hall, some in good preservation, others fragmentary, have been found among the ruins. These originally depicted the coronation of the king in whose honor it was built, his reception of the magnates and chief warriors of his court and of tribute bearers, his servants driving the cattle belonging to the domain of his temple and cutting down reeds to build boats with, the procession of funeral boats on the Nile—all scenes appropriate to the ante-chamber of a royal tomb at that period. These reliefs vary in artistic quality; some are of the rough style which has usually been supposed typical of the work of the XIth dynasty, but others are of very good work, equal to the best XIIth dynasty, delicate in touch and at the same time bold and free in style. It cannot be doubted that these excavations will teach us very much that was not known before with regard to the development of art under the XIth dynasty. We may also learn new historical facts with regard to this dynasty, of which very little is known; for instance, the true order of the kings, which is as yet uncertain, may be made clearer to us.

Further, the aspect of the new temple forces us to modify various speculations which have been made with regard to the origin of the peculiar style in which the great temple of Deir-el-Bahari, that of Hatshepsu, was built. One of the greatest charms of this temple is the unconventionality of its design, with its ramps or ascents leading up from court to court, its colonnades on either side of the ramps, and its simple "proto-Doric" columns, like those of the tombs at Beni Hasan. Hitherto this design has been unparalleled in Egypt, and various theories have been propounded to account for it. It has been supposed that the great queen wished to model her temple on the terraced hills of Somaliland (Punt), from which her famous naval expedition brought back the strange animals and plants, the frankincense and myrrh, which are depicted on the walls of her temple. The real explanation has only come to light with the discovery of the temple of Mentuhetep. This was built on an artificially squared rock platform, approached by an inclined ramp, flanked by colonnades (only one has yet been excavated). The pillars of the colonnade are of the same square form as those of Hatshepsu's lower colonnades, and its sculptured facing-wall has the same batter or slope as have Hatshepsu's. Further, the pillars of the temple hall on the platform are of the "proto-Doric" type of those of Hatshepsu's upper colonnades, the Shrine of Anubis, etc.; the only difference being that they are eight-sided, while Hatshepsu's are sixteen-sided. We are now reminded that the "proto-Doric" column is unknown after the Middle Empire, except in Hatshepsu's temple, whereas its most typical form is found in the XIIth dynasty tombs at Beni Hasan, and it occurs in other early tombs; furthermore, we find a modification of it used as a decorative motive in the "proto-Doric" pillar form commonly given to the central supports of the head rests which are found in tombs of the Vth and VIth dynasties. It is, in fact, typically early. The conclusion is obvious; Hatshepsu's architects simply imitated and enlarged upon the design of the older temple of Mentuhetep, which had already existed at Deir-el-Bahari for a thousand years before they began their work; for some reason they chose, instead of building in the style of their time, to imitate an XIth dynasty temple; the great temple of Deir-el-Bahari was then simply a magnificent piece of archaism.

Since Hatshepsu copied her temple from one of the XIth dynasty, a further interesting possibility presents itself. Hatshepsu's expedition to Punt is the only one known to us at the comparatively late period of the New Empire; all other known relations between Egypt and Punt are confined to the period between the Vth and XIth dynasties. Mentuhetep Sankhkara, a follower of Neb-kheru-ra on the throne, sent an expedition to Punt. It may well be that Hatshepsu's expedition was merely an echo of those of Sankhkara and his predecessors; she copied the XIth dynasty in her temple building, and carried her archaistic tendencies so far as to imitate them also in sending an expedition to Punt. These results are important. The new discovery explains why Hatshepsu's architects, instead of building in the exact center of the circus of Deir-el-Bahari, crammed the new temple up against the northern slope of the cliffs, leaving the great space to the south

which has seemed unoccupied until this season's work. We now see that they were compelled to do this by the presence, which we moderns had hardly suspected, of the older temple at Deir-el-Bahari. This temple, the newly discovered one, certainly existed side by side with the new temple of Hatshepsu, throughout the XVIIIth dynasty, and did not fall into ruin until the Ramesside period or later. One of the pillars of the hypostyle hall bears the royal label of a Rameses. The relief slabs of the hall and the pillars of the colonnade are covered with Ramesside graffiti, both written and incised, and the colonnade seems indeed to have been used as a sort of school or practice ground for young scribes and decorators. This would hardly have been tolerated if the building had still been in good repair, so that we can date its decadence with some certainty to the Ramesside period.

As it was, in order to obtain room for their temple at all, Hatshepsu's architects were compelled to plant its upper platform, and the shrine of the goddess Hathor adjoining, right on the top of part of the temenos wall of the older temple. This comes out from under the XVIIIth dynasty building and passes along, masking the face of the cliff, till it joins, at a remarkably acute angle, the facing wall of the platform of the XIth dynasty temple. This platform, which was originally about 15 feet to 18 feet high, is separated from the Hathor shrine of Hatshepsu's temple by an open court some 60 feet broad. Its facing wall, of remarkably fine stone work, reminding one of Knossos and of the nearly contemporary walls of Dashur in its general effect, and far superior to anything of the kind in Hatshepsu's temple, is about 120 feet long, running nearly east and west, roughly parallel with the later temple. The platform is rectangular; its eastern side is cut off vertically like the northern side, and the facing wall follows its right-angled turn round into the colonnade. The stone pavement of the colonnade is perfectly preserved; it is 68 feet long and 4 feet wide. Of its columns, which originally numbered 24, disposed in two parallel rows of 12 each, the row nearest the platform is complete. The columns, which are a little over 2 feet square, were originally 11 or 12 feet high. They are broken off short at a height of from 4 feet to 7 feet above the ground. The ramp at the southern end of the colonnade has not yet been excavated. This ramp led up to a great entrance gate on the platform, of which the original finely polished red granite threshold, measuring 9 feet by 5 feet, was discovered in position, with its door socket, etc. This gate leads directly into the hypostyle hall of octagonal "proto-Doric" columns which has already been mentioned. These pillars are small and thin; they are about 2 feet 6 inches in diameter, and rest upon circular bases 4 feet across. The bases of all are in position, but of the pillars themselves only a few remain; the highest (now covered up again for the summer) is about 9 feet high. Each bears the royal titles of King Mentuhetep, as do also the square columns of the colonnade below, and, like these also, they are made, not of the white limestone which was used for the facing walls and relief blocks of the temple and for the similar columns of Hatshepsu's temple, but of a gray sandstone which seems to have been specially affected by Mentuhetep Neb-kheru-ra; we find it also in work of his at Abydos. There seem to have been eight rows of columns on either side of the central axis of the hall; the intercolumniation is very narrow, measuring only 7 feet from center to center. The half-width of the platform from the northern corner to the central axis is about 80 feet. The hall was surrounded by a thick wall of limestone, which was decorated with the reliefs already mentioned. On the facing wall of the colonnade below remain the only reliefs still in their original position. They represent a procession of boats.

Only the northeastern corner of the platform has as yet been uncovered; there remains therefore much important work to be done, which, it is hoped, will produce results even more important than those gained in the present season's work. Several tombs of the XIth-XIIth dynasty, in the court and on the platform, were opened in the course of the work. Though violated by tomb robbers, probably in Ramesside times, they have yielded objects typical of interments of the period in good condition.

Many minor objects were found in the course of the excavating, including workmen's tools of the Ramesside period, baskets, mats, etc., numbers of ex-votos of wood, bronze, and faïence originally dedicated in the Hathor shrine of the great temple, and thrown, when broken or useless, by the priests into the court between the two temples, which seems to have served as a dust heap, and a number of Coptic ostraka thrown out from the latter *deir*. The two most important of these objects are the following: (1) A fragment of a stele mentioning a priest of the temple *Khut-asu* or *Akhet-asut*, which we know to be the name of Neb-kheru-ra's tomb, found intact by the inspectors of tombs in the reign of Rameses IX. The presumption is that the new funerary temple is *Akhet-asut*, which has not yet been identified. (2) A headless figure of a dignitary of the court of a Hyksos or Shepherd King, Aapehiti, a monarch who is otherwise only known from a contemporary scarab in the British Museum and a remarkable monument of the XIXth dynasty, discovered by Mariette at Tanis, which is dated in the "400th year" of King Setaapehti Nubti, and is therefore known as the "Tablet of 400 Years." It had been supposed, on account of the peculiar nature of the mention of this king on this monument, that he was not a king at all, but merely the god Set, but the newly discovered inscription seems to prove his historical existence.—London Times.

Correspondence.

GASOLINE INSPECTION CARS.

To the Editor of the SCIENTIFIC AMERICAN:

We call your attention to an article published in a recent number of your SCIENTIFIC AMERICAN SUPPLEMENT, namely, on page 23593, No. 1472, illustrating two types of small gasoline railroad cars.

The upper illustration shows a car made by us, which your article indicates is the invention and creation of Mr. Robert W. A. Brewer, of England. Now, this car is a car exhibited by our London agents, Messrs. Fairbanks, Morse & Co., 126 Southwark Street, London. The photograph was taken by them, and Mr. Wilson, the resident manager, is the central person in the group shown operating the car. The picture was taken by his own camera, and Mr. Brewer has no connection with the matter except that he was one of the parties in the group on the car, and as we understand it, is a railroad official who is an honorable gentleman, and would undoubtedly make no such claim as your article seems to indicate.

SHEFFIELD CAR COMPANY,
E. B. Linsley, Manager.

Three Rivers, Mich., June 20, 1904.

A PLAN FOR FILLING IN THE EAST RIVER.

To the Editor of the SCIENTIFIC AMERICAN:

At a time when the question of intercommunication between the various sections of this great metropolis, more especially that of communication between the cities of New York on the one side and of Brooklyn and Long Island City on the other, is uppermost in men's minds, I trust I may be permitted to make known to you and to the readers of the SCIENTIFIC AMERICAN a scheme having this object in view, which suggested itself to me last year for bettering the general conditions of city life in a business area so restricted and one so densely thronged with men and traffic throughout the day as is to be found in the lower portion of Manhattan Island. To be sure, New York labors under certain serious disadvantages of geographical situation, arising from the exceeding lowness of the adjacent land, together with the interposition of large bodies of water within her limits—disadvantages which are to be met with in a greater or less degree in many European cities of importance, notably at Antwerp, Amsterdam, St. Petersburg, Hamburg, Bristol, Marseilles, and Venice; but in none of these large centers of commercial activity has the necessity of looking ahead of the immediate present ever been so imperative as in the case of the Empire City, the great emporium of the New World on the eastern coast, in consequence of its rapid and prodigious growth of trade within late years and of its concurrent steady increase of population.

I may, perhaps, best preface my remarks by stating that the proposition which I am about to submit for your esteemed consideration first occurred to me about a year ago as, in great part, the result of a perusal of what seemed to me a very striking and impressive article by Mr. J. H. Gore, of Columbia University, in the Popular Science Monthly of April, 1902, entitled the "Draining of the Zuider Zee," a subject which I have since seen treated at greater length in McClure for October last. The project therein described, which is naturally one of colossal proportions, has, it appears, occupied the Dutch mind during the last fifty years or more, and contemplated nothing less than the reclamation of by far the greater portion of the land devastated by the incursion of the sea into Holland during the twelfth and thirteenth centuries, which body of water has since then been known as the Zuider Zee (South Sea). This reclamation is to be effected by the erection of a massive sea-dyke or wall from Ewijcksluis, about ten miles distant from the Helder, by way of the island of Wieringen, to the Frisian coast opposite which will then shut off the Zuider Zee entirely from the ocean except at certain points where locks are to be constructed in the dyke for the passage of steamers and sailing ships. The inland water is then to be divided into four segments where it is shallow—a northwestern, southwestern, northeastern, and southeastern—each to be inclosed by a smaller dyke, by pumping out the water from which so many "polders" or drained areas will be formed, leaving the deeper portion of the water in the center as a lake, according to the original *status quo* in the year 1170. Similar polders have already been recovered successfully at the Dollart and at Haarlem Lake, so that no serious trouble is anticipated in making them, once the seawall is built. This undertaking, it is estimated, will add about 800 square miles to the soil of Holland suitable for farming purposes. Although the royal commission appointed to consider the matter has reported favorably upon it, the project is still before the Dutch Cabinet, whose final sanction must be given before the works can be undertaken, the completion of which is by a gradual process to cover a period of thirty-three years. These are in brief the details of the project which in Mr. Gore's opinion "is not only feasible from a financial as well as from a technical standpoint," but "is almost a necessity to the State."

Now to apply this object lesson to the theatre of New York and its neighborhood. The principal drawback to the natural growth of the city of New York as a great commercial center appears to be in the fact that the business quarter of the city is located at the greatly attenuated termination of an island of longitudinal shape, which is separated from the sister municipality of Brooklyn by the East River. In the vicinity of City Hall Park and at the cis-pontine end of Brooklyn Bridge the greatest amount of passenger pressure is now felt; and although the erection during late years of the skyscraper type of building was devised to overcome the evils incidental to a lack of space in this hard-pressed corner of the town, the presence of these, to European eyes at least, unsightly structures has only partially remedied the defect, as the number of occupants which they account for has abnormally increased; and this again has multiplied the difficulty of conveying so many additional individuals to and from their offices. As this and other attendant troubles connected with the general congestion of traffic in the locality in question are allowed on all sides to present almost insuperable obstacles at every turn, which will, of course, become aggravated as time goes on, even with the advent to the city of new tunnels, subways, and bridges, the proposition which I would make would be to copy the Dutch method proposed above by—to make use of an English form of speech, but in a different acceptation—"setting the Thames on fire," as regards the East River at any rate. In pursuance of this object I would therefore advocate the early construction of two thick and substantial dams; one to be carried across from the Battery to Governor's Island, thence again to a point on the Brooklyn shore; the second to start from East Seventeenth Street, running in a straight line to North Thirteenth Street, Williamsburg. On the completion of these two dams the intervening water would be pumped out and a solid base and floor gradually laid down and substituted, the surface of which would be made level with the contiguous banks on either side. The space or area thus gained on completion of the work of the terrain would be then available. This I estimate at some hundreds of acres, which could be laid out in streets connecting with those at either end, and public buildings of the modern style erected, there being less necessity then for skyscrapers. Besides opening up endless avenues eastward in all directions for passenger and vehicular traffic, the accomplishment of such an engineering feat would place the whole of Long Island in direct communication with the most populous part of New York city, and this, too, at an angle, roughly speaking, of 90 deg.; and although the change would entail sundry hardships to corporations and private individuals, such as the removal of the jetties of the coasting steamship lines to positions nearer the entrance from the Sound; and although an entirely new station would have to be found somewhere in New York Bay for the Brooklyn navy yard, I cannot but entertain the conviction that the ultimate gain from such a transformation to the sister cities of New York and Brooklyn, and indeed to Greater New York as a whole, would prove incalculable as time goes on.

Should such a scheme be approved and found by experience to work well, it could easily be extended further northward to the sections of Blackwell's Island and even perhaps at some future day as far as the section at Lawrence Point to the Harlem River bank opposite by way of the Sunken Meadow and Randall's Island, when the city's growing needs so demanded. The Harlem River, indeed, I regard as likely to disappear in the no very distant future altogether from the municipal map, as did the old canal downtown which has bequeathed its name to the modern Canal Street.

Trusting that you may be led to view the above proposition with favor, inasmuch as it is an endeavor to deal with the question of existing difficulties in this metropolis on original lines; as also that it may not be found to contain any radical or inherent weakness, I beg to remain, sir TERRA FIRMA.

57 West Twelfth Street, New York, June 8.

ELECTRIC RESISTANCE OF IRON AND STEEL.*

THE writer has determined the resistance of different homogeneous samples of steel, not tempered and in different states of tempering. The samples tested have a different percentage of carbon, sulphur, silicium, phosphorus, and manganese. It has been ascertained that the solution in the iron of equivalent quantities of these substances will determine an equal augmentation of resistance. This increase is 5.9 microhms per cubic centimeter for solution of a weight equal to the atomic weight of each substance, in a weight of iron equal to one hundred times its atomic weight. The carbide present in the iron has no material influence on the resistance.

Experiments made with non-tempered steel containing from 0.45 to 1.70 per cent of carbon have proved that at the ordinary temperature it contains, along with cementite, not pure iron, but a solid solution of the latter, with 0.27 per cent of hardening carbon, identical with sorbite. This confirms the results of the purely chemical investigations of Osmond and Werth, Carnot and Goutal, Osmond and Brustlein, and Arnold and Stansfield. If there is not too great an excess of carbon in the state of carbide, for instance, if the percentage of carbon is only 0.2, then 0.06 to 0.07 per cent of carbon is dissolved in the iron.

At the ordinary temperature, the electric resistance of steel may be expressed by $7.6 + 26.8 \Sigma C$, in which ΣC represents the total percentage of carbon.

Absolutely pure iron has a resistance of 7.6 microhms per cubic centimeter. Recent investigations of Barrett, Brown and Hadfield confirm the results of the writer as to the influence of aluminium on the electric resistance of steel.

Chromium, nickel, and tungsten produce a different

* Condensed from the German of K. Benedicks in the Zeitschrift für den physikalischen u. chemischen Unterricht.

effect, which is probably due to the fact that in the samples of steel examined they are not found in the state of solution.

ENGINEERING NOTES.

During the third quarter of the financial year American shipbuilders completed 177 vessels of 55,066 tons gross, as compared with 187 vessels of 58,588 tons gross in the corresponding period of 1903. Thirteen measuring 35,033 tons were steel steamers—a year ago the proportion was 20 of 41,803 tons—Atlantic and Gulf ports contributing seven of 17,874 tons, as compared with 11 of 15,382 tons, and the Great Lakes four of 16,744 tons, as compared with five of 17,398 tons. The grand total for the nine months is 232,133 tons, as against 230,187 tons in 1902-3.

No special measures are adopted for the preservation of manila ropes except an occasional sprinkling with water when the shaft is hot and dry. Hemp ropes are sometimes tarred with a view to increasing their durability, though the utility of this practice seems to be doubtful. This tarring is always done by the makers, and no further treatment is necessary during the life of the rope. What is true of wire rope with regard to their reversal end for end or side for side applies equally to hemp ropes. It is also true of hemp ropes that one which bends in opposite directions around a sheave and drum wears out much faster than one in which the bends are in the same direction. When one engine hoists from two compartments, one rope bends the same way over headsheave and drum, while the other bends in opposite directions. This latter is more severely strained than the former, and usually wears out in much less time. In order to equalize the wear on the two ropes, they are sometimes interchanged at the end of a certain time. This lengthens the life of one rope and shortens that of the other, but the result is usually a net increase. It is claimed that this practice has in some instances resulted in from 20 per cent to 40 per cent increase in durability.—Mines and Minerals.

In a paper read before the Iron and Steel Institute Mr. B. H. Thwaite traces the early history and later development of steel frame construction as applied to lofty building design in the United States. Although a considerable part of this paper is devoted to details which are already perfectly familiar to most of our readers, it contains reference to several points that are worthy of note. The author shows that the new system of building has practically revolutionized professional constructional organization in the United States, for the consulting engineer and the ironworkers have largely displaced the architect and the ordinary builder, but the architect still finds scope for the exercise of his art as the colleague of the engineer. As steel frame construction seems likely to be more largely used in this country as years pass by, it is highly important that architects and builders alike should qualify themselves for dealing with the coming development by making themselves thoroughly acquainted with the theoretical and practical features of such work. The author shows that the steel-framed system enables buildings to be constructed in one-fourth of the time required for their erection by ordinary methods, thereby reducing to a minimum discomfort to the occupants of neighboring property and interference with street traffic. He further urges the suitability of steel for fire-resisting construction when the steel is properly fire-guarded, citing as examples buildings which came unscathed and unhurt out of the disastrous fires at Baltimore, Chicago, and Rochester.

In an important paper read to the Institution of Electrical Engineers by Mr. Alexander Siemens, a description was given of the high-speed electric railway experiments which were recently made on the Marienfelde-Zossen line near Berlin. All the data given in the paper were taken from official reports, and will be of the greatest use to English engineers. The experiments prove conclusively that it is possible to collect high-tension currents, even in unfavorable weather, from overhead conductors, at speeds up to 130 miles per hour. Mr. Siemens stated that at these high speeds birds were overtaken and killed by the train, and that at the conclusion of the run the front of the train was covered with bees, gnats, etc., which had been smashed by the impact. The experiments also seem to have settled the vexed question of the resistance of the air to an express train. The agreement between the formulæ arrived at experimentally, and those given by Drs. Chree and Stanton is remarkable and very satisfactory. As Mr. Siemens stated, the formula is virtually involved in a theorem given by Newton in the section of his Principia which deals with projectiles; but Newton gives no numerical constant. We are now able to predict that if ever an express train moves with a velocity of 200 miles per hour the power expended per square foot of sectional surface at right angles to the direction of the motion will be greater than 60 horse-power. It seems to us that about 150 miles an hour is the limit for the speed of express trains. At speeds of over one hundred miles per hour there must be practically no curves on the lines, owing to the enormous centrifugal forces developed. The experiments as to the proper shape of the front of the train were unsatisfactory. In his reply to the discussion, Mr. Siemens stated that it should be a paraboloid of revolution, but this result is too indefinite to be of any value, as the shape of this surface depends on the length of the frustum of the paraboloid we use. A flat surface is a limiting case of a paraboloid. The proper shape for a projectile has not yet been worked out mathematically, and the proper shape for the front of an express train is a much more difficult problem theoretically, owing to its closeness to the surface of the earth, which disturbs the lines of flow of the air and therefore has to be taken into account.

TRADE NOTES AND RECIPES.

Furniture Wax.—Melt over a very slow fire, 80 parts of beeswax, with 10 parts of clear American rosin, powdered, and 12 parts of Venetian turpentine. Pour the molten mass into an enameled vessel of large size and stir in 60 parts of turpentine oil. The polish is now ready. The articles to be polished should be washed with warm suds, or with water (on the top of which is poured a little benzin) and dried off carefully. The wax, smeared on a rag, is then applied and rubbed with a woolen cloth until it is polished.—National Druggist.

Cement for Leather.—

Gutta percha	20 parts
Syrian asphalt, powdered	20 parts
Carbon disulphide	50 parts
Oil of turpentine	10 parts

The gutta percha, shredded fine, is dissolved in the carbon disulphide and turpentine oil. To the solution add the asphalt and set away for several days, or until the asphalt is dissolved. The cement should have the consistency of honey. If the preparation is thinner than this let it stand, open, for a few days. Articles to be patched should first be washed with benzin.—National Druggist.

Photographic Flash Lights of Magnesium.—These powders, says the Annales de Pharmacie (translated by National Druggist), are composed of finely divided metallic magnesium mingled with an energetic oxidant and sometimes with some readily combustible body. They are made into little packages of from 1 to 2 grains each, furnished with a lighter of cotton. The powder thus lit burns instantly and produces a most intense illumination. They are, it should be remembered, explosives, and as such dangerous to keep on hand in any quantity. For this reason, some manufacturers keep the magnesium and oxidant in separate boxes, or in separate compartments of a box, and mix them at the moment when needed.

The following are typical formulas for these flash-light powders:

Poudre Bouillard.

Potassium chlorate	48.5 parts
Magnesium powder	46.7 parts

Mix.

Poudre Koch-Dubois.

Phosphorus, red	10.4 parts
Strontium nitrate	60.8 parts
Magnesium powder	28.8 parts

Mix.

Poudre Sabot.

Phosphorus, red	9.7 parts
Aluminium powder	5.5 parts
Strontium nitrate	72.0 parts
Magnesium powder	12.8 parts

Mix.

Cleaning Straw Hats.—Ours is a large country. When an almanac is made for use in all parts of it, several sets of figures have to be given, one for one latitude and one for another. So, to write that the almanac says, "About this time straw hats may be expected," would be putting that worthy book in an unenviable light, unless latitude were specified. Down in South Florida, where alligators bask in the warm December sun, feeling happy and full after dining on dark undressed kid, there is no month when white duck trousers, negligee shirts and straw hats are not in season, while in the opposite extreme of the country, where there are six months of winter, three of getting over winter and three of preparing for next winter, the mink-skin has the Mackinaw beaten so far that the latter is hardly worth serious consideration.

But for the happy medium. About this time the lighter headpiece is to the front—or, rather, top—and so is a seasonable subject for discussion. Here again we find extremes. The man who wears an indestructible Panama can usually afford to send it to the hat shop to be laundered, reblocked, and retrimmed, while his fellow citizen who buys the cheapest straw, either little recks whether it is clean or not, or buys a new one each season. However, there are many last year specimens of man millinery which will come out of their hiding places along about the time the apple blossoms burst, and cry loudly for a cleaning. The following process, although rather complicated, is the one which has received greatest recognition at the hands of the pharmaceutical press:

If the hat is very dirty, wash with a brush and strong soap-suds. Then prepare two solutions, as follows:

I.

Sodium hyposulphite	3	drachms
Glycerin	1½	drachms
Alcohol	3	drachms
Water	3	ounces

II.

Citric acid	35	grains
Alcohol	3	drachms
Water	3½	ounces

Sponge the hat with No. I., and leave in a moist cellar for twenty-four hours; then apply No. II. and set aside as before. The hat should then be smoothed with a warm flatiron, when it will be ready to again bedeck the head of its owner.—Druggists Circular.

ELECTRICAL NOTES.

Mr. Hornemann two years ago drew attention to the fact that an oxide layer, interposed between the parts of a metallic contact touching each other, will impart to the latter a singular sensitiveness, not only with respect to any current wave traversing the contacts but also with respect to electric oscillations acting on the contact from a distance. The contact is caused to oscillate under the action of electric waves, which oscillations can be heard with a telephone. These researches, published in Volume 7 of the Annalen der Physik, were taken up again quite recently, and in Volume 14 of the same periodical the author records some further experiments in which the contact effect with higher temperatures is investigated. While hot oxide layers do not exert stronger effects than a cold layer when the contact parts are composed of the same material, a notable increase of the effect is observed when different metals are used. Interesting results were obtained in a galvanometrical investigation of the influence of electric radiations on a heated lead-copper coherer (with an interposed oxide layer). This coherer was shown to behave, generally speaking, like an anti-coherer, in a manner analogous to the Schäfer plate, i. e., decohering itself spontaneously. Under certain conditions, however, its action will be like that of a Branly tube, which must be decohered by tapping. If a telephone be used instead of the galvanometer, the sound intensity will increase rapidly and to an extraordinary extent when the contact is heated.

This behavior is not accounted for on the hypothesis of a simple alteration of the resistance. The E. M. F. of a thermo-current seems to be also operative.

If we compare the efficiency realized in the production of light from electric energy, of perhaps 5 per cent, as a maximum, with the efficiency producing mechanical energy in the electric motor, or electric energy from mechanical energy in the electric generator, where values of 90 per cent to 97 per cent are commonly realized, the present methods of electric lighting appear rather crude in their principle; it is really heat that we produce, and light appears almost as a mere by-product. While, therefore, no very essential advance in the efficiency of electric motors, generators, etc., is possible, electric lighting is still in its very beginning. The amount of light produced from electric energy may well be increased tenfold, and the efficiency of light production would still be low compared with the efficiency of the electric motor. In this direction, then, an enormous advance in the use of electricity can be hoped for in the future. If the efficiency of production of light from electric energy could be raised only to the efficiency of the poorest electric motor on the market, electric light would sweep all other illuminants out of existence by its cheapness. This is well realized by those in control of the electrical industry of to-day, and some years since many of the giant electrical manufacturing companies of this country and abroad established extensive laboratories for the investigation and study of improved methods of electric lighting. In the last years avenues of research have been opened and are being energetically pursued in these laboratories, which promise to replace the present indirect and inefficient methods of light production by a more direct transformation of electric energy into light, with a far higher efficiency.—C. P. Steinmetz, in Cassier's Magazine.

Recently Sir Oliver Lodge gave at the Institute of Architects, to the members of the Lightning Research Committee and some others interested in the subject, a practical demonstration of the action of lightning, more especially as regarded lightning conductors. The electrically charged cloud was represented by a thin sheet of metal mounted on non-conducting standards charged from a battery at pleasure, and placed in a position sloping downward from front to back, so that the model lightning conductors could have their points brought nearer to or further from the under surface of the "cloud" by shifting their positions on the fable. Some of Sir Oliver's conclusions were much at variance with what are popularly accepted. He placed in operation successively conductors of three different substances—copper, iron, and wet string. The copper was the most intense and rapid conductor, producing a sharp crack at the flash; the iron took it with less noise; the wet string with hardly any, yet it was efficient in protecting the two other conductors. Wet string is, of course, impossible in practice (the thunder shower performs some of its function, however, in relieving pressure), but Sir Oliver maintained that iron was quite as efficient a conductor as copper—and more, that the intensity of action of copper was more likely than iron to set up side-flash, which, in protected buildings, has been the origin of most lightning accidents. Sir Oliver also illustrated and described his classification of lightning into two kinds, which he called "A-flash" and "B-flash." The former was the normal discharge of lightning from an overcharged cloud direct to earth; the B-flash occurred when a large cloud discharged into a smaller one, generally though not necessarily below it, which was overcharged suddenly and discharged to earth with great violence. Sir Oliver Lodge proceeded to show, by several illustrations, why the B-flash might be expected to be more sudden and intense than the A-flash, and proportionately more difficult to protect against, though he would not say that all lightning injuries had resulted from B-flashes. The practical outcome of the demonstration was that a building should have as many points of protection as possible, and that (if we accept Sir Oliver's teachings) the copper lightning conductor is dismissed with costs.

THE ZOELLY STEAM TURBINE.

CONDENSED TABLE OF TESTS OF A FIVE HUNDRED HORSE-POWER ZOELLY STEAM TURBINE.

Date—	Dec. 12, 1903.	Jan. 25, 1904.	Jan. 25, 1904.	Jan. 25, 1904.	Jan. 25, 1904.	Jan. 18, 1904.	Jan. 25, 1904.	Jan. 25, 1904.	Feb. 5, 1904.	Feb. 5, 1904.	Feb. 5, 1904.
Length, minutes	180	80	50	50	50	60	60	35	70	20	80
Current, kilowatts	363	388	335	240	182	86	....	....	392	390	390
Revolutions per minute	2,967	2,967	2,977	2,983	2,984	2,995	2,995	3,000	2,972	2,973	2,968
Before Separator—											
Pressure, lbs.	149	149	145	147	146	147	147	149	173	178	150
Temperature, degrees Fahr.	369	370	364	366	365	365	365	366	477	497	440
Before First Diaphragm—											
Pressure, lbs.	133	134	118	87	66	31	3	7.5*	128	128	129
Temperature, degrees Fahr.	356	356	347	329	314	277	228	217	422	427	422
Exhaust—											
Vacuum, ins. mercury	27.7	27.7	27.9	27.9	27.9	28.4	28.4	28.4	27.9	27.9	27.8
Temperature, degrees Fahr.	102	104	102	99	98	91	90	108	100	102	100
Steam con. per hour, lbs.	7,887	8,308	7,411	5,766	4,673	2,644	1,023	650	7,438	7,319	7,712
Steam con. per kw.-hr., lbs	21.7	21.4	22.1	24.0	25.6	33.0	....	....	19.0	18.8	19.7

*Ins. of mercury.

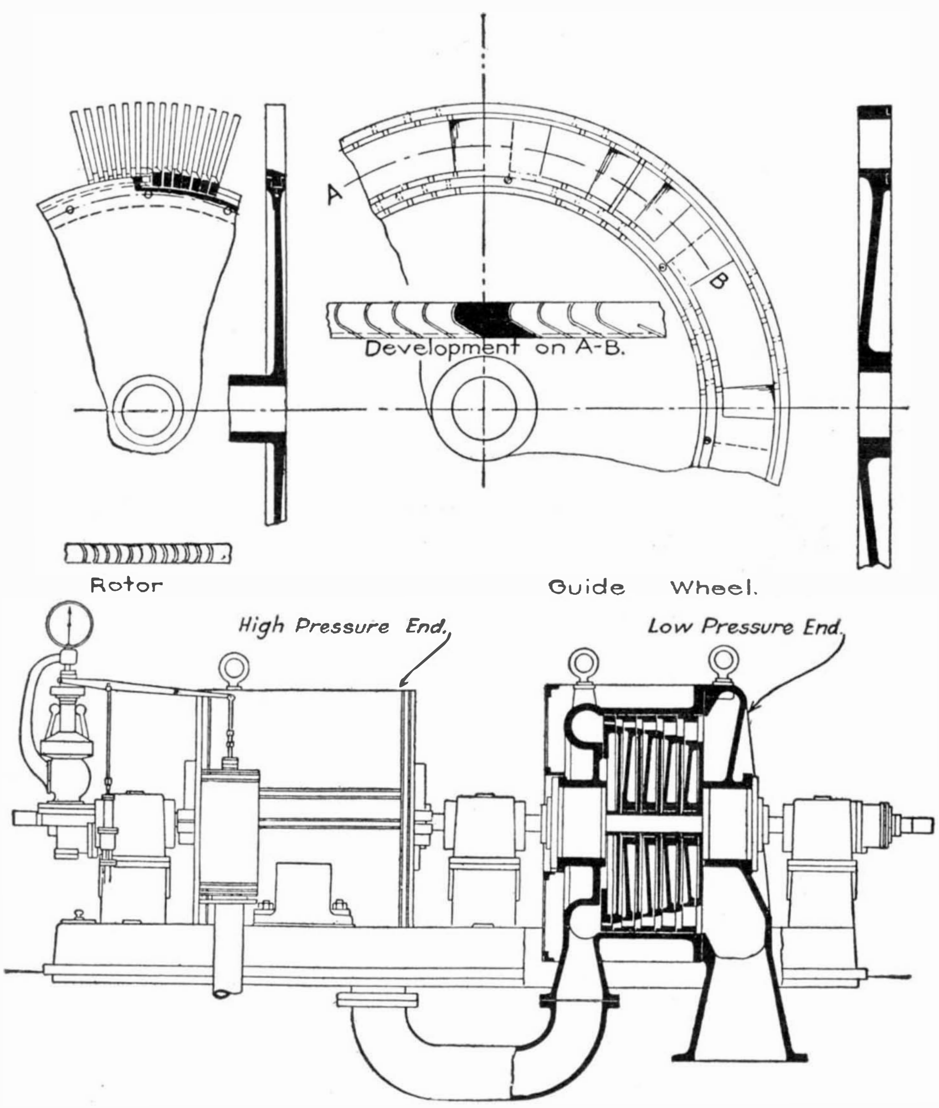
THE Zoelly steam turbine is of the multistage impulse type, in which the expansion of the steam takes place in the passages in the stationary parts of the apparatus. Its main point of difference from others of the type is in the construction of the rotors or bucket-wheels, which are intended for high peripheral velocities and require correspondingly few stages. The accompanying elevation of a compound turbine shows its general features. The high and low pressure ends are mounted independently on a single base. The housings are of cast-iron or cast-steel, divided on the horizontal plane through their axis, so that the upper half can be readily lifted off, and the flanges are fitted so closely that no packing is needed. The details of the mounting have been worked out with a special view to avoiding any appreciable displacement of the axis through temperature changes. The housings are covered with non-conductors and steel lagging.

The three main bearings are supported directly by the frame, and are thus independent of the housings. This arrangement was adopted to prevent any heating of the bearings by the steam or by conduction from the housings, thus keeping them uninfluenced by the condition of other parts of the turbine. They are readily accessible and easily inspected.

A rotary pump placed on the frame and driven from the main shaft by worm-gearing supplies lubricating oil to the bearings. The oil from the bearings is piped to a reservoir in the base, where it is purified and cooled in a coil if necessary, and is then ready for use again. In this way, although the lubrication is profuse, the consumption of oil is kept very low.

The disks of the rotors, of the best Siemens-Martin steel, are keyed to the shaft and have fastened on one side of their periphery a thin ring. This ring forms with the periphery of the wheel a dove-tail groove in which the buckets and their spacers are held. The radially located buckets are made of nickel steel, polished to reduce friction to a minimum. Nickel steel is employed on account of its resistance to rust. The disks of the wheels are also highly polished to keep down frictional losses.

It is considered of great importance to have the cross section of the blades decrease from their inner to their outer ends. In this way there is correspondingly small tension due to centrifugal action in the roots of the blades, even with high rotative velocity. In other words, with the same stresses the gradually thinning blades can be made much longer than those of uniform section. The resistance to bending due to the impact of the steam is greatest where the bending moment is greatest. The strength of the rotor, in consequence of this design, is so great that a high peripheral speed can be attained, and the number of stages correspondingly reduced, as before stated. This enables the length of the turbine to be diminished and its cost reduced. The steel spacing pieces between the blades have their tops coinciding with the curved surface corresponding to the widening of the steam passage between the blades, and consequently form an inner limit for the steam jet. The rotors are carefully balanced and tested at speeds above their nominal rates before they are put in place.



LONGITUDINAL SECTIONAL ELEVATION AND SOME DETAILS OF ZOELLY STEAM TURBINE.

Between each rotor there is a guide wheel or diaphragm in which the guide blades are held. Since the expansion of the steam takes place in these diaphragms between the blades, and there is a corresponding excess of pressure on one side of them, each must be steam-tight in the housing, as well as strong enough to resist the one-sided pressure. Cast-steel is used, and the guide blades are arranged in groups in the rim, as shown in the illustrations. Between the groups are thick projecting pieces to which a wrought-iron ring or tire is attached. The diaphragms are placed close together, the rims touching, and in this way the pressure is transmitted to the end wall of the housing. The hubs of the bucket wheels fit with slight play in holes in the bosses of the diaphragms, the construction being evident from the cuts. The blades have small ears which slip into slots in both the rim of the diaphragm and the outside tire. When they have been slipped into place they are held there by two rings screwed on the low-pressure face, as illustrated. These diaphragms are made in halves, with tight-fitting surfaces, and the upper halves are screwed to the top part of the housing, so as to be lifted with it. The shaft passes into and from the housing in stuffing boxes fitted with metal packing.

The governor is a slight modification of the well-known regulator used by the makers, Escher, Wyss & Co., of Zurich, Switzerland, in many water turbine installations. It consists of a ball governor which operates a pilot valve controlling the motion of a plunger directly over the main steam valve and mounted on the same rod. The pilot valve and the chamber of the plunger are connected by two small pipes, and the various operations are produced by the discharge of water under pressure through one or the other of the pipes. As this governor is one of the best-known water-wheel regulators, it is unnecessary to describe it in detail. The pressure water, or oil, in the case of the steam turbine, is furnished by a rotary pump driven from the main shaft by worm gearing. According to Mr. J. Weishäupt, chief engineer of the company, the regulator has behaved excellently in this new service, and the variation in rotative speed, even with the maximum fluctuation in the load, is very slight. Regulation by throttling the steam was chosen as being the simplest method for the purpose. In addition it has the great advantage of not influencing the steam consumption unfavorably at different loads.

If it becomes necessary to furnish more than the rated power of the turbine, the governor operates a valve which admits a part of the steam at the throttle pressure directly into the second and third stages. There is also a safety governor which shuts off the steam in case the number of revolutions rises above the normal to a predetermined limit, such as 10 per cent.

In impulse wheels, the play of the rotating parts in the casing can be made as great as seems desirable, and for the same reason the axial play between the rotors and diaphragms may be made very large without affecting the working of the turbine. Hence there need be no fear that in consequence of temperature changes or wear the running and stationary parts may rub against each other. It should be stated that a corrugated bearing like a thrust bearing is employed to keep this free play unchanged.

A ten-stage turbine of this type was put in operation at the works of Escher, Wyss & Co. last fall. It is rated at 500 horse-power per minute at 3,000 revolutions per minute, with steam at 147 pounds. It is directly coupled to a Siemens & Halske dynamo. A surface condenser driven by an independent steam engine is used. Part of the water for the condenser was taken from the city mains and part was pumped electrically from the works well. This renders it very difficult to determine the power needed for the condensing plant. The unit has been tested by Prof. Stodola and Director Wagner, of the municipal electric station. They made no attempt to determine the steam consumption of the condenser, and the output of the turbine was figured from the current delivered by the generator. The following statements concerning the test and its results are condensed from their report:

The pressure and temperature of the steam were observed in the main in front of the separator, which is close to the turbine. During the tests with superheating a thermometer was also placed in front of the throttle valve. The pressure and temperature were also measured immediately in front of the first diaphragm and the pressure behind the first rotor was observed, from which data a check on the feed-water determinations was obtained. The pressure in the pipe connecting the two halves of the turbine and the pressure and temperature at the entrance to the exhaust main were also observed. The temperature of the cooling water entering and leaving the condenser and the temperature of the discharge from the air pump were measured. The cooling water was only occasionally measured, while the circulating pump was stopped and the supply obtained through a meter from the city mains. The pressures were determined by manometers which, like the thermometers, were calibrated at the mechanical laboratory of the Federal Polytechnic Institute. The vacuum was measured directly by a mercury column, and the heights reduced to their equivalents at 32 deg. Fahr., a correction which seemed necessary on account of the high temperature of the housings. The revolutions were measured every few minutes by a tachometer. Owing to other uses of the steam from the boiler a measurement of the feed-water was useless. In consequence, such determinations were limited to weighing the condensed water delivered by the air pump. This was discharged into an elevated reservoir with inclined bottom, from which it flowed to the scales. The net weight of the apparatus was determined after each emptying, since the readings were restricted to ten-minute intervals. On account of the large capacity of the air pump, more frequent weighing would have resulted in less uniform readings. That a steady operating condition had been reached during the tests was shown by the uniform amount of condensation and the constant temperature of different parts of the turbine.

The electrical measurements were made with instruments calibrated by Prof. Weiss, of the physical department of the Federal Polytechnic Institute. A water rheostat was used.

The turbine was first run with a mixture of moderately superheated steam from one source and saturated steam from another. In front of the separator it showed a few degrees of superheat, but this had practically disappeared in front of the throttle valve. The results of the tests are given in the accompanying table. The first eight are with decreasing loads, but a constant speed and steam pressure. The tests were at first arranged in the opposite order, beginning with no load, but the temperature readings of different parts of the turbine showed that a steady operating condition would not be reached for hours. The observations made during the eighth of the tabulated tests show this clearly. In this run, the unit was first operated at half load for about 20 minutes, in order to warm it up, and two hours afterward the temperatures of the exhaust and of the base of the high-pressure housing were still falling. On this account the computation of the steam consumption is based only on the results of the last 35 minutes. With heavy loads, a preliminary

run of 15 minutes was sufficient. The last three tests were made with superheated steam. In all of these eleven runs the turbine operated with very little shaking of the shaft. The oil for the bearings was delivered at a temperature of 86 to 95 deg. Fahr. and came from them at 104 to 122 deg.—Engineering Record.

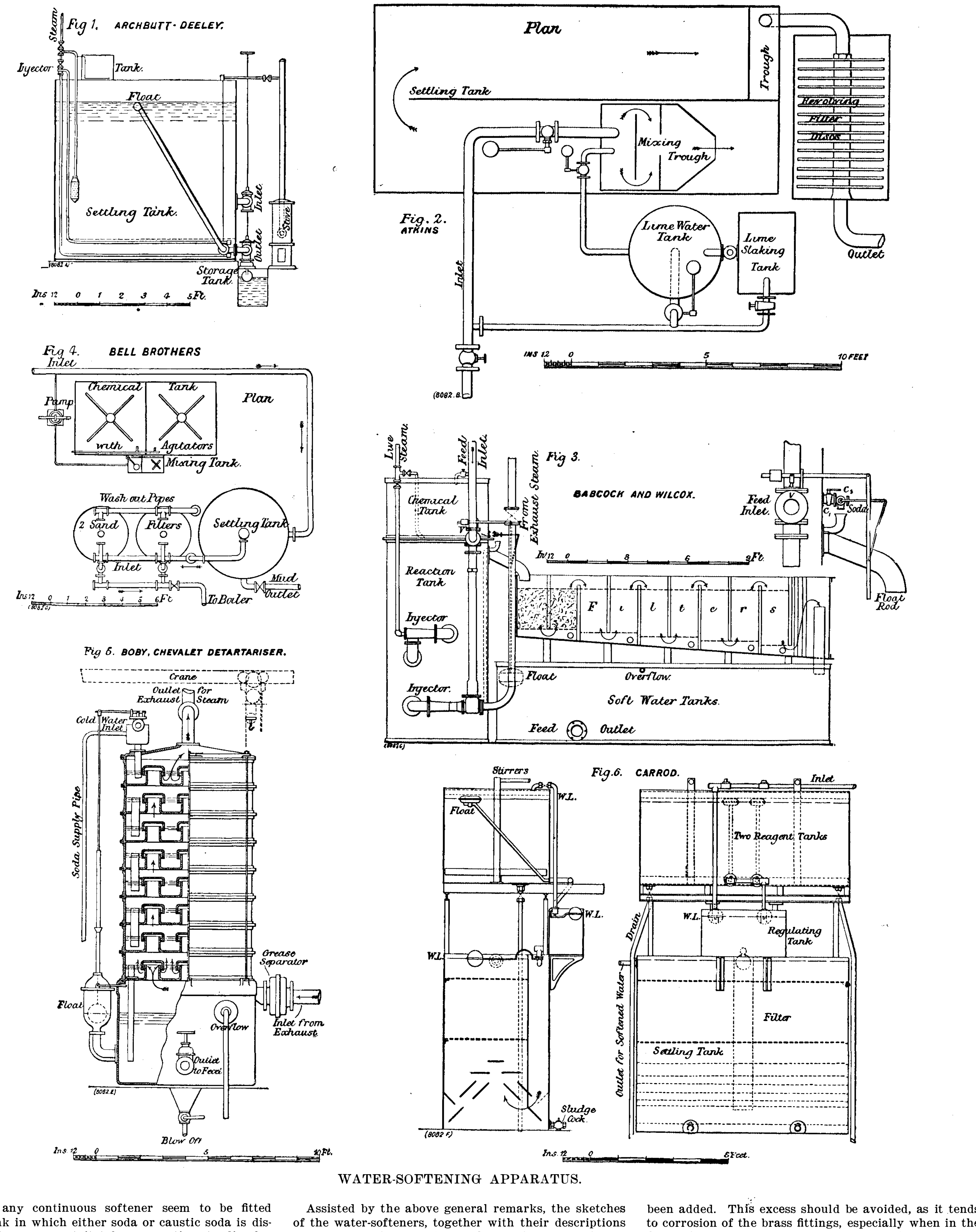
[Continued from SUPPLEMENT No. 1487, page 23831.]

WATER-SOFTENING.*

AN INQUIRY INTO THE WORKING OF VARIOUS WATER-SOFTENERS.

By C. E. STROMEYER and W. B. BARON, of Manchester.

MOST water-softeners are provided with small lime-slaking tanks, but this is not an invariable practice, nor does any continuous softener seem to be fitted with a tank in which either soda or caustic soda is dissolved before use; yet it takes some time to dissolve these salts and thoroughly mix the solutions. The addition of the soda to the untreated water is, perhaps, the most easily effected by a small pump, which must be of iron, working in unison with the feed pump. Scoops and bucket chains are also used. In all these arrangements the ratio of soda to water is best regulated by varying the strength of the soda solution. The Harris-Anderson softener has a very ingenious arrangement for delivering soda of the right density. It is, however, questionable whether all these extremely ingenious contrivances are at all necessary. They are intended to replace the pump, but have grown so complicated that they are unquestionably now more costly. Pumps for supplying the chemicals are used by Bell, Boby, Maxim, Porter-Clark, and Wollaston. Weirs, whose relative widths can be regulated, are used by Harris-Anderson and Wright. Carefully gaged holes or taps, whose openings can be regulated, are used by Babcock & Wilcox, Carrod, Desrumaux, and Doulton, and ball-taps by Atkins and Tyake.



WATER-SOFTENING APPARATUS.

Assisted by the above general remarks, the sketches of the water-softeners, together with their descriptions (Appendix II.), and the analyses of the unsoftened waters (Appendix III.), permit of a fair comparison being made as to the suitability of the various types for special purposes.

Glancing over the analyses it will be noticed that, with two exceptions, the various users have added too little lime. This cannot be on the ground of expense, as lime is very cheap, nor on account of increasing the amount of dissolved solids, for, unlike soda ash or caustic soda, it both decreases the temporary hardness and also the amount of dissolved solids. The cause of the insufficiency of lime is most probably due to an incorrect idea of the functions of the added lime. They are three in number:

(1) To combine with the free carbonic acid.
(2) To combine with the half-bound carbonic acid.
(3) To reduce all the magnesia to hydrate.

In most of the analyses only that represented by (2) has been approached. A simple differential soap and color test, devised by Mr. Baron (Appendix IV.) will permit of better softening effects being easily attained.

In nine cases out of nineteen an excess of soda has been added. This excess should be avoided, as it tends to corrosion of the brass fittings, especially when in the form of caustic soda or even sodium carbonate.

With regard to those apparatus in which the temporary hardness is supposed to precipitate by the use of steam, it would seem that only prolonged boiling completely evolves the free and half-bound carbonic acid. The result is that caustic soda is generally required to precipitate the permanent hardness and neu-

* Paper read before the Institution of Mechanical Engineers.

tralize the still unexpelled carbonic acid. The presence of any magnesia salts also calls for the use of caustic soda or lime, as explained above.

APPENDIX II.

The Archbutt-Deeley Water-Softener.

The apparatus, Fig. 1, consists of a small chemical tank, a reaction and settling tank combined, a storage tank, and a coke stove. The inlet for the untreated water is at the side of the tank, about 2 feet or 3 feet above the bottom. The treated water is drawn off the surface by means of a floating discharge pipe. This pipe is connected to the chimney of a coke stove. Steam pipes are led into the chemical tank, and an air blast actuated by a steam jet is led into the reaction tank.

Capacity.—2,500 gallons at a time or 1,000 gallons per hour.

Dimensions.—Reaction and settling tank, 8 feet cube; the storage tank is 22 feet long, 17 feet wide, 3 feet 9 inches high, and holds 5,500 gallons; floor space of softening tank, 64 square feet. Total floor space, 438 square feet. About 180 of these softeners of various sizes are in use.

Working.—The reaction tank is filled with the untreated water, a definite quantity of burnt lime is put into the chemical tank, slaked, mixed with water, and boiled by admitting live steam. The necessary quantity of soda is then added and again boiled. The untreated water is introduced, by means of a steam injector, through the upper one of two sets of pipes near the bottom of the tank. On its passage through the pipes the reagent is slowly added. By turning a cock the steam injector is made to drive air through the perforations in the lower pipe in the bottom of the reaction tank. This air effects a thorough mixing of the water and reagent, and also stirs up the sediment remaining from previous operations—the newly-formed sediment readily adheres to it, and is quickly settled. This precipitate is occasionally removed by suitable means. The softened water is drawn off through the swiveled floating discharge pipe. While passing down this pipe the water should come in contact with the waste gases from the coke stove, and should absorb some carbonic acid. The sample analyzed was not carbonated.

Supply.—Partly town water, partly brook.

Chemicals used per 1,000 gallons.—2.5 pounds lime, 0.6 pound soda, and 0.15 pound alumino ferric.

The user reports that this apparatus is easily worked and gives satisfactory results. The old boiler scale came off after six weeks' use. Now there is only a slight mud in the boilers. The carbonating is done for every alternate tank.

Result of Analysis.—The supply is the same as that for the Desrumaux apparatus, Fig. 7, but was not collected at the same time. A slight excess of lime as well as of soda was added, which had the effect of almost entirely removing the magnesia salts. This sample of water was not carbonated, but the treated water had absorbed 0.63 grain of carbonic acid, probably by contact with the atmosphere.

The Atkins Water-Softener.

The apparatus, Fig. 2, consists of a lime-slaking tank, a lime water tank, a settling tank, and a tank with revolving filter disks. The settling tank has a central division plate, and over it are placed two troughs—one for mixing the supply with the lime water, the other for collecting the treated water. The supply pipes to the mixing trough and to the bottom of the lime-water tank are controlled by ball taps.

The filters consist of hollow cast-iron disks covered with perforated sheet zinc and filtering cloths. They are bolted together by means of a hollow shaft which acts as a discharge pipe. Brushes are placed between the disks.

Capacity.—2,500 gallons per hour.

Dimensions.—Settling tank, 7 feet wide, 15 feet long, and 5 feet deep. Lime-water tank, 3 feet 6 inches in diameter and 8 feet deep. Filter tank, 5 feet 6 inches wide, 6 feet long, and 6 feet deep. Floor space, exclusive of lime-slaking tank, 138 square feet.

Working.—Slaked lime and water are poured into the lime-water tank, and a small stream of water, regulated by a ball-tap in this tank, enters the bottom of the tank, and clear lime water flows into a mixing trough, on to which the remainder of the water to be treated is poured. The supply and the outflow of the lime water are regulated by ball taps in the settling tank. The mixed water passes along the settling tank and overflows to the filters. These are cleansed occasionally by giving them a turn, when the brushes remove the sediment. No information was obtained as regards supply, chemicals used, or effects on boiler.

Results of Chemical Analysis.—In this case water which had only 3.165 deg. of permanent hardness was only treated for temporary hardness, which was successfully reduced to 2.32 deg.

The Babcock & Wilcox Water-Softener (Guttman).

The apparatus, Fig. 3, consists of a chemical tank, a reaction tank, filters, and soft-water tank. The supply pipe passes down the side of the chemical tank and ends in the bottom of the reaction tank. It has a branch pipe and cock over the chemical tank, and is fitted with valve *V*, shown on larger scale, which is regulated by the float in the soft-water tank. Live steam enters the reaction tank, as shown, through a silent injector; a branch from the steam pipe for occasional use is led into the bottom of the chemical tank. Where exhaust steam is available, an additional injector is fitted, as shown. Attached to the bottom of the chemical tank is a pipe with two cocks—C_1 for regulating the ratio of soda solution to the feed, and C_2 for regulating the quantity in accordance with the feed drawn off. At the top of the reaction tank is a weir, over which the treated water flows into the filter, which consists of a series of boxes filled with wood-wool. The bottoms of these boxes are provided with cocks, through which the sludge is drawn off occasionally. The filtered water passes into the soft-water tank, whence it is pumped into the boiler.

Capacity.—5,000 gallons per hour.

Dimensions.—Chemical and reaction tanks, 5 feet 5 inches square and 13 feet high. Filters and soft-water tank, 5 feet 5 inches wide, 17 feet long, and 8 feet high, measured over flanges. Total floor space, 122 square feet.

About thirty-five of these softeners, of various sizes, are in use.

Working.—Enough soda to last for one day is placed in the chemical tank, water is added, and steam turned on till all the soda is dissolved. The cock C_1 is opened to suit the density of the soda solution and the impurity of the feed water, and has to be adjusted during working, according to whether the softened water is alkaline or not. The cock C_2 and the feed valve *V* are actuated by levers from one float in the settling tank, so that the ratio of the amount of chemical and of the water is maintained. The mixture flows into the reaction chamber, where it is mixed with waste steam if available. It is here brought to the boiling point by live steam, which should remove the temporary hardness; the soda removes the permanent hardness. The hot water overflows to the filters, which it passes in half an hour, and here the sediment is removed. Some sediment collects in the lower tank. The grease from the exhaust steam adheres to the sediment, and does not pass the filters.

Supply.—From a reservoir.

Chemicals used.—Soda ash—quantity not stated.

The users report that this softener has worked well for three years, and has given every satisfaction, although the water is hard and sometimes acid. No trouble has been experienced with their three water-tube boilers with 1½ inches diameter tubes. An old scale is now removed, and only a little soft mud is formed. On one occasion a little grease was carried into the boilers, but it was found that the filter had not been properly packed.

Result of Chemical Analysis.—The analysis shows that about 60 per cent condensed steam has been added to the supply. Neither the high temperatures nor the chemicals have produced a beneficial effect, for on subtracting the above-mentioned condensed water (see third column of Table of Analysis, given later), the various constituents and the hardness are practically the same as the supply, except that some added soda has converted all the permanent hardness into temporary hardness.

The Bell Brothers Water-Softener.

The apparatus, Fig. 4, consists of a mixing-tank, a reaction tank, a settling-tank, and two sand filters. The mixing-tank and the chemical-tanks have mechanically-driven paddles. A pipe leads from the mixing-tank through a small pump to the inlet pipe of the untreated water. Another pipe leads from the top of the settling-tank to the two filters. The sand filters are provided internally with revolving hollow arms, which on occasion break up and wash the filtering sand.

Capacity.—2,500 gallons per hour.

Dimensions.—Two chemical tanks, 4 feet wide, 8 feet long, and 4 feet high. Settling tank, 5 feet in diameter, 9 feet above ground to top of hand-wheel. Each sand filter is 3 feet in diameter and 8 feet 6 inches high. The floor space is 172 square feet.

About twelve of these softeners of various sizes are in use.

Working.—The chemicals, lime and soda, are placed in their chemical-tanks and well stirred. They are then passed in correct proportions into the mixing-tank with its stirrer, and pumped into the feed inlet pipe, thence into the settling-tank, and then into the sand filters. When the pressure-gage indicates that the filters are nearly choked, the sand is loosened by water pressure from below, and then more water is injected through revolving arms into the body of the sand bed, which is thereby thoroughly washed out. The filters are under a pressure of 160 pounds per square inch.

Supply.—Well water.

Chemicals used per 1,000 gallons.—2 pounds alkali and 1.5 pound lime.

The users report that the softener works fairly well, but the pipes get choked too often. The makers affirm this to be due to faulty manipulation.

Result of Chemical Analysis.—By adding an excess of soda the permanent hardness was reduced from 30.9 deg. to nothing. The 2 pounds of lime, said to have been added, do not appear to have been properly mixed with the supply, and the temporary hardness has for this reason been increased from 5.2 deg. to 6.8 deg., which may account for the trouble.

The Boby Water-Softeners: Chevalet Detartarizer.

The apparatus, Fig. 5, consists of several perforated trays placed one above another and surrounded by a cylindrical shell, the lower part of which is the softened-water tank. At the side of this tank is placed a closed vessel with a float. The latter is connected to the inlet valve and regulates the supply. A pipe for injecting soda solution enters the untreated water-supply pipe. The exhaust pipe from the engines ends in a grease-separator attached to the softened-water tank. The outlet for the uncondensed exhaust steam into the atmosphere is at the top of the apparatus, and can be connected to a main condenser which would deliver water free from grease.

Capacity.—3,400 gallons per hour.

Dimensions.—Diameter of softened-water tank, 6 feet 2 inches. Height to top flange, 15 feet. Total floor space, exclusive of float and soda tank, 37 square feet.

About seventy-five of these softeners, of various sizes, are in use.

Working.—Soda is dissolved in a tank, not shown on the drawing, and the solution is pumped into the water supply, which falls on the top trays of the softener. There it comes in contact with the escaping steam, and gradually reaches the soft-water tank at the bottom. In its downward passage the water is in contact with the exhaust steam, acquires its temperature, and partly condenses it. The heat effects a precipitation of the carbonate of lime, and the soda precipitates the sulphate of lime. These precipitates, mixed with grease, adhere to the trays. Occasionally the apparatus is taken to pieces and the deposit removed. The joints are easily remade with putty. The feed-pump, drawing from the softened-water tank, actuates the soda-pump, and thus the ratio of the chemical to the feed-water is kept constant.

The exhaust steam, after passing the grease-extractor, comes first in contact with the softened water, and must inevitably impart to it traces of grease.

Supply.—Well water.

Chemicals used.—Soda—quantity not stated.

The users report that after three months' use it takes three days to clean the apparatus and to remove 2 tons of scale. No grease has been noticed in the feed, and no scale is formed in the boiler.

Result of Chemical Analysis.—The analysis shows that 27 per cent condensed steam was added to the supply. Subtracting this addition, the effect of the heat and the carbonate of soda is shown in the third column of the Table of Analysis, where it will be seen that the temporary and permanent hardnesses have been reduced from 22.7 deg. and 12.6 deg. to 4.6 deg. and 4.22 deg. Only a small part of the magnesia has been removed. Better results would have been obtained by the use of caustic soda instead of carbonate of soda. Heat alone does not appear to be able to reduce the temporary hardness to a minimum.

The Carrod Water-Softener.

The apparatus, Fig. 6, consists of two chemical-tanks, one mixing-tank, a settling-tank and filter combined, and a distributor. The water-supply pipe has a hand-cock over each reagent tank, and a ball-tap over the distributor, which discharges to the bottom of the settling-tank through a valve regulated by a float in the settling-tank. A trunk conveys the mixed water to the bottom of the settling-tank, where several baffles are fitted. The upper part of this tank is a filter. The settling-tank has a drain-cock for the sediment, and the chemical-tanks have also drain-cocks to remove the impurities of the lime.

Capacity.—600 gallons per hour.

Dimensions.—8 feet long, 4 feet wide, and 12 feet 9 inches high. Floor space, 32 square feet.

About sixty of these softeners, of various sizes, are in use in England, and about two thousand on the Continent.

Working.—The reagent is alternately prepared in the left or right-hand tank by mixing together the correct amounts of lime, soda, and water, and stirring these by hand. The reagent is drawn off near the surface through an India-rubber tube, supported by a float, and passes through a ball-tap into the mixing-tank. The untreated water also enters this tank through a ball-tap, and the two quantities should therefore always be in a definite ratio. The water is let out of the mixing-tank through another ball-tap, and descends to the bottom of the settling-tank, where baffles arranged in a peculiar manner are intended to assist precipitation. The precipitate is occasionally drawn off through a cock. The treated water now passes through the filter and thence to the feed-pump. The filtering material—wood-wool, which costs 4s. 6d. per hundredweight—is said to last two years.

Supply.—Well water.

Chemicals used.—Caustic soda—quantity not stated.

The users report that the softening (*sic*) is not carried quite so far for the quarry locomotives as for the fixed boiler, because of priming. The effect on the boilers is good, and the brasswork or copper fire-boxes are not injured, but the gage-glass, taps, etc., give more trouble than when ordinary water is used. The sediment from the apparatus is easily removed.

Result of the Chemical Analysis.—This apparatus is designed to use both lime and soda, but waste caustic soda and no lime was used, and the result is that the temporary hardness has been increased 10 deg. and the permanent hardness decreased. This bad result is not due to the apparatus.

(To be continued.)

Imitation of Antique Silver.—Plated articles can be colored to resemble old objects of art made of solid silver; for this purpose the deep-lying parts, those not exposed to friction, are provided with a blackish, earthy coating, the prominent parts retaining a leaden, but bright color. The process is simple. A thin paste is made of finely-powdered graphite and oil of turpentine (a little bloodstone or red ochre may be added, to imitate the copper tinge in articles of old silver) and spread over the whole of the previously plated article. It is then allowed to dry, and the particles not adhering to the surface removed with a soft brush. The black coating should then be carefully wiped off the exposed parts by means of a linen rag dipped in alcohol. This process is very effective in making imitations of objects of antique art, such as goblets, candlesticks, vessels of every description, statues, etc. If it

is desired to restore the original brightness to the object, this can be done by washing with caustic soda or a solution of cyanide of potassium. Benzine can also be used for this purpose.—Der Metallarbeiter.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Revolt Against American Cotton.—Foremost among the economic movements in Europe, which may have a serious meaning for important interests in America, is the present simultaneous effort of Great Britain, France, and Germany to emancipate their textile industries from dependence upon American cotton. The causes of this movement, which has been gathering force and inspiration for several years, are obvious to any one familiar with the cotton trade and have been brought into especial prominence by the events of the past season. This will be apparent from a brief *résumé* of the present situation.

Germany imported in 1902 348,302 metric tons of raw cotton, of which 267,000 tons, or 76 per cent, valued at $76,488,600, came from the United States. The total imports from January 1 to October 31, 1903, were 306,427 tons, of which 205,101 tons, or 67 per cent, was of American origin. Add to this the importations of cotton waste and of weaving yarns from Great Britain, Switzerland, and Belgium, that are spun in those countries from American fiber, and it will be apparent that the cotton-textile industries of this country are practically dependent upon American cotton, which ranks first in value and importance among all German imports from the United States. The same relative dependence upon American fiber is more or less true of the cotton industries of Great Britain, France, Switzerland, and the Netherlands.

The portentous feature of the situation is that there is, not only in Germany, but throughout Europe, a growing feeling of resentment against this dependence, and a determination that their spinning and weaving industries must at any cost be emancipated from such vassalage by the development of wholly new sources of supply. In England this movement has inspired the organization of the British Cotton-Growing Association, which after two years of more or less successful experiments in Sierra Leone has within the past few days received from the Province of Lagos, West Africa, a sample shipment of 30 tons from this season's crop, which is pronounced equal to the best American upland in both length and quality of fiber.

France has likewise a colonial cotton association, which is experimenting in the Sudan with such success that samples received from there are reported as having reached approximately the grade of Egyptian cotton, and are therefore adapted to the mercerizing process, which has of recent years consumed a large and growing percentage of the Egyptian staple.

But it is the German campaign for a colonial cotton supply that is at present most vigorous and interesting. For this activity there are three obvious and controling reasons. The first of these is the fact that the German colonies in Africa have been hitherto economically disappointing, and there is a natural desire on the part of the government and of the more influential classes that those possessions may be utilized and their acquisition justified by making them the means of securing a permanent future supply of cotton from a source under the German control. The second and, for the moment, quite the most potent reason grows out of the uncertainty and the violent, sudden, and extreme fluctuations of the American cotton market during the past three months. It is charged in the German press that the American cotton market is at the mercy of groups and combinations of conscienceless speculators, who by their manipulations drive prices up and down to suit their own purposes; that the government reports as to size and quality of crop are often contradictory, untrustworthy, and misleading; that in consequence of these irregularities in supply and price German manufacturers have sustained serious losses as well as frequent interruptions and uncertainties in their business. The third, and by no means the least urgent of these causes, is the constant growth and expansion of American cotton manufactures, particularly in the South, which consume a steadily increasing percentage of the total crop, leaving a constantly narrowing surplus for export to the non-cotton-growing countries of Europe. All these facts are made the most of by the party which advocates a vigorous pull all together for the development of cotton fields in East Africa that shall forever emancipate the spinners and weavers of the Fatherland from depending upon the American staple.

Thus far the movement is, of course, in its infancy, but its future may be ominous for the cotton growers of our Southern States. It is, in the first place, perfectly organized and ably managed, under the auspices of the colonial agricultural committee, which has its seat in Berlin and is in close touch with the Colonial Ministry. Its experiments in the East African colonies have been in progress two years and appear from the reports to have been entirely successful. A few bales of the new staple, which arrived a fortnight ago, have been examined and tested by the Cotton Spinners' Union in Saxony with highly encouraging results. In the exultation of the moment it is announced that there are many thousand square miles of land in East Africa with soil and climate perfectly adapted to the cultivation of cotton equal or even superior in quality to the American staple.

It is realized, however, that it will require far more than merely fertile soil and genial climate to make African cotton growing on a large scale permanent and profitable. Time, capital, improved methods, and cheap, tractable labor are the other essential elements in the problem. Capital is ready as soon as the requisite skill and experience can be provided, and in respect to this last requirement the German Colonial Society has begun with characteristic deliberation and thoroughness.

Through the German consul at Galveston arrangements are in progress to send over and educate at agricultural schools and on plantations in Texas a number of young Germans, who before going will sign contracts to spend a given number of years as superintendents of plantations in the German African colonies. A German-American from Texas, named Becker, has already been sent out to Dar-es-Salam to examine the cotton grown experimentally there and then travel over the country to explore and estimate the area of land in the colony that is adapted to that branch of agriculture. Coolie labor from China will be employed in case the native tribes prove too incompetent, and the question of transportation will be readily solved by the same industrious and venturesome steamship lines that now carry the trade of the German Empire to every corner of the globe.

It may be many years before this European crusade for colonial cotton will accomplish all that it seeks to achieve, but whether we like it or not the day will come, sooner or later, when the cotton of our Southern uplands and valleys will no longer be king beyond the frontiers of the United States.—Frank H. Mason, Consul-General at Berlin, Germany.

Faulty American Packing for China.—If more care were exercised in packing goods for Asia great benefits and increased trade would result therefrom. Let me give a few examples:

About four years ago the American soda crackers, or biscuits, as they are called here, were introduced into this market and found a ready sale. They were light, crisp, and far preferable to the English biscuits, which, nevertheless, now supply the market here. The first lot of these crackers was soon disposed of, and then several firms ordered a stock. When the second consignment was received and placed on sale they were returned to the merchants by their customers, who found them unfit for use. That supply is still on hand, but no further orders are given for the American soda crackers. Whether it was all due to packing or to the poor quality of shortening used it is difficult to say. I do know, however, that last winter several hundred cans of the same kinds of crackers were condemned on the United States transports as unfit for use.

The British biscuits and cakes are always fresh looking and sweet and seem to keep any length of time. They are packed in tin boxes, with outer and inner covers soldered on, the boxes being lined with specially prepared paper and a packing of cut tissue paper.

All English candies are packed the same way—every piece wrapped in tin foil. If American candies were properly packed, so as to resist moisture and the jarring incident to shipment, they would arrive in good condition, instead of being mashed and unsightly, as at present, and would be far superior in quality to any confectionery in this market. British oatmeal, or rolled oats, is packed in one and five-pound tin boxes, soldered; while most of the United States products of similar articles are sent packed in either pasteboard boxes or heavy paper bags.

The result of all this is that the dealer will inform you, on inquiry, that they have the American article, but advise you to take the English, as the American, on account of not being put up properly, is liable to be moldy and wormy.

A short time since, on inquiring for hams of the American brand, a British dealer said that he preferred them to the English, but that they are packed so badly that they mold and mildew, and his customers were afraid to buy them. English hams are first placed in a cloth bag and then in a large bag containing oat chaff, which carefully incloses the smaller bag and ham. The chaff absorbs the moisture and the ham opens in good condition.

A few weeks ago a dealer in tiger and leopard skins desired some artificial eyes. The order was sent to one of the largest mail-order houses in the United States. On arrival it was seen that one-third of an inch of oakum had been placed in the bottom and sides of the box; then one lot of eyes had been placed in the box in bulk, a layer of oakum thereon, and the box then filled with the other lot, put in all together on top of the first. On account of these articles not being wrapped separately, more than fifty per cent of them were broken.

The important factors to bear in mind are: To have the outside packing double extra strong to prevent moisture; delicate articles must be packed separately in some soft material, so that no amount of jarring will injure them. Many coolies seem to enjoy throwing boxes down as hard as possible in order to break them open.—L. S. Wilcox, Consul-General at Hankau, China.

Pumps and Lamps Needed in China.—Nearly all parts of China are greatly in need of better facilities for supplying the people with pure drinking water. In all the city of Fuchau, with its million of people, there is not a single pump, windlass, or other mechanical appliances for raising water from the wells or bringing it from the river to supply the city. Every householder brings his own pail and rope by which it may be lowered into the well, and when supplied carries both away with him, so that a traveler must be the recipient of his hospitality or go without a drink. If the supply is brought from the river it is carried on men's shoulders, two pails being suspended from a bamboo carrying pole. There is no public water system in all southern China. Some Japanese engineers recently made surveys with a view to introducing waterworks, but I am now informed that they have abandoned the project because of lack of encouragement or the least assistance from the local authorities.

Neither has this great city any system of lighting its streets or public buildings. Kerosene is being extensively used by the better class of Chinese, and there is a great demand for foreign-made lamps. Many of these are of very cheap quality, and are really unsafe to use. Most of the natives use small cups or tumblers about three-fourths full of oil, with a small piece of wood floating on the surface of the oil, through which a tin tube containing a round wick is placed. This is a very common form of lamp in which tea oil is burned, and is utterly unfit for kerosene. Many very poorly made foreign lamps are sent here, which are even more dangerous for use, as they are very poorly put together and the tops soon fall off. A really good low-priced lamp is desired.—Samuel L. Gracey, Consul at Fuchau, China.

Trade of the Canary Islands.—Never in the history of these islands have they been so prosperous as they are now; not even during the time when they virtually supplied the world with cochineal, now supplanted by the aniline dyes, could they compare in wealth with the present time.

The imports, roughly stated, amount to between $5,000,000 and $6,000,000. Of this, coal from Wales is the largest import. This, however, is again exported by vessels calling for bunkering and other purposes. The value of the coal amounts to about $3,000,000, but all the coal has to be handled from two to four times. This leaves a large amount of money in the country, expended for labor attached to the handling.

The exports, not including the coal, amount to over $3,000,000, but it must be borne in mind, in addition, that much money is drawn by supplying ships with provisions and water, by furnishing labor for loading and unloading cargoes, and for coaling; also from the large influx of visitors seeking health and recreation. It is estimated that there was a balance last year of from $2,000,000 to $3,000,000 in favor of the islands.

The trade was much better than in the previous year. More fruit was exported, a larger number of vessels called, and there was an increase in the number of visitors.—Solomon Berliner, Consul at Teneriffe, Canary Islands.

American Pianos Wanted in Brazil.—There appears to be a market here for a good cabinet piano if it fulfills the following requirements: It must be an upright piano, purchasable here at from $500 to $750. The duties on such a piano are about $90 here and the freight $30. It should be put together as far as possible with screws, or, at least, not with glue; it should possess a rich, full tone, which should be permanent, not becoming "tinny," and it must be able to withstand a very hot and very damp climate. German pianos that answer pretty well these requirements are sold here, but if our pianos, at the same price, have a better tone and are lasting, a good trade can be done in them. I would like to receive catalogues and price lists from all manufacturers interested. The following information is absolutely necessary or the sending firm will waste time: Weight of piano, net and boxed; price, net f. o. b. New York.—Louis H. Aymé, Consul, Para, Brazil.

American Goods Wanted in Abyssinia.—I am in receipt of a letter from Goolamally M. Mohamedally & Co., of Harrar, Abyssinia, stating that they are now buying boots, shoes, saddlery, rifles, revolvers, and swords, camp furniture, jams, pickles, biscuits, candy, table salt, corrugated sheet iron, round iron disks, wire nails, wrought-iron nails, sheet tin, and screws from England; enameled ironware, glassware, perfumery, knives, and beads from Germany. They request me to have sent to them immediately prices and information in regard to these articles. Prices should be quoted c. i. f. Djibouti, French Somaliland. I have a very similar letter from Ohannes Assadourian, Addis-Ababa, Abyssinia. Mr. Assadourian is particularly interested in guns, and suggests that rifles of the United States regular army type "might become an article of commerce in a large way." Both of the houses above mentioned have excellent financial standing.—Robert P. Skinner, Consul-General, Marseilles, France.

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Other Reports can be obtained by applying to the Department of Commerce and Labor, Washington, D. C.

SELECTED FORMULA.

Aromatic Water.—Hager gives two formulas for the German preparations known under the various names, aqua aromatica, aqua cephalica, schlagwasser, mutterbalsam, kinder-balsam, etc. They follow:

I.

Oil of cloves	2 parts
Oil of cinnamon	2 parts
Oil of lemon	2 parts
Oil of fennel	1 part
Oil of lavender	1 part
Oil of peppermint	1 part
Oil of rosemary	1 part
Oil of sage	1 part
Alcohol	600 parts
Distilled water, enough to make	1,000 parts

This is used externally for headache and other ailments, and internally in doses of from 30 to 60 drops, for cramps, colic, etc.

II.

Sage leaves	56 parts
Rosemary leaves	28 parts
Peppermint leaves	28 parts
Lavender flowers	28 parts
Fennel	14 parts
Cinnamon bark	14 parts
Alcohol	364 parts
Water	1,820 parts

Beat the herbs together, add the alcohol and water, macerate for a day and then distill off 1,000 parts.

Formulas for the same preparation varying slightly from these are given in Dietrich's Manual.

Blue Black Writing Fluid.—For ordinary school or correspondence purposes anilin inks are perhaps as good as any, but for bookkeeping and making records they are not sufficiently permanent and an iron-and-tannic-acid combination should be used. Anilin inks usually make good copies, especially if thickened slightly with gum arabic.

Permanent Blue-Black Ink.

Bruised galls	3 ounces
Iron sulphate	1 ounce
Gum arabic	1 ounce
Vinegar	1 ounce
Water, enough to make	24 ounces
Indigo carmine enough to give a blue tint.	

Macerate with frequent shaking for fourteen days and then decant.

Blue-Black Anilin Ink.

Methyl violet	4 grains
Bengal green	5 grains
Bismarck brown	3 grains
Gum arabic	20 grains
Water	4 ounces

This makes a good copying ink, and costs only a few cents a quart.

Knowledge of proper manipulation is essential to the making of a satisfactory gall ink. No great skill, however, is required to weigh out a few grains of anilin colors and dump them into a bottle of water.

It is feared that the ease with which anilin inks are made, and their cheapness, are securing their adoption for purposes for which they are ill-fitted, and that the next generation will have to suffer on account of their too free use by this one.—Drug. Circ.

Stove Polish.—The following makes an excellent graphite polish:

Cerasin	12 parts
Japan wax	10 parts
Turpentine oil	100 parts
Lampblack, best	12 parts
Graphite, levigated	10 parts

Melt the cerasin and wax together, remove from the fire and when half cooled off add and stir in the graphite and lampblack, previously mixed with the turpentine.

The following is a variation of the above:

Cerasin	23 parts
Carnauba wax	5 parts
Turpentine oil	220 parts
Lampblack	300 parts
Graphite, finest levigated	25 parts

Mix as above.

The following we can recommend from personal experience:

Make a mixture of water-glass and lampblack of about the consistency of thin syrup, and another of finely levigated plumbago and mucilage of Soudan gum (or other cheap substitute for gum arabic), of a similar consistency. After getting rid of dust, etc., go over the stove with mixture number one and let it dry on, which it will do in about 24 hours. Now go over the stove with the second mixture, a portion of the surface at a time, and as this dries, with an old blacking brush give it a polish. If carefully done the stove will have a polish resembling closely that of new Russian iron. A variant of this formula is as follows: Mix the graphite with the water-glass to a smooth paste; add, for each pound of paste, 1 ounce of glycerin and a few grains of anilin black. Apply to stove with a stiff brush.

Finally, the following is said to equal the best of the patented preparations: Make two saturated solutions, one of tannic acid in water, and the other of iron sulphate in water. Mix 2 parts, by weight, of the iron solution and 3 parts of the tannin and to the mixture add 1 part of good oil blacking, 1 part of lampblack and 5 parts of plumbago and grind the whole together to a smooth paste. Apply as plain blacking is applied. —National Druggist.

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