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THE QUEEN REGENT AND ALFONZO XIII.

[Illustration: *The queen Regent and her son, king Alfonso XIII. Of Spain.*]

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In the present war between the United States and Spain, the Queen Regent is an impressive figure, and it is entirely owing to her charm and fortitude that the present dynasty of Spain is maintained. Since his earliest youth she has constantly made efforts to fit her son to wear the crown. The Queen Regent came from the great historic house of Hapsburg, which has done much to shape the destinies of the world. All the fortitude that has distinguished its members is represented in this lady, who is the widow of Alfonso XII. and the mother of the present king. Her father was the late Archduke Karl Ferdinand and she is the cousin of Emperor Franz Joseph. She has had a sad history. Her husband died before the young king was born, and from the hour of his birth she has watched and cared for the boy. She is the leader in all good works in Spain, and her sympathy for the distressed is proverbial. She gives freely from her private purse wherever there is need, whether it be for the relief of misery or, as recently, when the state is in peril. The young king has been carefully educated. By a curious fate, his birth deposed from the throne his sister Maria de las Mercedes, who as a little girl was queen for a few months. The boy has been brought up under the influence of family life and has a warm affection for his mother and sisters. He has never had the full delights of childhood, for he has been educated in that false, punctilious and thoroughly artificial atmosphere of the court of Spain, in which every care has been taken to fit him for his royal position. His health is far from robust, though the military education he has received has done much to strengthen his constitution. He has been taught to interest himself especially in the naval and military affairs, and the study of the models of ships and military discipline has been one of the principal occupations of his childhood. It is the earnest wish of Spain that he should prove worthy of his mother.

* * * * *

THE MILESTONES OF HUMAN PROGRESS.[1]

[Footnote 1: A lecture delivered by Prof. Daniel G. Brinton at the Academy of Natural Sciences, Philadelphia.]

The subject pertains directly to the advancement of the race. Indeed, it is to the measure of this advancement I shall ask your attention. There is no doubt about the advancement. There are some people who believed and believe that man began in a state of high development and has since then degenerated into his present condition. The belief in some period of Arcadian simplicity and human perfection is still to be found in some remote nooks and crannies of the learned world; but those minds who have been trained in archaeological studies and in ethnographic observations know well that when we go back to the most ancient deposits, in which we find any sign of man at all on the globe, we find also the proofs that

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man then lived in the rudest possible condition of savagery. He has, little by little, through long centuries and millenniums of painful struggle, survived in made his weapons and his most effective tools for the time being would be a good criterion to go by, because these weapons and tools enabled him to conquer not only the wild beasts around him and his fellow man also, but nature as well. These materials are three in number. They particularly apply to European archaeology, but, in a general way, to the archaeology of all continents. The one is stone, which gave man material for the best cutting edge which he could make for very many millenniums of his existence. After that, for a comparatively short period, he availed himself of bronze—of the mixture of copper and tin called bronze—an admixture giving a considerable degree of hardness and therefore allowing polish and edge making. The bronze age was not long anywhere. It was succeeded by that metal which, beyond all others, has been of signal utility to man—iron. We live in the iron age, and it is from iron in some of its forms and products that all our best weapons and materials for implements, *etc.*, are derived. We have, therefore, the ages of stone, of bronze and of iron. These are the measures, from an artistic source, of the advancement of human culture; and they certainly bear a distinct relation to all man's other conditions at the time. A tribe which had never progressed beyond the stone age—which had no better material for its weapons and implements than stone—could never proceed beyond a very limited point of civilization. Bronze or any metal which can be moulded, hammered and sharpened of course gives a nation vast superiority over one which uses stone only; and the value of iron and steel for the same purposes I need not dwell upon.

To be sure, we have here several measures; and it would seem more desirable, if we could, to obtain one single measure—one single material or object of which we could say that the tribe that uses or does not use that to an equal degree is certainly lower or, in the other respects, higher than another; but I believe that there has been no single material which has been suggested as of sufficient use and value in this direction to serve as a criterion; but, yes! I remember there was one and, on the whole, not a bad one. It was suggested by Baron Liebig, the celebrated chemist, who said: "If you wish a single material by which to judge of the amount of culture that any nation, or, for that matter, any individual, possesses, compared to another one, find out how much soap they use. Nothing," he said, "more than personal cleanliness and general cleanliness differentiates the cultured man from the savage;" and as for that purpose he probably had in view a soap, he recognized that as the one criterion. It is not amiss, but open, also, to serious objections; because there are tribes who live in such conditions that they can get neither water nor soap; and the Arabs, distinctly clean, are not by any means at the highest pinnacle of civilization.

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The Germans, therefore, as a rule, have sought some other means than all those above mentioned. Almost all the German writers on ethnography divide the people and nations of the world into two great classes—the one they call the “wild peoples,” the other the “cultured peoples”—the “Natur-Voelker” and the “Kultur-Voelker.” The distinction which they draw between these two great classes is largely psychological. Man, they say, in the condition of the “wild people”—of the “Natur-Voelker”—is subject to nature; therefore, they call them “nature people.” The “Kultur-Voelker,” on the other hand, have emancipated themselves, in great measure, from the control of nature.

Furthermore, the man in the condition of the “wild people” is in a condition of practically unconscious life: he has not yet arrived at self-consciousness—he does not know and recognize his individuality—the “Ego”—“das ich;” that is a discovery which comes with the “Kultur-Voelker”—with the “cultured people;” and just in proportion as an individual (or a nation) achieves a completely clear idea of his own self-existence, his self-consciousness, his individuality, to that extent he is emancipated from the mere control of nature around him and rises in the scale of culture.

Again, to make this difference between the two still more apparent, it is the conflict between the instinctive desires and the human heart and soul and the intelligent desires—those desires which we have by instinct, which we have by heredity and which have been inculcated into us wholly by our surroundings, which we drink in and accept without any internal discussion of them: those are instinctive in character. We go about our business, we transact the daily affairs of life, we accept our religion and politics, not from any internal conviction of our own or positive examination, but from our surroundings. To that extent people are acting instinctively; and, as such, they are on a lower stage of culture than those who arrive at such results for themselves through intelligent personal effort. This is a real distinction also, although somewhat more subtle, perhaps, than the ones previously given. Therefore, the differentiation made by the German ethnographers between wild people and the cultured peoples is, in the main, right; but it does not admit of any sharp line of distinction between the two. We cannot draw a fixed line and say, “On this side are the cultured people and on that the wild,” because there are many tribes and nations who are about that line, in some respects on one side of it, in others on the other; but in a broad, general way this distinction (which is now universally adopted by the German writers) is one we should keep in our minds as being based upon careful studies and real distinctions.

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Usually the writers in the English tongue prefer a different basis than any of these which I have mentioned; they prefer the basis as to whence is derived the food supply of a nation, or a tribe; and on the source of that food supply they divide nations and tribes into the more or less cultured. In earliest times (and among the rudest tribes to-day) the food supply is furnished entirely by natural means; there is little or no agriculture known to speak of; there is nothing in the way of preserving domestic animals for food; hunting the wild beasts of the forests and fishing in the streams are the two sources. Therefore, we call that last condition the hunting and fishing stage of human development. You will observe that when that prevails there can be no congregation of men into large bodies. Such a thing as a city would be unknown. The food supply is eminently precarious. It depends upon the season and upon a thousand matters not under the control of man in any way. Moreover, inasmuch as the supply at the best is uncertain, it allows but a very limited population in a district; nor does it permit any permanent or stable inhabitations. The towns, such as they are, must be movable; they must go to one part of the country in the summer and another in the winter; they must follow the game and the fruits; and in that condition, therefore, of unstable life it is not possible for a nation or a tribe to gain any great advance. You observe, therefore, that when the food supply is drawn from this source it does entail a general depravity of culture everywhere.

Above that would come the food supply which is obtained from other sources. There is one which is not universal but still widely extended, and that is the pastoral life. There are many tribes (as, for instance, in southern Africa and in India and throughout the steppes of Tartary and elsewhere) who live on their herds and drive their herds from one pasture to another in order to obtain the best forage. This nomadic and pastoral life extended very widely over the old world in ancient times, but existed nowhere in the new world, for the simple reason that they had no domesticated animals. Our own remote ancestors—both the Aryans and the Semites—all the early ancestors of the white race so far as known, were pastoral or nomadic; and the Aryans of central Europe remained so until after the fall of Rome, when, for the first time, they became practically sedentary. This nomadic and pastoral life is a very great advance over the mere hunting and fishing stage. It requires considerable care and attention to domesticate the wild animals in any sufficient quantity to form a reliable source of food. Moreover, the attention which it was necessary to give to the rearing and training and the looking after domestic animals was to a certain extent, humanizing. When a man found that it was necessary to be careful about his animals, he would also be careful about his neighbors. We would say that the same sense which enabled him,

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or directed him, to look after the welfare of the herd would justify and, in fact, impel him to look after that of man also; so that the nomadic and pastoral life, although not stable nor favorable to the development of cities, nor the great extension of commerce, was nevertheless a decided advance over the ruder hunting and fishing stage. So far as we know, neither Aryan nor Semite ever depended upon a hunting and fishing stage. They doubtless did, but not in the time of any history that we know. The Bedouins, *etc.*, wandering tribes to-day, and, among the Semitic, the Tuaregs of the Sahara, are a purely nomadic or pastoral race; yet are very much above the negroes of the south, who depend upon hunting and fishing.

Above it, however, and a very great improvement upon it, is the agricultural stage, where the main source of the food supply is the harvests. You observe, at once, that that means a sedentary life. When a man sows corn, he must wait thereabout and tend it and till it and finally reap it and store it and thrash it and then preserve the grain and build granaries for it; and it involves, in fact, the remaining in one place all the whole year; and then the regularity of that life led very distinctly to making men regular, generally, in their habits. They wanted to defend their homes—defend these grain fields of theirs, or starvation would result; therefore, they built towers and strong-walled cities; and they took great care in the selection of the best men among them to do the fighting, while others looked after the crop. We find that agriculture began at a very, very early period in both continents. In our own continent we cannot tell when agriculture was first in use—the main crop being the maize, or Indian corn. It was raised by the more advanced tribes from the extreme north, where its profitable culture invited, to the extreme south, from about the northern line of Wisconsin in North America to the latitude of southern Chile in South—extending, therefore, over some seven to eight thousand miles of linear distance.

In the old world (going back to the time of the lake dwellers) we know they had barley, rye and a species of millet; and later on they were introduced to oats and wheat and a variety of others. Rice was of the very earliest of our cereals, in the extreme east of the old world. Wherever we find a very ancient civilization we also find that it is intimately connected with some important cereal, and it has been said that all you have to do is to study botany—the history of botany—and you will find the history of human culture; and much there is that could be said for that.

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Fourth, and finally, those who divide human culture according to the food supply consider that the highest stage is reached through commerce. Commerce brings to all the great centers of human life the food essential to their sustenance. It would be absolutely impossible—obviously so—to have a city like Philadelphia in existence for a month without constant and ceaseless commerce brought here the food for its inhabitants. It is quite likely that, were Philadelphia shut off at once from all connection with the world, within ten days there would be an absolute famine here—so closely do we depend upon our commercial supplies for our subsistence. These supplies are not drawn from any one locality; were we to draw a radius of five hundred miles around our great city of a million inhabitants, we should still find that the greater part of our food supply comes from a wider distance from us than that; and there is no one of us that will go to his table this evening but will see upon that table food products drawn from every quarter of the world. Thus it is that commerce enables man to reach an indefinite degree of consolidation; and it is through consolidation—through the more and more intimate relationship, and the closer and closer juxtaposition of man—that his real benefit and progress may be derived.

These, therefore, are the four stages of culture, as depending upon food supply: the hunting and fishing stage, the nomadic or pastoral, the agricultural and the commercial. These have been generally adopted by English writers, and they are so adopted to-day; and you will probably find them in many of the text books.

The American writers have, in many instances, followed the principles laid down and defined most clearly by Mr. Lewis H. Morgan, a distinguished ethnologist of the last generation. He divides (or accepted the division and largely defined it) the progress of man into a series of stages: beginning at the lowest point with savagery; then barbarism, semi-civilization, civilization, and fifth, enlightenment.

I may briefly refer to what he would include in these and the main criteria which he gives for each of them. He would place the savage condition as being that of the lowest tribes known to us. They have little or no agriculture; their commerce is very inchoate and rude: they have no knowledge of the metals as such; their best weapon is the bow and arrow, or the throwing stick; and their best tool is the stone hatchet and the stone spade. This is very much like the lowest condition of the “wild people” to whom I referred.

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Above that he would place the condition of barbarism. In the stage of developed barbarism he would place such inventions as, for instance, pottery, the art of weaving (which is a very primitive art) and the taming of a certain number of domestic animals, some for food, some for amusement and hunting, and also the beginnings of the development of agriculture. A type of such a nation of barbarism would be the Indians who used to live here—the Algonkian—the Delaware Indians. When the first Europeans came to the shores of the Delaware River they did not find absolutely rude savages. The Delaware Indians had moderately stationary villages surrounded by pickets, the houses being built of strong timber; they had large fields of maize, pumpkins, squashes and beans, which they cultivated diligently during the summer and stored the food for their winter's supply. They depended largely, to be sure, upon hunting and fishing also; but along with that they had these simple arts: From the rushes which grew below Philadelphia, in a place called the "Neck," they used to weave mats for protecting the floors and also for building the sides of their summer houses and for sleeping upon. They had a method of tanning and dressing buckskin and using it for the purposes of clothing. They were by no means naked savages; they were clothed, and tolerably well clothed; they could make pottery, and the pottery was decorated sometimes with interesting designs, of which we have specimens in our cabinets. Therefore, we find among the old Delaware Indians who formerly lived on the site of Philadelphia a fair specimen of a nation in a barbarous stage, decidedly superior to the Australian natives of to-day or the Indians of the Terra del Fuego or the northern part of British America, who are in the state of complete savagery.

Above that is the period of semi-civilization, a stage marked by the discovery of the method of building stone walls. No Algonkian or Iroquois Indian ever built a stone wall in his life; there is no record of any and no signs of any throughout the United States east of the Mississippi; there was never a stone wall built by a native tribe that really amounted to anything more than a stone pile; but we do find that in the southwest, among the cliff dwellers, and in various parts of Central America and South America, the stone wall was not only known, but it was constructed with a great deal of durability and skill. Also, some knowledge of metals was found among most of the semi-civilized people. The Mexicans and the Peruvians were in a state of semi-civilization when they were discovered by the whites the first time. They, built many extensive temples and houses, erected frequently upon pyramids, the pyramids themselves being supported by stone walls. They knew the dressing of stone; they were distinctly agricultural and depended more on that than anything else for their food supply. They had developed a system of mnemonic records which,

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in the Yucatan culture, might be called picture writing, but was not phonetic writing in our true sense of the term. They also knew something about weighing and measuring. They had definite laws, laws which were carried out by properly appointed individuals. Their towns and cities would often number thousands of inhabitants; they had roads connecting them, which roads were kept in good condition; they had a regular army made up of men selected and trained for that purpose. In all these respects we see nations who were semi-civilized, but they were not yet civilized. We could call a nation civilized that had a distinct system of phonetic writing and used it; but not all nations having this are civilized. It is only when it is used freely and for purposes of business that we can call them civilized.

The wild Tuaregs of the Sahara have a system of phonetic writing used by a few of them—the women being the literati of those tribes (the men not knowing how to read or write); but civilization means more than this; it means the use of iron weapons and tools; it means also the adoption of a definite currency which is established on a fixed basis and recognized throughout the community; it means the establishment of commercial lines—a progress distinct above that which is the mere barter of the lower conditions of savagery and barbarism. In all these respects we see that civilization means a type about such as we enjoy at present. It is such as has existed in Europe since the Renaissance; because during the middle ages we could only say that Europe was in a semi-civilized condition. They knew something about writing; but at a time when Dean, the writer of the early history of England, said that throughout the whole of England there were not half a dozen men who could read what he had written, you can see that writing was a very unimportant part of the culture of that nation; so it can only be when writing becomes a common possession of the majority that we can call it an element of civilization.

It is not to be supposed that we ourselves have reached the type of the highest culture. We leave something for our descendants to do. We do not wish to relieve them of the privilege of being better than ourselves; and we shall leave them, probably, plenty of room; because it is supposed that the stage of enlightenment which is the highest stage of culture—which we foresee, but do not see—that that rather applies to the future than to ourselves. That period will come when mankind has freed itself very much more than now from the bonds of nature and the environment of society. It will come when the ideas of our equality are much more perfect than they are now; when that equality extends to the equality of women with men before the law and in all rights; when it comes to the equality of all men of all castes before the law and the equal opportunity of all men to obtain that which is best in the life of all. We are very far from that yet. It will come also when the idea of international legislation is such that it will not be necessary, in order to cure great evils, that we should have recourse to weapons of any material whatsoever; that time is not yet come; and so we have much that is left for our descendants to work out in this direction.

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It would, however, appear that all these various criteria which I have named are somewhat unsatisfactory. They do not, it appears to me, quite touch the question at issue. They are in a measure external measures altogether—even that somewhat psychological one which I quoted from the German authorities. Were I to propose a criterion, or a series of criteria, of culture which could be applied to all nations, it would be that which might as well and easily be applied to each individual; and when we come to apply it in that manner it is much more easy to understand its bearing. Herbert Spencer, in defining what he means by culture, says: “It means the knowledge of one thing thoroughly and a knowledge of the groundwork of all other branches of human knowledge.” He claimed that we can only understand one thing thoroughly; but that we could and ought to understand the general outline of all other things which are studied by mankind. This is somewhat defective, it appears, because it bases culture entirely from an intellectual point of view; and if man were merely a walking intellectual machine, it would be well enough; but he is not; for the intellectual man is but a small portion of his life. We are engaged, most of our time, in something which is very far from purely intellectual action. We are governed distinctly by our emotions and our feelings—our sentiments; and culture must touch them, or it is vague and empty. Therefore it is that I would say that we should think with Goethe—to whom we must often recur for an insight into the profoundest trends of human nature—must recur to him; and we find that he lays down the principle of culture in the individual to be “A general sympathy with all the highest ideas which have governed and are governing the human mind.” He said: “We should keep ourselves first (each man and woman should keep himself and herself) in touch with the highest elements of his and her own nature.” He said, “It is not so difficult, if we give but a little time to it—provided we give that time regularly. We must remember,” he says, “to cultivate our intellect by some study, every day and our sense of the beautiful by looking at something which is beautiful; and there is much around us which costs us nothing to look at were we to observe it—the cloud, the sunlight, the tree, the flower, a butterfly—anything of that kind studied for a few minutes each day would continue to develop in man’s mind the sense of the beautiful. We should also appreciate carefully our actions and govern them and measure them, as to whether they are just to others—a matter which a very few minutes a day will probably enable us to do;” and so also he would go further and seek to find, in the idea of truth itself, as to what we ought and ought not to believe—trying to discover some one test of truth which we can apply.

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Indeed, we may therefore formulate and apply to nations at large what Goethe has there suggested; and we shall find it can be arranged in what I may call a pentatonic scale of culture. You may be aware that all musical scales of all savage and barbarous and primitive tribes are not in the octave, as ours, but in five notes only; they all have one musical scale only, and that is a pentatonic scale; and it is perhaps because they feel that their own minds are based upon some such arrangement as that (although that is an idea which I do not subscribe to, but only suggest); but when we come to look over the whole cycle of culture, as we find it described in the histories of culture—in the histories of civilization—we find that they are all efforts to develop one or the other, or several, of five primary ideas which are in the mind of every human being; and when they are developed, then culture is perfect, either in the individual or in the nation or the race. These five primitive ideas, innate in every human soul, are the ideas of the useful, of the beautiful, of the just, of the good and of the true, and you will not find any savage (provided he is not deficient in the ordinary mental ability of his tribe) who does not indicate an appreciation of every one of these in his own way. It is the idea of the useful which teaches him his utilitarian arts; which teaches him to build his house; to chip the flint for his weapon; to sharpen the stick to dig the place to drop the seed; and all those we call the arts of utility, the useful arts; and yet you will not find a savage tribe to-day but what goes somewhat above this; because among them all they make also an effort that these tools and weapons of theirs shall have some sign about them of the beautiful; and you will find decoration—indeed, “the painted savage” is a name we give to the lowest order of humanity; yet this same paint is to make himself beautiful; and so it is throughout all his games and amusements in life—you will find he is constantly striving at the idea of decoration—at the idea of beauty; little by little he develops this, until it becomes, in some nations, the joy of their existence and the lesson of the race, as in the ancient Greeks; as in the Italians of the time of the Renaissance. These are what we call the aesthetic emotions, based upon an innate sense and love of the beautiful: and we may also turn to the lowest savage—we shall not find him deficient in justice; on the contrary, among the rudest Australians, without shelter or clothing, you will find that the law of the tribe is well defined and also implacable; and a man who has sinned knows that he must meet it or flee; he knows that there is no avail or recourse beyond the tribal council, and he knows what they will decide in his particular case, because he knows the law and the penalty of its infringement. And this rude notion of justice develops, little by little, into the great edifice of jurisprudence, the

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law of nation and the law of nations. Thus we find that the idea of the just, and of what is right from man to man, is something which is found everywhere; and as that develops culture develops; but the mere just alone does not satisfy the human heart; the man who merely metes out to his fellow that which the tribal law, or the law of the land, requires of him, certainly is not up to the ideal of any man or woman in this assembly or in this city.

There is something beyond that, and what is that? We find that it rests in the idea of the good—that which is often brought forward in the beautiful forms of religion, which tells man that above justice there is something greater and nobler than mere ethics or morality—the mere right and wrong—the mere giving what is due. It is not enough to do that; there must be a giving of more than is due; because the idea of the good transcends the present life—it passes into the future life of the species; and it is only through going above what is needed to-day that we may endow our posterity with something greater than we ourselves possess. It is the idea of the good, therefore, which lifts that which is merely just into a higher—into, I might say, an immortal sphere of activity. It has always had an intense attraction for noble souls, which history shows us; and it is not to be supposed that that attraction will ever diminish; it will ever increase, although its forms may change; and finally, along with this betterment of the emotions, and of the sense of justice—of right and of ethics and of aesthetics—we find the constant effort and desire of all mankind, in all stages of culture, to find out what is true, as distinct from that which is not true. You will not be mistaken if you seek for this in the soul of the rudest savage; he, too, likes to know the truth. The methods by which he arrives at it, or seeks to arrive at it, are widely different from those which you have been taught. Nevertheless, the logical force of his mind; the methods of thought that he has; the laws that govern his intelligence, are exactly the same as yours: and it is only with your enlightenment you have gained more and more acquaintance with the methods. You know something about the great discovery which has advanced all modern science from its mediaeval condition to that of the present—of the application of the inductive system of science and thought; and you know that it is by constant and close mathematical study of analogy—of probability—that we exclude error little by little from our observations—we improve more and more our instruments of precision—we count out the errors of our observation; and we are constantly seeking those laws which are not transient and ephemeral only, but which are eternal and immortal. Upon those laws, finally, must rest all our real, certain knowledge; and it is the endeavor of the anthropologist to apply those laws to man and his development; and such, indeed, is the recognized and highest mission

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of that science. We thus find that the idea of truth is at the summit of this scale which I have placed before you—not separated from it. It interprets every one of the ideas and justifies them and qualifies them and lifts them up into their highest usefulness. Chevalier Bunsen, in describing what he thought would be the highest condition of human enlightenment, said, “It will be when the good will be the true and the true will be the good;” and he might have extended that further and said, when both those ideas were the inspiring motives of all these five great ideas which I have stated are at the basis of the culture of every individual and are also at the basis of the culture of the race and of the nation.

This, therefore, will serve as a sketch of the milestones of human progress. The way has been long and painful; the results have been far from satisfactory; and yet they have been enormous and wonderful, when we compare them now with what our ancestors were when history began. We can conclude, however, from looking back on this thorny and upward path, that it is still going to ascend; we do not know it for certain; progress may cease, through some unknown law, now and here; but if there is anything that we can derive from the lesson of the past—if we can project into the future any of the facts which history shows us are our own now—it guides us forward to a firm belief that the hereafter will have in its breast greater treasures for humanity, greater glories for posterity, than any that we know or can understand.

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TOMBS OF THE FIRST EGYPTIAN DYNASTY.[1]

[Footnote 1: The Independent.]

By *Ludwig Borchardt*, Ph.D., Director of the German School in Cairo.

For many years various European collections of Egyptian antiquities have contained a certain series of objects which gave archaeologists great difficulty. There were vases of a peculiar form and color, greenish plates of slate, many of them in curious animal forms, and other similar things. It was known, positively, that these objects had been found in Egypt, but it was impossible to assign them a place in the known periods of Egyptian art. The puzzle was increased in difficulty by certain plates of slate with hunting and battle scenes and other representations in relief in a style so strange that many investigators considered them products of the art of Western Asia.

The first light was thrown on the question in the winter of 1894-95 by the excavations of Flinders Petrie in Ballas and Neggadeh, two places on the west bank of the Nile, a little below ancient Thebes. This persevering English investigator discovered here a very

large necropolis in which he examined about three thousand graves. They all contained the same kinds of pottery and the same slate tablets mentioned above, and many other objects which did not seem to

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be Egyptian. It was plain that the newly found necropolis and the puzzling objects already in the museums belonged to the same period. Petrie assumed that they represented the art of a foreign people—perhaps the Libyans—who had temporarily resided in Egypt in the time between the old and the middle kingdoms. He gave this unknown people the name “New Race.” But his theory met with little approval, least of all from German Egyptologists; and even at that time, an opinion was expressed that this unusual art belonged before the known beginning of Egyptian culture. However, in spite of much discussion, the question could not then be decided.

About the same time another riddle was presented to Egyptologists by the results of the excavations made in Abydos by the French scholar Amelineau; and another hot discussion was raised. Amelineau had excavated several large tombs and had also found objects which could not be arranged in the known development of Egyptian art. The fortunate discoverer ascribed these to the dynasties of the demigods, who, according to Egyptian tradition, reigned before the kings; but of course this idea met with determined opposition, and indeed especially among his French colleagues. The tomb of Abydos offered, however, on quiet consideration, more material for establishing its date than those of Ballas and Neggadeh. In Abydos a number of inscriptions had been found which, rude as they were, showed that the people buried in the tombs had known the hieroglyphic system of writing. The occurrence of so-called “Horus names” in these inscriptions was especially important. For every old Egyptian king had a long list of names and titles, and among them a name surmounted by the picture of a hawk (i.e., Horus), and called on that account the “Horus name.” As the name is, at the same time, written on a sort of standard, it is also called the “Banner name.” Such “Horus” or “Banner names” occur, then, on the objects found by Amelineau. Accidentally, one of these names occurs, also, on a statue in the Grizeh Museum which, according to its style, is one of the oldest statues which the museum possesses. Thus it became evident that the Abydos objects were, in any case, to be placed in the earliest period of Egyptian history.

The discussion stood thus when, in the spring of 1897, the fortunate hand of De Morgan, the former Directeur-general des Services des antiquites egyptiennes, succeeded by renewed excavations in Neggadeh in furnishing the connections between the objects found by Petrie in Ballas and Neggadeh and those found by Amelineau in Abydos. He discovered, not far from the necropolis, excavated by Petrie, the tomb of a king which, on the one hand, contained pottery and tablets like those found by Petrie, and on the other, objects entirely like those found by Amelineau. Thus it was proved that both Petrie’s tombs and those of Amelineau belonged to the same period, and, indeed, the oldest period, of Egyptian history, before the third dynasty. They were older than the most ancient objects which we had thought that we possessed. But it was still impossible to date them exactly.

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At this point, an epoch-making discovery of Dr. Sethe, privat-docent at the University of Berlin, placed the whole matter at a single stroke on a comparatively sure foundation. He pointed out that the inscriptions on a few unassuming potsherds from Abydos contained not only Banner names of old kings, but also their ordinary names. These names were not inclosed, as later, in cartouches, and even contained many unusual spellings; but they were still too clear to be misunderstood. Sethe succeeded in identifying the names of the fifth, the sixth and the seventh kings of the first Manethonian dynasty, called by the Greek authors Usaphais, Miebaïs and Semempses. Thus it became extremely probable that all these newly discovered objects were from the first dynasty, but still not absolutely certain; for the three names occurred only on fragments of vases, and absolutely nothing was known of how these fragments were found. The proof that they belonged to the other objects was wanting. A very skeptical investigator might still have said that the other objects were older, that the potsherds had only fallen accidentally into ruined tombs of an older period; or he might have said quite the contrary, that the potsherds were older than the tombs.

At this point occurred the possibility of finding a solution of the question in the objects found in the royal tomb of Neggadeh. For the report of the excavations at Neggadeh was more exact than that of the excavations at Abydos; and the whole contents of the tomb of Neggadeh had been kept together and preserved in a separate room in the Grizeh Museum. The possibility became a reality. One of the principal objects of this royal tomb was found to bear the ordinary as well as the Horus name of the king—a fact which had escaped the fortunate discoverer. The object is a small ivory plate with incised representations of funerary offerings before the king. Animals are being sacrificed to him; jars full of beer and other things are being offered. The figure of the king, in front of a hanging mat, is not preserved; but the upper corner still remains with the two names, which were written above the figure. First, there is the same Horus name which occurs on all the inscribed objects of this tomb and which may be translated “The Warrior.” Beside the Horus name in a sort of cartouche is the title “Lord of Vulture and Serpent Crown” (Lord of Upper and Lower Egypt), and beneath the title the sign which represents a checkerboard, and has the syllabic value Mn. There can therefore be no doubt that the king buried in the royal tomb of Neggadeh, of whom we had only known the Horus name “The Warrior,” had also the name Mn. Now, there is no other known Egyptian king who could be identified with this name Mn than the first king of the first Manethonian dynasty, called Menes by the Greeks. It is impossible here to go into the philological basis of the identification of Mn and Menes. The final conclusion is this: In Neggadeh, we have before us the tomb of the oldest king of whom the Egyptians had preserved any memory, and whom they considered the founder of the Egyptian monarchy.

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In consideration of the importance of the questions involved, a short description of the tomb of Menes and of the objects found in it will certainly be of interest. The second part of De Morgan's book, "Recherche sur les origines de l'Egypte," which has just appeared, furnishes us with the facts concerning the tomb, and the objects found in the tomb I will describe from the originals in the Gizeh Museum.

The tomb consists of a large building, standing alone, measuring 54 X 27 m. (about 100 X 50 Egyptian ells), and built of burned brick. The outside walls were ornamented, as was usual in later Egyptian buildings, with pilasters composed of groups of smaller rectangular pilasters. It is the same motive so often to be observed in the sham doors in tombs of the old kingdom, and is really the most natural facade ornamentation for brick buildings, as it may be made by simply setting every alternate column of bricks forward or backward. The walls were, in addition, plastered. Back of the thick outside wall on each side lay a row of narrow rectangular rooms, formed by dividing a corridor by means of cross walls. Inside this surrounding row of rooms was the real tomb, a building with thick walls and five rooms in a row. The middle one of these rooms, noticeably larger than the others, is the real burial chamber. These five rooms were originally connected by doors which were afterward walled up. As to the roof, we can only make surmises, as the excavator has furnished us with no material on this point. The walls as they now stand are at the highest point about four meters high, and thus may form only the lower part of the building. Whether the roof was an arch of stone or simply of wood, is uncertain; but it seems to me probable that it was of wood. For the tomb contained a layer of ashes in which all the objects put in the grave with the dead man were found; and, assuming that the roof was of wood, it is possible that the roof was set on fire at the time when the tomb was robbed and that the ashes came from this fire. The explanation which the excavator gives of these ashes, that the body and the offerings were burned in the closed grave, hardly deserves consideration. In any case, the grave has been robbed and destroyed. That is shown by the fact that many pieces of funeral furniture, which originally could only have been put in the central rooms, were found partly broken in the outside rooms, or on the side toward the fields, the side most exposed to the attack of grave robbers.

The assumption that the grave has been robbed and intentionally destroyed agrees entirely with the fact that all the more valuable objects found in the grave were in fragments. But, fragmentary as they are, they are sufficient to give us a good idea of the art of the first period of the Egyptian kingdom, a period which is now most generally estimated to be five and a half millenniums before the present day (3600 B.C.) The skill with which ivory carving was done in that

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early time is indeed amazing. Reclining lions, hunting dogs and fish are so skillfully reproduced that one asks how many centuries of development must have preceded before the art of carving reached this perfection. A number of feet taken from the legs of small chairs and other similar furniture, and made in imitation of bulls' legs, show such a fixity of style and at the same time such a freedom of execution, that no archaeologist, without the report of the excavator, would dare to proclaim them the oldest dated works of Egyptian art. But it was not only in carving ivory, which is easy to work, that the Egyptian artists showed their skill. They also make bowls and vases of diorite and porphyry with the same success; and the forms presented by the smaller ivory vases are also to be found in vases made of those refractory stones. Further, the vases made of stone present not merely such forms as might be made by turning or boring, but there are also bowls with ribs which are as finely polished as the turned bowls. The hardest material used in the objects already found is rock crystal, of which several small flasks and bowls and a little lion are composed. But the lion, it must be confessed, is rather rudely worked. A few small vases of obsidian also occur—remarkable in view of the fact that we do not know of any place in or near Egypt where this stone may be found. Besides these vessels of hard stone, there are, of course, a large number made of softer stone. Alabaster vases occur in every conceivable form. Cylindrical pots, with wavy handles or simple cordlike ornamentation, appear to have been especially favored. The great beer jars, closed with enormous stoppers of unbaked clay, were made of ordinary baked clay. Of course the different stone and clay vessels, which, undoubtedly, originally contained offerings for the dead, form the bulk of the contents of the grave. The slate tablets for rubbing cosmetics for painting the body, and the flint weapons and knives of all sorts, follow in point of numbers. Remarkably enough, metal objects occur in this oldest historical period alongside the stone implements, though, of course, in less numbers. Several objects made of copper and a slender bead of gold have been found. Such, in short, is all that remains of the things put in the tomb with the king. But little as there is, it gives us an idea of the richness and splendor with which these old royal tombs were furnished.

It might certainly be productive of unusual emotions to know that the few human bones found in the tomb, and now preserved in the Gizeh Museum, once belonged to the oldest Egyptian king. But as we know almost nothing of him, except some unfounded traditions, this sort of relic worship deserves very little respect. The scientific value of the proof that Menes was the king buried in the royal tomb of Neggadeh lies rather in the fact that we have now settled the question of the age of that culture which was presented to us

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by the excavations of Ballas, Neggadeh and Abydos. The products of a whole period of Egyptian civilization which had been misunderstood, and had been used to support false historical conclusions, fall into their true place; and our knowledge of the history of Egyptian culture is carried back not merely a few centuries, but to a period presenting characteristics different from the oldest previously known period, but containing the germs of the later development.

Cairo, Egypt.

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ROSE PSYCHE.

The hybrid Polyantha Rose Psyche is a seedling from the dwarf Polyantha Rose Golden Fairy, crossed with the pollen of the Crimson Rambler. Its growth and habit, though more delicate, much resembles the Rambler. It is apparently quite hardy, and is very free flowering, but we fear not perpetual. The flowers are produced in clusters of from fifteen to twenty-five, and are 2 to 2 1/2 inches across when fully expanded. In the bud stage they are very pretty and well formed. The color is white, suffused with salmon-rose and pink, with a yellow base to the petals. It is a real companion to Crimson Rambler.—The Gardeners' Chronicle.

[Illustration: *Rose hybrid polyantha "Psyche"*—Color, *Pale pink.*]

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SLEEP AND THE THEORIES OF ITS CAUSE.

The theory of the origin of sleep which has gained the widest credence is the one that attributes it to anaemia of the brain. It has been shown by Mosso, and many others, that in men with defects of the cranial wall the volume of the brain decreases during sleep. At the same time, the volume of any limb increases as the peripheral parts of the body become turgid with blood. In dogs, the brain has been exposed, and the cortex of that organ has been observed to become anaemic during sleep. It is a matter of ordinary observation that in infants, during sleep, the volume of the brain becomes less, since the fontanelle is found to sink in. It has been supposed, but without sufficient evidence to justify the supposition, that this anaemia of the brain is the cause and not the sequence of sleep. The idea behind this supposition has been that, as the day draws to an end, the circulatory mechanism becomes fatigued, the vasomotor center exhausted, the tone of the blood vessels deficient, and the energy of the heart diminished, and the circulation to the cerebral arteries lessened. By means of a simple



and accurate instrument (the Hill-Barnard sphygmometer), with which the pressure in the arteries of man can be easily reckoned, it has been recently determined that the arterial pressure falls just as greatly during bodily rest as during sleep. The ordinary pressure of the blood in the arteries of young and healthy men averages 110-120 mm. of mercury. In sleep,

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the pressure may sink to 95-100 mm.; but if the pressure be taken of the same subject lying in bed, and quietly engaged on mental work, it will be found to be no higher. By mental strain or muscular effort, the pressure is, however, immediately raised, and may then reach 130-140 mm. of mercury. It can be seen from considering these facts that the fall of pressure is concomitant with rest, rather than with sleep. As, moreover, it has been determined on strong evidence that the cerebral vessels are not supplied with vasomotor nerves, and that the cerebral circulation passively follows every change in the arterial pressure, it becomes evident that sleep cannot be occasioned by any active change in the cerebral vessels. This conclusion is borne out by the fact that to produce in the dog a condition of coma like to sleep, it is necessary to reduce, by a very great amount, the cerebral circulation. Thus, both carotids and both vertebral arteries, can be frequently tied at one and the same time without either producing coma or any very marked symptoms. The circulation is, in such a case, maintained through other channels, such as branches from the superior intercostal arteries which enter the anterior spinal artery. While total anaemia of the brain instantaneously abolishes consciousness, partial anaemia is found to raise the excitability of the cortex cerebri. By estimation of the exchange of gases in the blood which enters and leaves the brain, it has been shown that the consumption of oxygen and the production of carbonic acid in that organ is not large. Further, it may be noted that the condition of anaesthesia is not in all cases associated with cerebral anaemia. Thus, while during chloroform anaesthesia the arterial pressure markedly falls, such is not the case during anaesthesia produced by ether or a mixture of nitrous oxide and oxygen.

The arterial pressure of man is not lowered by the ordinary fatigue of daily life. It is only in extreme states of exhaustion that the pressure may be found decreased when the subject is in the standing position. The fall of pressure which does occur during rest or sleep is mainly occasioned by the diminished rate of the heart. The increase in the volume of the limbs is to be ascribed to the cessation of muscular movement and to the diminution in the amplitude of respiration. The duty of the heart is to deliver the blood to the capillaries. From the veins the blood is, for the most part, returned to the heart by the compressive action of the muscles, the constant change of posture and by the respiration acting both as a force and suction pump. All of these factors are at their maximum during bodily activity and at their minimum during rest. On exciting a sleeper by calling his name, or in any way disturbing him, the limbs, it has been recorded, decrease in volume while the brain expands. This is so because the respiration changes in depth, the heart quickens, the muscles alter in tone, as the subject stirs in his

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sleep in reflex response to external stimuli. Considering all these facts, we must regard the fall of arterial pressure, the depression of the fontanelle, and the turgescence of the vessels of the limbs as phenomena concomitant with bodily rest and warmth, and we have no more right to assign the causation of sleep to cerebral anaemia than to any other alteration in the functions of the body, such as occur during sleep.

We may well here summarize these other changes in function:

- (1) The respiratory movement becomes shallow and thoracic in type.
- (2) The volume of the air inspired per minute is lessened by one-half to two-thirds.
- (3) The output of carbonic acid is diminished by the same amount.
- (4) The bodily temperature falls.
- (5) The acidity of the cortex of the brain disappears.
- (6) Reflex action persists; the knee jerk is diminished, pointing to relaxation in tone of the muscles; consciousness is suspended.

Analyzing more closely the conditions of the central nervous system, it becomes evident that, in sleep, consciousness alone is in abeyance. The nerves and the special senses continue to transmit impulses and to produce reflex movements. If a blanket, sufficiently heavy to impede respiration, be placed upon the face of a sleeping person, we know that it will be immediately pushed away. More than this, complicated movements can be carried out; the postilion can sleep on horseback; the punkah-wallah may work his punkah and at the same time enjoy a slumber; a weary mother may sleep, and yet automatically rock her infant's cradle. Turning to the histories of sleep walkers, we find it recorded that, during sleep, they perform such feats as climbing slanting roofs or walking across dangerous narrow ledges and bridges. The writer knew of the case of a lad who, when locked in his room at night to prevent his wandering in his sleep, climbed a partition eight to ten feet in height which separated his sleeping compartment from the next, and this without waking.

The brain can carry out not only such complicated acts as these, but it has been found to maintain during sleep its normal inhibitory control over the lower reflex centers in the spinal cord.

Thus, in sleeping dogs, after the spinal cord has been divided in the dorsal region, reflexes can be more easily evoked from the lumbar than from the cervical cord, because the former is freed from the inhibitory control of the brain.

The strength of stimulus necessary to pass the threshold of consciousness and to produce an awakening has been measured in various ways. It has been determined that it takes a louder and louder sound or a stronger and stronger electric shock to arouse a sleeper during the first two or three hours of slumber; after that period, the sleep becomes lighter and the required stimulus need be much less.

The alternative theories which have been suggested to account for the onset of sleep may be classed as chemical and histological.

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In relation to the first, it has been suggested that if consciousness be regarded as dependent upon a certain rate of atomic vibration, it is possible that this rate depends on a store of intramolecular oxygen, which, owing to fatigue, may become exhausted; or it may be supposed that alkaloidal substances may collect as fatigue products within the brain, and choke the activity of that organ. Against this theory may be submitted the facts that monotony of stimulus will produce sleep in an unfatigued person, that over-fatigue, either mental or bodily, will hinder the onset of sleep, that the cessation of external stimuli by itself produces sleep. As an example of this last, may be quoted the case recorded by Strumpel of a patient who was completely anaesthetic save for one eye and one ear, and who fell asleep when these were closed. Moreover, many men possess the power, by an effort of will, of withdrawing from objective or subjective stimuli, and of thus inducing sleep.

The histological theories of sleep are founded on recent extraordinary advances in the knowledge of the minute anatomy of the central nervous system, a knowledge founded on the Golgi and methylene blue methods of staining. It is held possible that the dendrites or branching processes of nerve cells are contractile, and that they, by pulling themselves apart, break the association pathways which are formed by the interlacing or synapses of the dendrites in the brain. Ramon y Cajal, on the other hand, believes that the neuroglia cells are contractile, and may expand so as to interpose their branches as insulating material between the synapses formed by the dendrites of the nerve cells. The difficulty of accepting these theories is that nobody can locate consciousness to any particular group of nerve cells. Moreover, the anatomical evidence of such changes taking place is at present of the flimsiest character.

If these theories be true, what, it may be asked, is the agency that causes the dendrites to contract or the neuroglia cells to expand? Is there really a soul sitting aloof in the pineal gland, as Descartes held? When a man like Lord Brougham can at any moment shut himself away from the outer world and fall asleep, does his soul break the dendritic contacts between cell and cell; and when he awakes, does it make contacts and switch the impulses evoked by sense stimuli on to one or other tract of the axons, or axis cylinder processes, which form the association pathways? Such a hypothesis is no explanation; it simply puts back the whole question a step further, and leaves it wrapped in mystery. It cannot be fatigue that produces the hypothetical interruptions of the dendritic synapses and then induces sleep, for sleep can follow after fatigue of a very limited kind. A man may sleep equally well after a day spent in scientific research as after one spent in mountain climbing, or after another passed in idling by the seashore. He may spend a whole day engaged in mathematical calculation or in painting a landscape. He fatigues—if we admit the localization of function to definite parts of the brain—but one set of association tracts, but one group of cells, and yet, when he falls asleep, consciousness is not partially, but totally suspended.

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We must admit that the withdrawal of stimuli, or their monotonous repetition, are factors which do undoubtedly stand out as primary causes of sleep. We may suppose, if we like, that consciousness depends upon a certain rate of vibration which takes place in the brain structure. This vibration is maintained by the stimuli of the present, which awaken memories of former stimuli, and are themselves at the same time modified by these. By each impulse streaming into the brain from the sense organs, we can imagine the structure of the cerebral cortex to be more or less permanently altered. The impulses of the present, as they sweep through the association pathways, arouse memories of the past; but in what way this is brought about is outside the range of explanation. Perhaps an impulse vibrating at a certain rate may arouse cells or fibrils tuned by past stimuli to respond to this particular rate of vibration. Thus may be evoked a chain of memories, while by an impulse of a different rate quite another set of memories may be started. Tracts of association are probably formed in definite lines through the nervous system, as during the life of a child repeated waves of sense impulses beat against and overcome resistances, and make smooth pathways here and there through the brain structure. Thus may be produced growth of axons in certain directions, and synapses of this cell with that. If the same stimulus be often repeated, the synapses between groups of cells may become permanent. A memory, a definite line of action which is manifested by a certain muscular response, may thus become structurally fixed. If the stimulus be not repeated, the synapses may be but temporary, and the memory fade as the group of cells is occupied by a new memory of some more potent sense stimulus. Many association tracts and synapses are laid down in the central nervous system when the child is born. These are the fruits of inheritance, and by their means, we may suppose, instinctive reflex actions are carried out.

So long as the present stimuli are controlled by past memories and are active in recalling them, so long does consciousness exist, and the higher will be the consciousness, the greater the number and the more intense the character of the memories aroused. We may suppose that when all external stimuli are withdrawn, or the brain soothed by monotony of gentle repetition, and when the body is placed at rest, and the viscera are normal and give rise to no disturbing sensations, consciousness is then suspended, and natural sleep ensues. Either local fatigue of the muscles, or of the heart, or ennui, or exhaustion of some brain center usually leads us to seek those conditions in which sleep comes. The whole organism may sleep for the sake of the part. To avoid sleeplessness, we seek monotony of stimulus, either objective or subjective. In the latter case, we dwell on some monotonous memory picture, such as sheep passing one by one through a gap in the hedge. To obtain our object, we dismiss painful or exciting thoughts, keep the viscera in health, so that they may not force themselves upon our attention, and render the sense organs quiet by seeking darkness, silence and warmth.—L.H., in *Nature*.

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AMATEUR CHRONOPHOTOGRAPHIC APPARATUS.

At the time that we described the Demeny chronophotographic apparatus we remarked that it had the advantage of permitting of the projection of very luminous images of large dimensions; but it is certain that the cases are somewhat limited in which there is any need of using a screen 24 or 25 feet square, and, as a general thing, one 6 or 10 feet square suffices. The manufacturer of the apparatus, M. Gaumont, has, therefore, been led to construct a small size in which the bands have the dimensions usually employed in the French and other apparatus, thus permitting of the use of such as are now found in abundance in the market.

By reducing the size, it has been possible further to simplify the construction, and at the same time to reduce the price, thus making of the new form a genuine amateur apparatus.

It will be remembered that the Demeny principle consists especially in the avoiding of traction upon the perforated part of the band, which is the portion that always presents the most fragility. This principle has naturally been preserved in the small model, and a preservation of the bands for a long time is thus assured.

[Illustration: *Fig. 1—Arrangement of the sensitized band in two magazines.*]

[Illustration: *Fig. 2—Arrangement for taking views with special Gearing for the winding of the band.*]

The apparatus is reversible, and may be used for making negatives as well as for projecting positives. In its new form it is easily transportable and is no more bulky than an ordinary 5 by 7 inch apparatus. Nothing is simpler than to carry it on a journey, if one desires to make his own negative bands. Since the sensitized film has to be protected against the light during its entire travel, two magazines have been arranged (Fig. 1). One of these, A, which is fixed upon the top of the camera, contains the clean film, while the other, B, which is placed beneath the objective, receives the strip after it has been acted upon by the light. A train of toothed wheels, C (Fig. 2), actuates the roller of this second magazine. This arrangement may, moreover, be utilized also when projections are made, if one does not desire the band to float in measure as it unwinds behind the objective. As the upper magazine is entirely closed when it is placed upon the apparatus, it is necessary, in order to prepare for taking a negative, to pull out a few inches of the film, pass the latter over the guide roller and fix the extremity to the winding roller in the lower magazine.

It is clear that we can have any number of magazines whatever for carrying about, all charged, just as one carries the frames of his ordinary camera.

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Chronophotography presents no more difficulty than ordinary photography as regards the taking of negatives, and the amateur who has not the proper facilities for developing and printing the latter can have these operations performed by a professional. Animate projections are beginning to be introduced into parlors, and some day will entirely replace the magic lantern therein. The excitement caused by the catastrophe at the Charity Bazar is now calmed, and it has been ascertained that the accident was not due to the lamp of the projector, but to a carelessly handled can of ether. So the extension of this sort of spectacle, momentarily arrested, is taking a new impetus, which will be further aided by the apparatus under consideration, for the description of which and the illustrations we are indebted to La Nature.

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THE RECLAIMING OF OLD RUBBER.

By Hawthorne Hill.

The complaint of high prices of India rubber is as old as the rubber industry, one result of which has been an unceasing effort to discover a practical substitute. Never was the secret of the transmutation of metals sought more persistently by ancient philosophers than the secret of an artificial rubber has been by modern chemists, but, thus far, the one search has been hardly more successful than the other. One discovery has been made, however, by which our rubber supplies have been so far conserved that, for the want of it, we might be obliged now to pay double the current prices for new rubber. This is the reclaiming of rubber from worn-out goods, in a condition fit for use again in almost every class of products of the rubber factory.

Soon after the vulcanization of rubber became fully established, attempts began to be made to "devulcanize" the scrap and cuttings of rubber which accumulated in the factories. So extensive were these accumulations that one company are reported to have built a road with rubber scrap through a swamp adjacent to their factory, while most other manufacturers were unable to find even so profitable a use for their wastes. As time advanced there came to be large stocks, also, of worn-out rubber goods, such as car springs and the like, all of which appealed to a practical mind here and there as being of possible value, since the price of new rubber kept climbing up all the while.

No fewer than nineteen patents were granted in the United States for "improvements in devulcanizing India rubber," or "restoring waste vulcanized rubber," beginning in 1855, or eleven years after the date of Goodyear's patent for the vulcanization process. In that year Francis Baschnagel obtained a patent for restoring vulcanized rubber to a soft, plastic, workable state, by treating it with alcohol absolutus and carbon bisulphuratum, in a closed vessel, without the application of heat. Later he obtained a patent for accomplishing the same result by "boiling waste rubber in water, after it has been

reduced to a finely divided state;" and still later, one for treating the waste to the direct action of steam.

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Patents were granted in 1858 to Hiram L. Hall, for the treatment of waste rubber by boiling in water; also, by subjecting it to steam; and again, by combining various resinous and other substances with it. The two inventors named assigned their patents to the Beverly Rubber Company, of Beverly, Mass., controlled then by the proprietors of the New York Belting and Packing Company, and their processes became the basis of an important business in rubber clothing.

The low cost of the devulcanized rubber, as compared with new rubber, alone gave them a great advantage over other manufacturers, in addition to which they escaped the payment of a license to work under the Goodyear patents.

Many army blankets, made for the government during the civil war, were waterproofed with Hall's devulcanized rubber, and from that period little new rubber has been used in the manufacture of heavy rubber coats. The other patents in this class do not deserve special mention.

It having been established that rubber is rubber, no matter where found, manufacturers gradually turned their attention beyond the scraps and cuttings which remained after making up their goods. There was beginning to be a good demand for ground-up rubber car springs, wringer rolls, tubing and other rubber goods free from fiber, after it had been so treated as to remove the sulphur contents and restore the gum to a workable condition. But this left out of account rubber footwear, belting, and hose, not to mention the later heavy production of bicycle tires. There were only a few uses to which rubber waste containing fibrous material could be put when ground up and devulcanized without the removal of the fiber. It could be put into a cheap grade of steam packing or mixed in a powdered form with new rubber for the heels of rubber boots and shoes. There was an early patent for a process for "combining fibrous materials with waste vulcanized rubber, rendered soft and plastic." But all the other patents which come within the scope of this article had for their object the separation of fibers from the rubber.

An important advance was marked by the Hayward patent (No. 40,407), granted in 1868, for "boiling waste rags of fibrous material and rubber in an acid or alkali, for the purpose of destroying the tenacity of the fibers of the rags, so that the rubber may be reground." But this process extended only to the weakening of the fibers, and not their complete destruction. A later patent, in the same year, provided for exposing the ground rubber waste to the direct action of flames of gas or inflammable liquids, by which the foreign matters would be consumed and the rubber rendered plastic and cohesive, but it is not on record that this process received any particular application.

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The principal activity of invention in the field of reclaiming rubber dates from 1870, since which year 37 patents have been granted for processes more or less distinctive from those which had for their object only the devulcanization of rubber. Prior to that time the use of rubber reclaimed from fibrous wastes had been confined practically to one large factory in Boston and one near New York. One concern, for a while, bought old rubber shoes and sent them to women in the country, whom they paid so much a pound for the rubber stripped off—a very expensive process. There were several claimants for priority in the matter of reclaiming rubber by the processes which finally became standard, and some conflicting interests were brought together under the head of the Chemical Rubber Company. This corporation controlled the leading patents for the “acid” process, licensing various parties to work under them, and bringing suits against concerns who reclaimed rubber without their license. In 1895 the United States courts decided in favor of the defendants, practically rendering the patents invalid, on the ground that the inventions claimed under them had been disclosed by the Hall patents of 1858 and the Hayward patent of 1863.

The two patents upon which the suits for infringement rested principally were No. 249,970, granted to N.C. Mitchell, in 1881, and No. 300,720, granted to the same, in 1884. About the same time the Rubber Reclaiming Company, formed in 1890 by the combination of five leading rubber reclaiming plants, and working under license from the company above named, was resolved into the original elements. There were about that time five other rubber reclaiming plants in the United States, operating either the “acid” or the “mechanical” process, besides nine general rubber factories producing their own reclaimed rubber by the “acid” process. While several of the latter—rubber shoe concerns controlled by the United States Rubber Company—have been consolidated, there has been an increase in the number of rubber manufacturers reclaiming their own rubber, since the end of the patent litigation, so that the total number of reclaiming plants now probably is twenty.

The first step in any process for reclaiming rubber is the grinding of the waste, for which purpose several machines have been designed specially, an early patent for disintegrating rubber scrap by “subjecting it to the abrading action of grindstones” having failed to meet with favor. The most usual chemical treatment is a bath in a solution of sulphuric acid in lead-lined tanks. Generally heat is employed to hasten the process, through the medium of steam, in which case the tanks are tightly closed. The next step is the washing of the scrap, to free it of acid and dirt, after which it is sheeted by being run between iron rollers and hung in drying rooms. As soon as it has become dry it is ready for sale.

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In the extended litigation over the acid process patents, the points at issue related to the strength of the acid named in the various specifications and also to the methods of applying steam. Prof. Charles F. Chandler, called as an expert in one case, testified that the effects of acids, such as sulphuric or hydrochloric, upon rubber and rubber compounds, under varying strength and temperature, had been known at a period antedating all the patents then the basis of suits for infringement; also that their effect upon cotton and woolen fabrics had been equally well known. They had the same effect upon fibers, whether the latter were combined with rubber or not, but very strong acids would affect the rubber injuriously. The line of defense in this case was that "no invention was required in selecting the strength of acid; only the common sense of the manufacturer, aided by his skill and experience, was necessary to bring about the proper results." In support of this a factory superintendent testified that varied stocks required skill and judgment in their treatment and more or less variation as to the strength of acid, temperature, *etc.*

As to the use of steam, Prof. Henry B. Cornwall, of Princeton College, called as an expert in another case, testified that, having put to a test the specifications in all the patents involved, he had found it necessary in no case to inject live steam into the mixtures of acid and rubber scrap in order to effect the decomposition and removal of either woolen or cotton fiber. The use of the acids specified was sufficient for this, and the various high temperatures called for were not essential for the destruction of the fibers. He neglected to mention, however, that the steam served an equally important purpose in devulcanizing the rubber.

It appeared that the practice in different factories had included the use of sulphuric acid varying from a 21/2 per cent. solution to the full commercial strength of the acid, but one of the defendant companies based their case upon their use of acid of the strength of 28 deg. to 30 deg. Baume, whereas the patent they were charged with infringing specified a strength of 66 deg.. Their tanks were lead-lined and provided on the interior with steam pipes running down the sides and along the bottom, the sections at the bottom being perforated and the steam admitted at a pressure of 75 to 80 pounds. The chemical treatment lasted from 21/2 to 4 hours.

The sulphuric acid treatment, however, is confined mainly to scrap containing cotton fiber. Where woolen fibers occur, which is much less frequently, their disintegration is accomplished generally by the use of caustic soda.

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In the mechanical process of reclaiming rubber, the rubber is separated from the fiber, after the whole has been finely ground, by means of an air blast, the method being not unlike that practiced by furriers for separating hair and fur from bits of pelt after skins have been finely divided. As the powdered waste comes from the blower, the rubber falls in a heap near the machine, while the particles of fiber, being lighter, are carried far enough away to make the separation complete. Devulcanization in this case is effected by exposure to live steam at a high temperature. No oil is used in the process, the sheeting of the product being facilitated by means of hot friction rollers.

The cost of reclaiming rubber by the acid process is less than by mechanical means, for which reason the former is now much more generally used. But some manufacturers are willing to pay more per pound for mechanically-reclaimed rubber, either (1) because it can be "compounded" more heavily than the acid product, or (2) because of certain inherent disadvantages of the latter. It is the testimony of these manufacturers that the action of sulphuric acid upon whiting (one of the most common adulterants used in rubber shoes) is to turn it into sulphate of lime—an ingredient which is far from advantageous in a rubber compound. Again, any acid which may remain in the reclaimed rubber is liable to rot thin textile fabrics with which it may be combined in manufacture. Finally, rubber recovered by the chemical process, it is claimed, is harder than that obtained by any other; so that it is usual to add, during vulcanization, in order to soften the product, the residuum obtained from petroleum manufactures, or palm or other oils. Unvulcanized rubber clippings also have been used for this purpose. One of the most successful of our rubber factory superintendents, who formerly made the reclaimed rubber used by his factory, has stated that his practice was to subject the material to an alkaline bath after the acid treatment, not only for the better cleaning of the rubber, but to neutralize any acid which might remain. Considering all the points involved, it was his opinion that, when scrap rubber is cheap, the mechanical process is the more economical, while, if it is high priced, the acid process has the advantage. Since this expression of opinion, however, prices of rubber scrap have ranged constantly at higher figures than before, and there is no indication that we shall have again what was known formerly as "cheap" scrap. It is not surprising, therefore, that the volume of mechanical "shoddy" should be placed by the best estimates at not above one-sixth of the total production of reclaimed rubber in the United States. And the acid product, with all its admitted shortcomings, is still superior to any of the so-called rubber substitutes.

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Reclaimed rubber is not to be considered as an adulterant, except in the same sense as fillings, like whiting, litharge or barytes, the use of which in rubber compounds often gives to the product desirable qualities that are unobtainable by the use of "pure gum." It lacks some of the qualities of good native rubber, and yet it is rubber, and fills its proper place as acceptably as any raw material of manufacture. Rubber shoes made of new gum entirely would be too elastic, and for that reason would draw the feet, besides being too costly for the ordinary trade. The construction of a rubber shoe, by the way, is well adapted for the use of different compounds for the different parts. Rubber enters into twenty-six pieces of a rubber boot and nine or more pieces of a rubber shoe. Consequently, as many different compounds may be used, if desired, for the output of a single factory for rubber footwear. The highest grades of native rubber may be used for waterproofing the uppers of a fine overshoe, while reclaimed rubber, of a cheap class even, may be good enough for the heel, which requires only to be waterproof and durable, without too much weight, and with no elasticity. Reclaimed rubber goes into many classes of goods of high grade. The result is that such goods have been cheapened legitimately, placing them within the reach of immense numbers of consumers who otherwise would be obliged to do without.

While the extensive use of reclaimed rubber is a matter of common knowledge to all who are familiar with the rubber industry, there are nowhere available any statistics of either the absolute or comparative volume of its consumption, with the single exception of the official returns of imports into Canada. There separate accounts are kept of crude India rubber and of recovered rubber received in each year, and as only a consuming market exists for these commodities in the Dominion, the figures given below may be taken to represent closely the actual consumption by the rubber factories of Ontario and Quebec. It is interesting to note the heavy growth of the percentage of recovered rubber shown in the table, all the figures representing pounds:

Fiscal Year.	Crude Rubber.	Recovered Rubber.	Total Imports.
1885-86	739,169	19,499	758,668
1886-87	785,040	46,508	831,548
1887-88	1,225,893	88,471	1,314,364
1888-89	1,669,014	221,674	1,890,688
1889-90	1,290,766	147,377	1,438,143
1890-91	1,602,644	8,254	1,610,898
1891-92	2,100,358	106,080	2,206,438
1892-93	2,152,855	195,281	2,348,136
1893-94	2,077,703	529,900	2,607,603
1894-95	1,402,844	611,745	2,014,589
1895-96	2,155,576	643,169	2,798,745
1896-97	2,014,936	1,061,402	3,076,338

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Percentage, 1885-86	97.5	2.5	100
" 1896-97	65.5	34.5	100

If it were possible to examine the books of the several rubber reclaiming plants on this side of the border, including rubber shoe and mechanical goods factories producing their own reclaimed rubber, the percentage of this material used, in comparison with the total rubber consumption, might be found to be as great in the United States as in Canada. The rubber manufacture in the Dominion, in its inception, was practically an offshoot from the industry in this country. Our manufacturers supplied the Canadian demand for rubber goods until, under the stimulus of heavy protective duties, rubber works were established beyond the border, since which time, to quote a leader in the trade in the United States, "the methods of the Dominion rubber industry have mirrored the best practice in our country." Hence it seems not unreasonable to conclude that if the Canadians are using so large a percentage of reclaimed rubber, they are doing no more nor less than the older and larger concerns here. The most trustworthy authorities place the consumption of new rubber in the United States during 1897 at not far from 35,000,000 pounds. Assuming that the rate of consumption of reclaimed rubber was as great as in Canada, we have 18,435,000 pounds more, or a total of 53,433,000 pounds. But there are producers of reclaimed rubber who insist that the amount of this material used in this country equals, pound for pound, the consumption of new rubber.

The use of reclaimed rubber in Europe is increasing gradually, and especially in Great Britain. The American product is sold extensively in that country, and some native reclaiming plants have been started. The most extensive "galosh" factory in Russia, which is said to be the largest in the world, is reclaiming rubber according to American methods. But, as a rule, the Continental rubber manufacturers make more use of "substitutes," a class of materials which has not found favor in America. These rubber substitutes belong chiefly to the class of oxidized oils and may be classed in three divisions: Those obtained (1) by the action of oxygen or air on linseed oil; (2) by acting on rape oil with chloride of sulphur; and (3) by the action of sulphur on rape oil at a high temperature. The first class has little application to the rubber trade, though its use is universal in the linoleum industry. In Europe the chemist holds a more important position in the rubber manufacture than here, one result of which has been cheaper compounds of rubber and another the satisfactory employment of the refractory African rubbers long before they were used extensively in the United States. Hence the cost of raw materials in the rubber industry has been, on the whole, cheaper abroad. The Europeans have had an advantage, too, in respect to cheaper labor, which has offset somewhat our own advantage from the use of reclaimed rubber as a cheap material.

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There are numerous grades of reclaimed rubber, due to differences in the quality of stock used, and also to the different degrees of care used in its preparation, according to the requirements of manufacturers. The declared value of reclaimed rubber exported from New York during July, 1897, averaged 12.6 cents per pound, while the value of exports for September averaged only 9.1 cents. The average value for the eight months ending February 28, 1898, was 10.08 cents per pound. The total declared value of such exports for the fiscal year 1896-97 was \$119,440, which, at the prices prevailing since, would represent considerably more than 1,000,000 pounds. Some of the material sold at home is known to bring less than any prices quoted above. "Mechanical" stock brings about two cents per pound more than "acid" stock of corresponding grade.

The collection of old rubber has acquired large proportions as an adjunct to the trade in junk or rags. Not long ago the estimated yearly collection of rubber shoes alone amounted to 18,000 tons, and since that time the business in bicycle tire scrap has also become very large. During the past ten years the price of old rubber shoes has ranged between \$60 and \$120 per ton in carload lots, being at present about \$90 per ton. Some 1,500 tons of rubber scrap are imported annually by the reclaiming companies in the United States.

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In the Baltic Sea there are more wrecks than in any other place in the world. The average throughout the year is one each day.

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ENGINEERING NOTES.

The Austrian government has ordered thirty-seven engines arranged to burn kerosene, for use in the Arlberg tunnel, in which lack of proper ventilation at present causes the tunnel to remain filled with smoke.—Uhland's Wochenschrift.

One of the first essentials to modern military enterprise is the establishment of a military railway system for war purposes. To be in a position to carry out efficiently and speedily what we may expect to be called upon to do on the outbreak of serious war, previous preparation in time of peace is an absolute requisite. In connection with General Sherman's operations in Georgia, during the American civil war, an army was supplied for six and a half months over a line 473 miles long. The corps of workmen was 10,000 strong, and on one occasion replaced 35,000 sleepers and nine miles of rails in seven days. The true defense of the line was effected by the engineers always having men and material ready. In spite of the large and skilled railway population on which the army could call, and of the fact that practically the nation was in arms, it was found

extremely difficult to keep this railway construction corps together until they were placed under a severe military discipline.—United Service Gazette.

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A *hospital* car has been introduced on the Belgian railroads, says The Engineer. It is designed for use in the event of a serious railway accident, and can be run to the spot where the wounded may be picked up and carried to the nearest city for treatment, instead of being left to pass hours in some wayside station while awaiting surgical attendance. The interior of this car is divided into a main compartment, a corridor on one side and two small rooms at the end. The largest compartment, the hospital proper, contains twenty-four isolated beds on steel tubes hung upon powerful springs; each bed is provided with a small movable table, a cord serving to hold all the various small objects which may be needed, and each patient lies in front of two little windows, which may be closed or opened at will. The corridor on the outside of the hospital chamber leads to the linen closet and the doctor's apartment; in the latter is a large cupboard, the upper portion being used for drugs, while the lower is divided into two sections, one serving as a case for surgical instruments and the other as a receptacle for the doctor's folding bed.

The dust collected from the smoke of some Liege furnaces, burning coal raised from the neighboring mines, produces, when dissolved in hydrochloric acid, a solution from which considerable quantities of arsenic and several other metallic salts may be precipitated. Commenting on this fact, ascertained by M.A. Jorissen, M. Francis Maur asks whether this breathing of arsenic and other minerals in a finely divided state may not account for the singular immunity from epidemics enjoyed by certain industrial districts, such as that of Saint Etienne, and hopes that some mine doctor will throw additional light on the subject. In the meanwhile, it may be suggested that the ventilating effect of the numerous chimneys in iron making and other industrial centers has its due share in constantly driving off the vitiated air and replacing it by fresh quantities of pure air. At any rate, when pestilence was raging in the high and pleasant quarter of Clifton, its inhabitants migrated to the low-lying and not overclean parish of St. Philips, Bristol, where the air is black from the smoke of numerous chimneys, but where also the mortality compared very favorably with that in the fashionable quarter.

A *two-speed* movable sidewalk, of the Blot, Guyenet and De Mocomble type, is to be used for conveying visitors at the Paris Exposition, says Engineering News. It differs from those of Chicago and Berlin in the reduction of the weight of the moving platform by spacing the driving wheels 127.5 feet apart and using electricity as a motive power. The driving wheels are mounted in the bed of the track and impart motion to a central rail on the under side of the platform. Bearing wheels, spaced about 20 feet apart under this rail, also carry the platform, and the central rail supports one-half the total weight of the platform;

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small side wheels carry the other half on side tracks. This arrangement enables the platform, which is divided into sections and hinged, to pass around quite sharp curves. The high speed platform, 4 feet 3 inches wide, is supposed to move at the rate of 61/2 miles per hour on a 35 1/2-inch gage track; the slow platform is 31 1/2 inches wide, moves at half speed and runs on a 17-3/4-inch gage track. The whole structure will be elevated on girders carried by cast iron columns, with stations about 656 feet apart. The high speed platform weighs 146 pounds per lineal foot; and with passengers, nearly 400 pounds per foot. The slow speed platform weighs about half this. The track will be about 2 1/2 miles long; the initial motive power is figured at 472 H.P. and the carrying capacity at 38,880 per hour.

The "SCHLAMM," or mud, thrown down from the water of coal washing has hitherto been regarded as worthless, says The Engineering and Mining Journal, except that sometimes a portion of the coal particles it contained have been separated and made of value by a washing process; but Bergassessor Haarmann, of Friedrichsthal, has invented a new method for treating it dry and dividing it into two products, one of which, with low ash content, is distinguished by its granular nature, while the other contains a large proportion of ash and is of the fineness of flour. The former of these two products is, on account of its low ash content, useful for various purposes, and the latter constitutes a fuel quite ready for use in coal dust firing. The method is founded on the circumstances, hitherto lost sight of, that the incombustible constituents of the "schlamm" chiefly consist of clay which was formerly more or less dissolved in the wash water; and on the mud being dried and subjected to a suitable mechanical process, the clay falls into fine dust, while the coal particles, on the contrary, retain their granular nature. The method is carried out by drying the mud and a subsequent fine sifting, which effects a breaking up of the lumps that occur in the dried "schlamm," and a separation into the two products above named. The dust that falls through the sieve has a high ash content, being in the nature of flour, while what remains behind is granular and has a low ash content. It seems to us that this game is hardly worth the candle.

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ELECTRICAL NOTES.

Electricity at the Paris Exposition.—Electricity will play a large part at the Paris Exposition of 1900, says the Revue Technique. No less than 15,000 h.p. will be used for lighting and 5,000 h.p. for furnishing electric power to the various parts of the grounds. As far as possible all the machinery exhibited will be shown at work and for this purpose electric conductors will be laid down to all points on the grounds. The boiler plant will be located at the end of the Champ de Mars, and will occupy two spaces

of 130 X 390 feet each, one being devoted to French boilers and the other to those of foreign makers. This plant will be in itself a very interesting exhibit. It is proposed to provide a capacity for evaporating not less than 440,000 pounds of water per hour.

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An interesting little plant in which the rise and fall of the tides is used as motive power for the generation of electricity is described in L'Electricien. Near Ploumanach, on the northern coast of France, where the tides have a daily range of 39 feet, a small fish pond separated from the sea by a dike is arranged with gates so that at high tide the water flows in and fills it, the gates closing automatically when the tide recedes. The machinery of an old grist mill is used to operate a small dynamo, which charges a storage battery and furnishes light for the fish industry there. Another wheel in the same mill works an ice making machine, the whole being under the charge of one man. It is stated that the total daily expense for generating about 2,000 horse power hours is only \$2.

Peat bogs as generators of electrical power are suggested by Dr. Frank in Stahl und Eisen. He says that the great peat bogs of North Germany may be thus utilized, and figures that one acre of bog, averaging 10 feet in thickness, contains about 1,000 tons of dried peat, or 313,000 tons per square mile; and 430 square miles would be equivalent in heating power to the 80,000,000 to 85,000,000 tons of coal annually mined in Germany. The bogs of the Ems Valley alone cover 13,000 square miles; and Dr. Frank proposes the erection in that district of a 10,000 horse power electric station, which would yearly consume 200,000 tons of peat, or the product of 200 acres. He would use the electrical energy on the Dortmund and Emshaven Canal, and for the manufacture of calcium carbide.

The success attending an application of electric towing on the Burgundy Canal was such that two new applications of electricity to canal haulage and also for barge propulsion were made last year in the neighborhood of Dijon, on the same canal, under the superintendence of M. Gaillot, Ingenieur des Ponts et Chaussees. In the method of haulage, says The London Engineer, the receptor dynamo is mounted on a tricycle, to which the name of "electric horse" has been given, and which, running on the towing path, takes its current from an air line consisting of two wires, mounted five meters (nearly 17 feet) above the surface. This "horse," which weighs two tons, and is guided by a driver mounted upon it through the front wheel, proceeds on the towing path like a traction engine; and the boats are connected with it by a rope, with automatic disengaging gear, in case the force of the stream or a gust of wind should drive a boat backward. Speeds of from 1,990 to 4,240 meters (mean 3,319 yards) were obtained with the electric horse, towing from three to four boats, so that it is more suitable than the electric propeller for towage in rivers or very long reaches; but it requires a driver, while the propeller, with which speeds of from 2,150 to 4,240 meters (mean 3,406 yards) per hour were obtained, is worked by the bargee on board his boat. The towing path is not worn,

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and there is no occasion for a tow rope, which always causes difficulty when two boats cross one another. M. Maillet and M. Dufourny, Belgian Ingenieurs des Ponts et Chaussees, who watched the trials, conclude that a practical solution of the question depends upon the cost of producing the motive power; but they also consider that horse haulage on canals will soon be superseded by mechanical traction, based on the use of an automotive tricycle, working with petroleum or some other hydrocarbon, and capable of running on the tow path without requiring any fixed plant.

It has long been known that feathers and hair are electrical bodies, but until recently we have had little information about their electrical properties or the conditions in which these properties are manifested. Most of these phenomena were first observed by Exner, and in the work of Dr. Schwarze are found collected a mass of facts that cannot fail to interest the physician and the biologist; besides, we find there a description of Exner's apparatus which was used by Schwarze in most of his experiments on electrical phenomena of this kind. By the side of gold leaf electroscopes we see a feather electroscope, which is fastened to its support by means of a silken thread. A feather waved through the air is positively electrified, while the air itself seems to be charged with negative electricity.... Two feathers rubbed together in the natural position are so electrified that their lower surface is negative and the upper positive.... These experiments and others still have been utilized to study the vital relations of animals and the biological signification of these phenomena. Most feathers stick together and remain so even after being dried; if they then are waved through the air, the barbs of the feather separate, owing to differences of electrification. No bird needs to attend to its plumage at the end of a long flight, for while the large feathers are positively electrified by friction against the air, the white down has become negative, and so there is attraction between it and the feathers. Another consequence of this production of electricity during flight is that during winds, even the most violent, the plumage does not become ruffled, but rests tightly against the bird's body, for in this case the wing feathers, which overlap, rub against each other and become electrified in contrary senses. If the bird flies toward the ground, flapping its wings, it compresses the air below them, and, supposing that the wing feathers can bend aside, the experiments of Exner show that by the friction the upper side of one feather and the lower side of that which is just above are electrified oppositely, the more powerfully as the rubbing is greater, which always causes them to resume the normal position.—L'Electricien.

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SELECTED FORMULAE.

Removal of ink from hectograph.—It is recommended in Suedd. Ap. Ztg. to pour crude hydrochloric acid upon the hectograph, rub with a wad of cotton, then wash off by

holding under cold running water and drying with a cloth. The hectograph may be used again immediately.

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To clean wall paper.—Four ounces of pumice stone in fine powder are thoroughly mixed with 1 quart of flour and the mass is kneaded with water enough to form a thick dough. This dough is formed into rolls about 2 inches in diameter and 6 or 8 inches long; each one is sewed up in a piece of cotton cloth and then boiled in water for from 40 to 50 minutes—long enough to render the dough firm. After cooling and allowing the rolls to stand for several hours, the outer portion is peeled off and they are then ready for use, the paper being rubbed with them as in the bread process.—Druggist's Circular.

Insulating compound.—Prof. Fessenden recommends for armature work a compound made by boiling pure linseed oil at about 200 degrees with 1/2 per cent. of borate of manganese, the boiling being continued for several hours, or until the oil begins to thicken. An advantage of this borated oil is that it always retains a slight stickiness, and so gives a good joint when wrapped around wires, etc. Many substances so used are not sticky and let moisture in through the joints. Where a smooth surface is required, it is readily obtained by dusting on a little talc. It can also be given a coat of japan on the outside.—American Electrician.

How to clean diatoms.—As a general rule, we may say that every specimen of diatomaceous earth or rock needs a special treatment. The following, however, may serve as a basic treatment, from which such departure may be taken in each case as the nature of the specimen would indicate: Boil the material in hydrochloric acid, in a test tube, from two to five minutes. Let settle, pour off the hydrochloric acid, substitute nitric acid in its place, and boil again for two or three minutes. Pour into a beaker of water, stir a moment with a glass rod and let settle. After the material has fallen to the bottom, decant the liquid, and fill with fresh water. Repeat the operation until the water no longer shows an acid reaction. A portion of the deposit may now be examined, and if not clean, boil the deposit with tincture of soap and water in equal parts, decant, wash, first with water, then with stronger ammonia water, and finally, with distilled water. This usually leaves the frustules bright and sharp.—National Druggist.

Red indelible ink.—It is said that by proceeding according to the following formula, an intense purple red color may be produced on fabrics, which is indelible in the customary sense of the word.

No. 1.	
Sodium carbonate	3 drs.
Gum arabic	3 "
Water	12 "

No. 2.	
Platinic chloride	1 dr.
Distilled water	2 oz.



No. 3.

Stannous chloride 1 dr.

Distilled water 4 "

Moisten the place to be written upon with No. 1 and

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rub a warm iron over it until dry; then write with No. 2, and, when dry, moisten with No. 3. An intense and beautiful purple-red color is produced in this way. The following simpler and less expensive method of obtaining an indelible red mark on linen has been proposed by Wegler: Dilute egg albumen with an equal weight of water, rapidly stir with a glass rod until it foams, and then filter through linen. Mix the filtrate with a sufficient quantity of finely levigated vermilion until a rather thick liquid is obtained. Write with a quill, or gold pen, and then touch the reverse side of the fabric with a hot iron, coagulating the albumen. It is claimed that marks so made are affected by neither soaps, acids nor alkalies. This ink, or rather paint, is said to keep moderately well in securely stoppered bottles, but we should not rely on it as a “stock” article. A white paint for marking dark colored articles might be made by substituting zinc white for the red pigment in the foregoing formula.—Druggist's Circular.

Brown or black discoloration of silvered mirrors.—Generally these spots are due to faulty manipulation, too great dilution of the silver solution, or touching the plates with the fingers after they have been cleaned. Sometimes, however, they are due to chemical defects in the glass itself. In these cases, as a general thing, the discolorations occur only after several days—a faultless mirror having been made at first, and the browning subsequently developing slowly. The writer was a student in the laboratory of Baron Liebig during the time that distinguished chemist was carrying out the series of experiments which resulted in devising a method of making silver mirrors commercially. One of the greatest troubles with which he had to contend was this browning—the cause for which was never fully cleared up by him. Some years ago, the writer, having in his possession two mirrors made by Liebig, and which had gradually become brown throughout, undertook an examination of the deposit (which had been thoroughly protected from extraneous influences by a strong film of varnish), and was surprised to find that it consisted of a layer of silver sulphide. Without going into detail, the source of the change was later found to lie within the glass itself. In making glass to be used for mirrors, a considerable portion of sodium sulphate is used, and in annealing, this is partly reduced to sodium sulphide, which effloresces on the surface of the glass. This efflorescence is, of course, removed on cleaning the glass before silvering; but it is found that, in many instances, on exposure of the mirror to the light for some time, a further efflorescence occurs, and it is this which produces the discoloration in cases such as we have cited. It has been suggested that the tendency to subsequent efflorescence may be corrected by boiling the plates, intended for silvering, for a couple of minutes, in a 10 per cent. solution of sodium carbonate or bicarbonate. We have no experience with the process, however.—National Druggist.

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WILD AND DOMESTIC SHEEP IN THE BERLIN ZOOLOGICAL GARDEN.

As a rule, domestic animals are accorded very little space in zoological gardens, but, although it is doubtless the first duty of these popular institutions to show visitors animals which live in a wild state in foreign lands, it is well, where there is sufficient space and adequate means, to extend the limits of the collection so as to include natives of our own woods and fields, thus enabling people of a great city who are unfamiliar with nature to form an idea of the changes wrought in animal life by the influence of man, for domestic animals are a great aid in the study of natural history. The accompanying engravings are reproductions of instantaneous photographs of occupants of the new sheep and goat house—mostly foreign breeds; but there are a few that belong to that South European-Asiatic group which are looked upon as the progenitors of the domestic sheep: the mouflon, of Sardinia and Corsica (*Ovis Musimon* L.), which has a coat of brownish red, flecked with darker color; and the slender, long-legged, reddish-gray sheep of Belochistan (*Ovis Blanfordi* Hume). The first glance at these creatures convinces one that they are wild, not domestic sheep, an impression which is caused chiefly by the monotonous coloring and the dry, short coat, which bears no resemblance to the thick fleece of the tame sheep, although the eye is soon attracted by other differences, such as the shape of the tail, which is short and thick, and of the horns, which extend over the back and then turn inward, so that when the old ram is kept in captivity, it is necessary to cut off the points of the horns to prevent their boring into the flesh of its neck. Horns of this shape form a strong contrast to those with snail-like windings and points standing away from the body. When looking at one of these sheep from the front, it will be noticed that the left horn turns to the right and the right horn to the left.

[Illustration: *Sardinian mouflon (Ovis Musimon* L.)]

[Illustration: *Belochistan sheep (Ovis Blanfordi* Hume).]

Former authorities have been unwilling to admit that the domestic sheep have come from any species of wild sheep of the present time. They hold that they are the descendants of one or more species of wild sheep that are now extinct. Recently, however, men have thought more deeply and freely on such subjects, and Nehring and others have traced the modern tame sheep back to the mouflon, but not to him alone. It is thought that in this case, as with other domestic animals, there has been a mixture of species, and in this connection attention was directed to the Transcaspian arkal, the argalis of the interior of Asia and the North African species. Dr. Heck, director of the Berlin Zoological Garden, thinks that the horns of the tame ram, which are turned outward, the points being directed away from the body, constitute one of the strongest

proofs that the blood of the argalis and its extinct European ancestors—which are known only by the fossil remains—flows in the veins of all domestic sheep.

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The other characteristic marks of the domestic sheep—the wool and the length of the tail—vary greatly. The heath sheep—the little, contented, weather-hardened grazing sheep of the Luenenburg and other heaths—belong to one of the oldest species, and their tails are as short and their horns as dark as those of the moufflon. A cross between these two breeds is not distinguishable, even in the second generation, as has been shown by the interesting experiments in the Duesseldorf Zoological Garden.

[Illustration: *Heath sheep.*]

The little, black and red-spotted Cameroons sheep, from the western coast of Africa, have not a trace of wool. But why should they have? The negroes need no clothing, and, consequently, they have not bred sheep with wool; and, besides, such an animal could not live in the tropics, even if the black man were a much better stock raiser and breeder than he is. The mane on the neck, and breast of the Cameroons ram reminds one of the North American sheep; but it must be remembered that the moufflon and arkal rams have this ornament quite clearly, although not so strongly defined.

[Illustration: *Cameroons sheep.*]

The large, short-bodied and long-legged sheep found in the interior of western and northern Africa are a complete contrast to the short-legged, long-bodied little Cameroons sheep. There is a very valuable pair of the former in the Berlin Zoological Garden—the Haussa sheep—which are very regularly marked, the front parts of their bodies being red and the hind parts white. They were brought from the neighborhood of Say, on the middle Niger, by the Togo Hinterland expedition. The ram has beautiful horns, and the ewe is distinguished by two strange, tassel-like pendants of skin that hang from her neck. This zoological garden also possesses a fine ram from the interior of Tunis, which is similar in shape to the Haussa ram, but has shorter horns and a heavier mane. Its color is grayish black.

[Illustration: *Ram from Tunis.*]

[Illustration: *Haussa ram.*]

[Illustration: *Haussa ewe.*]

Dr. Heck considers the long tail of the domestic sheep the chief impediment to the adoption of the theory of its descent from the short-tailed wild sheep. And yet, in sheep, this member is of secondary importance, for it varies greatly in form. The short-tailed heath sheep are just the opposite of the fat-tailed Persian sheep, which are represented in a fabulous account as being obliged to draw their broad tails, that weighed 40 pounds, behind them on wheels. These are the sheep that supply the Astrakan and Persian lamb which is so much worn now. The fur is caused to lie in peculiar waves or

tight rings by sewing the newly born lamb in a tightly fitting covering which keeps the fur from being mussed. In the Berlin Zoological Garden there is a very fine four-horned,

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fat-tailed ram, from the steppes on the lower Volga. From this region come also the large-boned, fat-rumped sheep, which have a large mass of fat on each side of the stunted tail. In the illustration this peculiarity does not show well, on account of the thick winter wool. Their color is red, with dirty white. When Wissman and Bumiller returned from their last expedition, they brought a fine ram of a different breed of fat-rumped sheep, which are raised by the Kirghise, on the Altai Mountains. They are smaller than those from the steppes of the Volga, but have finer wool, and evidently belong to a finer breed. As mutton tallow is very useful, and has been used even from the most ancient times by sheep raisers in the preparation of food, they prize sheep with these masses of fat on the tail and rump, which were purposely developed to the greatest possible degree.

[Illustration: *Fat-tailed sheep (four-horned ram).*]

[Illustration: *Fat-rumped sheep.*]

The steinbock and the chamois, which live in the highest mountains, are still found, but other breeds, such as the argalis, which inhabited the foot hills and the high table lands, have disappeared, as Europe has become more thickly populated. We know that they formerly lived there, by the fossil remains of the oldest Pliocene in England (*Ovis Savinii* Newton), of the caves of bones near Stramberg in Moravia (*Ovis argaloides* Nehring), and of the diluvial strata near Puy-de-Dome Mountain in the south of France (*Ovis antiqua* Pommerol).

For the above and the accompanying illustrations we are indebted to Daheim.

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[Continued from *supplement*, No. 1172, page 18756.]

PATENTS.[1]

[Footnote 1: To be presented at the Niagara Falls meeting (June, 1898) of the American Society of Mechanical Engineers, and forming part of Vol. six of the Transactions.]

By *James W. See*, Hamilton, Ohio, Member of the Society.

EMPLOYERS' RIGHTS.

An invention, to be patented, must be applied for by the actual inventor, and in the absence of acts constituting a transfer, the patent, and all legal ownership in it, and all rights under it, go exclusively to the inventor. In the absence of express or implied contract, a mere employer of the inventor has no rights under the patent. Only contracts or assignments give to the employer, or to anyone else, a license or a partial or entire ownership in the patent. The equity of this may be appreciated by examples. A journeyman carpenter invents an improvement in chronometer escapements and patents it. The man who owns the carpenter shop has no shadow of claim on or under this patent. Again, the carpenter invents and patents an improvement in

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jack planes. The shop owner has no rights in or under the patent. Again, the carpenter invents an improvement in window frames, and the shop owner has no rights. He has no right even to make the patented window frame without license. The shop owner, in merely employing the carpenter, acquires no rights to the carpenter's patented inventions. But there are cases in which an implied license would go to the shop owner. For instance, if the carpenter was employed on the mutual understanding that he was particularly ingenious in devising carpenter work, and capable of improving upon the products of the shop; and if in the course of his work he devised a new and patentable window frame, and developed it in connection with his employment and at the expense of his employer; and if the new frames were made by the employer without protest from the carpenter, the carpenter could, of course, patent the new frame, but he could not oust the employer in his right to continue making the invention, for it would be held that the employer had acquired an implied license.

If he could not use it, then he would not be getting the very advantage for which he employed this particular carpenter, and if he did get that right, he would be getting all that he employed the carpenter for, and that right would not be at all lessened by the fact that the carpenter had a patent under which he could license other people. The patent does not constitute the right to make or use or sell, for such right is enjoyed without a patent. The patent constitutes the "exclusive" right to make, sell or use, and this the shop owner does not get unless he specially bargains for it. Implied licenses stand on delicate ground, and where men employ people of ingenious talent, with the understanding that the results of such talent developed during the employment shall inure to the benefit of the employer, there is only one safeguard, and that is to found the employment on a contract unmistakably setting forth the understanding.

NEW PURPOSE.

If an invention is old, it is old regardless of any new purpose to which it is put. It is no invention to put a machine to a new use. If an inventor contrives a meritorious machine for the production of coins or medals, his invention is lacking in novelty if it should appear that such a machine had before been designed as a soap press, and this fact is not altered by any merely structural or formal difference, such as difference in power or strength, due to the difference in duty. The invention resides in the machine and not in the use of it. If the soap press is covered by an existing patent, that patent is infringed by a machine embodying that invention, regardless of whether the infringing machine be used for pressing soap or silver. And it is no invention to discover some new capacity in an old invention. An inventor is entitled to all the capacities of his invention.

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COMBINATION CLAIMS.

Many people have an erroneous notion regarding patent claims, and consider the expression "combination" as an element of weakness. The fact is, that all mechanical claims that are good for anything are combination claims. No claim for an individual mechanical element has come under my notice for many years and I doubt if a new mechanical element has been lately invented. All claims resolve themselves into combinations, whether so expressed or not. Combination does not necessarily imply separateness of elements. The improved carpet tack is after all but a peculiar combination of body and head and barbs. The erroneous public contempt for combination claims is based upon the legal maxim, that if you break the combination you avoid the claim and escape infringement, and this legal maxim should be well understood in formulating the claims. If the claim calls for five elements and the competitor can omit one of the elements, he escapes infringement. Therefore, the claim is good only when it recites no elements which are not essential.

Many inventors labor under the delusion that a claim is strong in proportion to the extent of its array of elements. The exact opposite is the truth, and that claim is the strongest which recites the fewest number of elements. It is the duty of the inventor to analyze his invention and know what is and what is not essential to its realization. It is the duty of the patent solicitor to sift out the essential from the non-essential, and to draft claims covering broad combinations involving only essential elements. Sometimes the inventor will help him in this matter, but quite as often he will, through ignorance, hinder him and combat him. The invention having been carefully analyzed and reduced to its prime factors, and the claim having been provided to comprise a combination involving no element which is not essential to a realization of the invention, a new and more important question arises. The elements have been recited in terms fitted to the example of the invention thus far developed. The combination is broadly stated, but the terms of the elements are limiting. Cannot some ingenious infringer realize the invention by a similar combination escaping the literalism of the terms of the elements? It is at this stage that the claim must be carefully studied. The inventor, or some one for him, must assume the position of a pirate, and set his wits to work to contrive an organization realizing the invention but escaping the terms of the proposed claim. When such an escaping device is schemed out, then the defect in the claim is developed and the claim must be redrawn. In this way every possible escape must be studied so as to secure to the inventor adequate protection for his invention. Solicitors find it difficult to get inventors to do or consider this matter properly, inventors being too often inclined to disparage alternative constructions, the matter being largely one of sentiment founded on the love of offspring.

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The wise inventor will recognize the fact that the patent which he proposes to get is the deed to valuable property; that the object of the deed is not to permit him to enter upon the property, for he can do that without the deed, but that it is to keep strangers from entering upon the property; that he desires to enjoy his invention without unauthorized competition; that when the property begins to yield profit it will invite competition; that competitors may make machines worse than or as good as or better than his; and that he can get adequate protection only in a claim which would bar poorer as well as better machines embodying his invention. Briefly, then, all good claims for mechanism are combination claims; the fewer the elements recited, the stronger will the claim be; non-essential elements weaken or destroy the claim; the claim should not be considered satisfactory so long as a way is seen for the escape of the ingenious pirate.

COMBINATIONS AND AGGREGATIONS.

A given association of mechanical elements may be entirely new, but it does not follow that it forms a patentable association, for not all new things are patentable. If the new association is a combination, it is patentable, but if it is a mere aggregation, it is unpatentable. An association may be new and still all of its separate elements may be old, the act of invention lying in the fact that the elements have been so associated with relation to each other as to bring about an improved result, or an improved means for an old result. All new machines are, after all, composed of old elements. The law presupposes that the elements are old, and that the invention resides in the peculiar association of them. If we take a given mechanical element, recognized as having had a certain capacity, and if we then similarly take some other mechanical element and employ it only for its previously recognized capacity, and if we then add the third element for its recognized capacity, we have in the end only an association of three elements each performing its well recognized individual office, and the entire association performing only the sum of the recognized individual elements. Such an association is a mere aggregation, a mere adding together of elements, without making the sum of the results any greater in the association than it was in the individual elements. It is simply adding two to one and getting three as a result. An aggregation is unpatentable. As an illustration, a heavy marble statue of Jupiter is found in the parlor and difficult to move. Ordinary casters are put under its pedestal and it becomes easier to move. Modern anti-friction two-wheeled casters are substituted for the commoner casters, and the statue becomes still easier to move. Casters were never before associated with a statue of Jupiter. Here is a new association, but it is a mere aggregation. The statue of Jupiter has been unmodified by the presence of the casters, and the casters perform precisely the same under the statue of Jupiter that they did under the bedstead. There is no combined result, and there is no patentable combination.

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But if an inventor takes a given mechanical element for the purpose of its well recognized capacity, and then associates with it another mechanical element for its recognized capacity, but so associates the two elements that one has a modifying effect upon the capacity of the other element, then the association will be capable of a result greater than the sum of the results for the individual elements. This excessive result is not due to the individual elements, but to the combination of them. One has been added to one and a sum greater than two has been secured. The modification of result may be due merely to the bringing of the two elements together, so that they may mutually act upon each other, or it may be due to the manner or means by which they are joined. In a patentable combination the separate elements mutually act upon each other to effect a modification of their previous individual results, and secure a conjoint result greater than the sum of the individual results. The elements of a combination need not act simultaneously; they may act successively, or some may act without motion. As an illustration, assume an old watch in which there was a stem for setting the hands, and assume another old watch with a stem for winding the spring. If an inventor should make a watch, and provide it with the two stems, he would have only an aggregation. But if he employed but one stem, and so located it that it could be used at will for setting the hands or for winding the spring, then he would have produced a combination. The particular instance just given is not a case of the same number of elements, producing a result in excess of the individual results of the separate elements, but is rather a case of a lesser number of elements, producing a combination result equal to the sum of the previous results of a greater number of elements. A better example would perhaps be a new watch with its two old stems so related that either could be used for setting the hands or for winding the spring.

GENERA AND SPECIES.

An inventor, being the first to produce a given organization, and desiring to patent it, may see at once a patentable variation on the device. In other words, he makes two machines patentably different, but both embodying his main invention. He drafts his broad patent claim to cover both machines. In his patent he must illustrate his invention, and he accordingly shows in the drawings the preferred machine. The two machines represent two species of his generic invention, and for illustration he selects the preferable species. He drafts his generic claim to cover both species, and he follows this with a specific claim relating to the selected species. The question might be asked, If the broad generic claim covers the selected and all other species, why bother with the specific claim, why not rest on the generic claim? The answer is that it might in the future develop that

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the genus was old, and that the generic claim was invalid, while the specific claim would still be good. The infringer of the specific claim may thus be held notwithstanding the generic claim becomes void. But the inventor cannot claim his second species in his patent. He can claim the genus, and he can claim one species under that genus, but all other species must be covered in separate patents. It is even unwise to illustrate alternative species in a patent for, in case, of litigation, some one of the alternative species might prove to be old. This would have the effect, of course, to destroy the generic claim, but it might possibly have the effect of damaging the specific claim if it should appear that the specific claim was after all merely for a modification as distinguished from a distinct species. Were it not for the danger of broad generic claims being rendered void by discovered anticipations, there would be no need for claiming species, but in view of such possibility it is important to claim one species in the generic patent, and to protect alternative species by other patents.

COMBINATION AND SUB-COMBINATION.

A given machine capable of a given ultimate result having been invented, a claim may be drawn to cover the combination of elements comprised in the machine. Such claim will cover the machine as a whole. But, the fact being recognized that many machines are, after all, composed of a series of sub-machines, and that these sub-machines, in turn, are composed of certain combinations of elements, and that within these sub-machines there are still minor combinations of elements capable of producing useful mechanical results, and that the sub-machines, or some of the subordinate combinations of elements within the sub-machines, might be capable of utilization in other situations than that comprehended by the main machine, it becomes important that the inventor be protected regarding the sub-machines and the minor useful combinations. Claims may be drawn for the combination constituting the main machine, other claims may be drawn for the combinations constituting the operative sub-machines, and claims may be drawn covering the minor useful combinations of elements found within the sub-machines. Each claimed combination must be operative. But secondary claims cannot be made for sub-machines or sub-combinations which are for divisional matter or matter which should be made the subject of separate patents.

MECHANICAL EQUIVALENTS.

Where an inventor produces a new mechanical device for the production of a certain result, he can often see in advance that various modifications of it can be made to bring about the same result, and even if he does not see it he may in the future find competitors getting at the result by a different construction. He analyzes the competing

structure, and determines that “it is the same thing only different,” and wonders what the legal doctrine of mechanical equivalents means, and asks if he is not entitled to the benefits of that doctrine, so that his patent may dominate the competing machine.

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An inventor may or may not be entitled to invoke the doctrine of mechanical equivalents, and the doctrine may or may not cause his patent to cover a given fancied infringement. If an inventor is a pioneer in a certain field, and is the first to produce an organization of mechanism by means of which a given result is produced, he is entitled to a claim whose breadth of language is commensurate with the improvement he has wrought in the art. He cannot claim functions or performance, but must limit his claim to mechanism, in other words, to the combination of elements which produces the new result. His claim recites those elements by name. If the new result cannot be produced by any other combination of elements, then, of course, no question will arise regarding infringement. But it may be that a competitor contrives a device having some of the elements of the combination as called for by the claim, the remaining elements being omitted and substitutes provided. The competing device will thus not respond to the language of the claim. But the courts will deal liberally with the claim of the meritorious pioneer inventor, and will apply to it the doctrine of mechanical equivalents, and will hold the claim to be infringed by a combination containing all of the elements recited in the claim, or containing some of them, and mechanical equivalents for the rest of them. Were it not for this liberal doctrine, the pioneer inventor could gather little fruit from his patent, for the patent could be avoided, perhaps, by the mere substitution of a wedge for the screw or lever called for by the claim. The court, having ascertained from the prior art that the inventor is entitled to invoke the doctrine of equivalents, will proceed to ascertain if the substituted elements are real equivalents. A given omitted element will be considered in connection with its substitute element, and if the substitute element is found to be an element acting in substantially the same manner for the production of substantially the same individual result, and if it be found that the prior art has recognized the equivalency of the two individual elements, then the court will say that the substituted element is a mechanical equivalent of the omitted element, and that the two combinations are substantially the same. This reasoning must be applied to each of the omitted elements for which substitutes have been furnished. In this way justice can be done to the pioneer inventor. But the courts, in exercising liberality, cannot do violence to the language of the claim. The infringer will not escape by merely substituting equivalents for recited elements, but he will escape if he omits a recited element and supplies no substitute, for the courts will not read out of a claim an element which the patentee has deliberately put into the claim, and a combination of a less number of elements than that recited in the claim is not the combination called for by the claim.

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It is seldom that the exemplifying device of the pioneer inventor is a perfect one. Later developments and improvements by the original patentee, or by others, must be depended on to bring about perfection of structure. Those who improve the structure are as much entitled to patents upon their specific improvements in the device as was the original inventor entitled to his patent for the fundamental device. These improvers are secondary inventors, and are not entitled to invoke the doctrine of mechanical equivalents. The secondary inventor did not bring about a new result, but his patent was for new means for producing the old result. His patent is for this improvement in means, and his claim will be closely scrutinized in court, and he will be held to it, subject only to formal variations in structure. The justice of thus restricting the claim of the secondary inventor must be obvious, in view of the fact that if the doctrine of mechanical equivalents were applied to his claim, then the fundamental device on which he improved would probably infringe upon it, which would be an absurdity. It is thus seen that the pioneer inventor may have a claim so broad in its terms that its terms cannot be escaped; that he may invoke the doctrine of equivalents and have his claim dominate structures not directly responding to the terms of the claim; that the secondary inventor, who improves only the means, is limited to the recited means and cannot invoke the doctrine of equivalents. But within this general view, sight is not to be lost of the fact that secondary inventors may be pioneers within certain limits. They are not the first to produce the broad ultimate result, but they may be pioneers in radically improving interior or sub-results, and they may thus reasonably ask for the application of the doctrine of equivalents to their claims within proper limits. The matter often becomes quite complicated, for it is sometimes difficult to determine as to what is the result in a given machine, for many machines consist, after all, of a combination of subordinate machines. Thus the modern grain-harvesting machine embodies a machine for moving to the place of attack, a machine for cutting the grain, a machine for supporting the grain at the instant of cutting, a machine for receiving the cut grain, a machine for conveying the cut grain to a bindery, a machine for measuring the cut grain into gavels, a machine for compressing the gavel, a machine for applying the band, a machine for tying the band, a machine for discharging the bundle, a machine to receive the bundles and carry them to a place of deposit, and a machine to deposit the accumulated bundles. The machine would be useful with one or more of these sub-machines omitted, and each machine may be capable of performing its own individual results alone or in other associations. Pioneership of invention might apply to the main machine, or to the sub-machines, or even to the sub-organization within the sub-machines.

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(To be continued.)

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[Continued from *supplement*, No. 1172, page 18764.]

THE DEVELOPMENT OF THE CENTRAL STATION.

By *Samuel Insull*.^[1]

[Footnote 1: Before the Electrical Engineering Department of Purdue University, Lafayette, Ind., May 17, 1898.]

The success of the low-tension system was followed by the introduction of the alternating system, using high potential primaries with the converters at each house, reducing, as a rule, from 1,000 down to either 50 or 100 volts. I am not familiar with the early alternating work, and had not at my disposal sufficient time in preparing my notes to go at any length into an investigation of this branch of the subject; nor do I think that any particular advantage could have been served by my doing so, as it has become generally recognized that the early alternating work with a house-to-house converter system, while it undoubtedly helped central station development at the time, proved very uneconomical in operation and expensive in investment, when the cost of converters is added to the cost of distribution. The large alternating stations in this country have so clearly demonstrated this that their responsible managers have, within the last few years, done everything possible, by the adoption of block converters and three-wire secondary circuits, to bring their system as close as they could in practice to the low-tension direct-current distribution system. I do not want to be understood as undervaluing the position of the alternating current in central station work. It has its place, but to my mind its position is a false one when it is used for house-to-house distribution with converters for each customer. The success of the oldest stations in this country, and the demonstration of the possibilities of covering areas of several miles in extent by the use of the three wire system, resulted in much capital going into the business. One of the earliest stations of a really modern type installed on either side of the Atlantic was built by the Berlin Electricity Works. The engineers of that station, while recognizing the high value of the distributing system, went back to Edison's original scheme of a compact direct-connected steam and electric generator, but with dynamos of the multipolar type designed and built by Siemens & Halske, of Berlin, the engines being of vertical marine type.

This was followed by the projecting in New York of the present Duane Street station, employing boilers of 200 pounds pressure, triple and quadruple expansion engines of the marine type, and direct-connected multipolar dynamos. Almost immediately thereafter, the station in Atlantic Avenue, Boston, somewhat on the same general design

so far as contents is concerned, was erected. In 1891 a small station, but on the same lines, was projected for San Francisco, and in 1892 the present Harrison Street station of the Chicago Edison company was designed, and, benefiting by the experience of Berlin, New York and Boston, this station produces electric current for lighting purposes probably cheaper than any station of a similar size anywhere in this country.

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It is not necessary for me to go into detail in explanation of the modern central station. You are all doubtless quite familiar with the general design, but if you will examine the detail drawings of the Harrison Street station, which I have brought with me, you will find that every effort has been made to provide for the economical production of steam, low cost of operating, good facilities for repairs and consequently low cost, and for permanency of service. You have but to go into any of the modern central stations in midwinter, to see them turning out anywhere from 10,000 to 80,000 amperes with a minimum of labor, to appreciate the fact that central station business is of a permanent and lucrative character.

To go back to the question of alternating currents, the work done in connection with the two-phase and three-phase currents and the perfection of the rotary transformer has resulted in introducing into central station practice a further means of economizing the cost of production—by concentration of power. According to present experience, it is (except in some extraordinary cases) uneconomical to distribute direct low-tension current over more than a radius of a mile and a half from the generating point. The possibility of transmitting it at a very high voltage, and consequently low investment in conductors, has resulted in the adoption of a scheme, in many of the large cities, of alternating transmission combined with low tension distribution. The limit to which this alternating transmission can be economically carried has not yet been definitely settled, but it is quite possible even now to transmit economically from the center of any of our large cities to the distant suburbs, by means of high potential alternating currents, distributing the current from the subcenter distribution by means either of the alternating current itself and large transformers for a block or district or else, if the territory is thickly settled, by means of a system of low-tension mains and feeders, the direct current for this purpose being obtained through the agency of rotary transformers.

There are various methods of producing the alternating current for transmission purposes. In some cases the generators are themselves wound for high potential; in others they are wound for 80 volts, and step-up transformers are used, carrying the current up to whatever pressure is desired, from 1,000 to 10,000 volts. In other cases dynamos are used having collector rings for alternating current on one side and a commutator for direct current on the other side of the armature, thus enabling you, when the peak in two districts of a city comes at two different times, to take care of this peak by means of the same original generating unit, furnishing direct low-tension current to the points near the central station and alternating current to the distant points. In other cases, where a small amount of alternating current is required on the transmission line, it has even been found economical to take direct current from a large unit, change it by means of a rotary transformer into alternating current, step up from 80 to, say, 2,000 volts, go to the distant point, and step down again to 80 volts alternating, and then convert again by means of a rotary transformer into low-potential direct current.

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The introduction of alternating current for transmission purposes in large cities is probably best exemplified in the station recently erected in Brooklyn, where alternating current is produced and carried to distant points, and then used to operate series arc-light machines run by synchronous motors, the low-tension direct-current network being fed by rotary transformers, and alternating circuits arranged with block converters, and even in some cases separate converters for each individual customer in the scattered districts.

It would be very interesting to go at length into the details of cost in this, the latest development of central station transmission, but time will not permit; nor have I the time at my disposal to go at length into the central station business as developed by the electric street railways now so universally in use, or another phase of the business as exemplified by the large transmission plants, the two greatest examples of which, in this country, are probably those at Niagara Falls, N.Y., and Lachine Rapids, near Montreal. So far as street railways and power transmission are concerned, I would draw your attention to the fact that the same underlying principle of multiple-arc mains and feeders originally conceived by Mr. Edison is as much a necessity in their operation as it is in the electric lighting systems, whether those systems be operated on the old two-wire plan, the three-wire plan or by means of alternating currents.

Passing from a review of central station plants and distribution system naturally bring us to the operating cost and the factors governing profit and loss of the enterprise. In considering this branch of the subject, I will confine my remarks to the business as operated in Chicago by the company with which I am connected.

Our actual maximum last winter came on December 20, our load being approximately 12,000 horse power. A comparison of the figures of maximum capacity and maximum load of last winter shows that we had a margin in capacity over output of about 20 per cent. The load curves shown this evening represent the maximum output of last winter (December 20), an average summer load last year (June 4), and an average spring load of this year (May 2). For our purposes we will assume the maximum capacity of the plant and the maximum load of the system to be identical. The maximum load last winter occurred, as I have stated, on December 20, about 4:30 o'clock in the afternoon, and lasted less than half an hour. It should be borne in mind that the period of maximum load only lasts for from two to three months, and that the investment necessary to take care of that maximum load, has to be carried the whole year. It should not be assumed from this statement that the whole plant as an earning factor is in use 25 per cent. of the year. The fact is that, during the period of maximum load, the total plant is in operation only about 100 hours out of the 8,760 hours of the year; so that you are compelled, in order to get interest on your investment, to earn the interest for the whole of the year in about 11/2 per cent. of that period, on about 50 per cent. of your plant.

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This statement must bring home to you a realization of the fact that by far the most serious problem of central station management, and by far the greatest item of cost of your product, is interest on the investment. It may be that the use of storage batteries in connection with large installations will modify this interest charge, but even allowing the highest efficiency and the lowest cost of maintenance ever claimed for a storage battery installation, the fact of high interest cost must continue to be the most important factor in calculating profit and loss. This brings home to us the fact that in his efforts to show the greatest possible efficiency of his plant and distribution system, it is quite possible that the station manager may spend so much capital as to eat up many times over in interest charge the saving that he makes in direct operating expenses. It is a common mistake for the so-called expert to demonstrate to you that he has designed for you a plant of the highest possible efficiency, and at the same time for him to lose sight of the fact that he has saddled you with the highest possible amount of interest on account of excessive investment. Operating cost and interest cost should never be separated. One is as much a part of the cost of your current as the other. This is particularly illustrated in connection with the use of storage batteries. Those opposed to their use will point out to you that of the energy going into the storage battery only 70 per cent. is available for use on your distribution system. That statement in itself is correct; but in figuring the cost of energy for a class of business for which the storage battery is particularly adapted, the maximum load, that portion of your operating cost affected by the 30 per cent. loss of energy in the battery, forms under $4\frac{1}{2}$ per cent. of your total cost, and it must be self-evident, in that case at least, that the 30 per cent. loss in the storage battery is hardly an appreciable factor in figuring the operating cost of your product. So far as I have been able to ascertain, it would appear to be economical to use storage batteries in connection with central station systems the peak of whose load does not exceed from two to two and one-half hours.

In order to illustrate the important bearing which interest has on cost, I have prepared graphical representations of the cost of current, including interest, under conditions of varying load factors. For the purpose of this chart I have assumed an average cost of current, so far as operating and repairs and renewals and general expense are concerned, extending over a period of a year, although of course these items are more or less attested by the character of the load factor. For the purpose of figuring interest, I have selected seven different classes of business commonly taken by electric light and power companies in any large city. Take, for instance, an office building. It has a load factor of about 3.7 per cent., that is,

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the average load for the whole year is 3.7 per cent. of the maximum demand on you for current at any one time during that period; or, to put it in another way, this load factor of 3.7 per cent. would show that your investment is in use the equivalent of a little over 323 hours a year on this class of business. This is by no means an extreme case. You can find in almost every large city customers whose load factors are not nearly as favorable to the operating company, their use of your investment being as low as the equivalent of 75 or 100 hours a year. Take another class of business, that of the haberdasher, or small fancy goods store. As a rule these stores are comparatively small, with facilities for getting a large amount of natural light and little use for artificial light. The load factor as shown by the chart is about 7 per cent., the use of your investment being not quite twice as long as that of the office building. Day saloons show an average of 16 per cent. load factor; cafetiers and small lunch counters about 20 per cent., while the large dry goods stores, in which there is comparatively little light, have a load factor of 25 per cent. and use your investment seven times as long per year as the office building. Power business naturally shows a still better load factor, say 35 per cent., and the all-night restaurant has a load factor of 48 per cent.

You will see from this that the great desideratum of the central station system is, from the investors' point of view, the necessity of getting customers for your product whose business is of such a character as to call for a low maximum and long average use. This question of load factor is by all means the most important one in central station economy. If your maximum is very high and your average consumption very low, heavy interest charges will necessarily follow. The nearer you can bring your average to your maximum load, the closer you approximate to the most economical conditions of production, and the lower you can afford to sell your current. Take, for instance, the summer and winter curves of the Chicago Edison company. The curve of December 20, 1897, shows a load factor of about 48 per cent.; the curve of May 2, 1898, shows a load factor of nearly 60 per cent. Now, if we were able in Chicago to get business of such a character as would give us a curve of the same characteristics in December as the curve we get in May; or, in other words, if we could improve our load factor, our interest cost would be reduced, an effect would be produced upon the other items going to make up the cost of current, and we probably could make more money out of our customers at a lower price per unit than we get from them now.

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Many schemes are employed for improving the load factor, or, in other words, to encourage a long use of central station product. Some companies adopt a plan of allowing certain stated discounts, provided the income per month of each lamp connected exceeds a given sum. The objection to this is that it limits the number of lamps connected. Other companies have what is known as the two-rate scheme, charging one rate for electricity used during certain hours of the day and a lower rate for electricity used during the balance of the day, using a meter with two dials for this purpose. Other companies use an instrument which registers the maximum demand for the month, and the excess over the equivalent of a certain specified number of hours monthly in use of the maximum demand is sold at greatly reduced price. The last scheme would seem particularly equitable, as it results in what is practically an automatic scale of discounts based on the average load factor of the customers. It does not seem to be just that a man who only uses your investment say 100 hours a year should be able to buy your product at precisely the same price as the man who uses your investment say 3,000 hours a year, when the amount of money invested to take care of either customer is precisely the same. Surely the customer who uses the product on an average 30 times longer than the customer using it for only 100 hours is entitled to a much lower unit rate, in view of the fact that the expense for interest to the company is in one case but a fraction per unit of output of what it is in the other. This fact is illustrated by the interest columns on the graphic chart already referred to. Supposing that the central station manager desired to sell his product at cost, that is, an amount sufficient to cover his operating, repairs and renewals, general expense, and interest and depreciation, he would have to obtain from the customer having the poorest load factor, as shown on the load chart, over four times as much per unit of electricity as it would be necessary for him to collect from the customer having the largest load factor. No one would think of going to a bank to borrow money and expect to pay precisely the same total interest whether he required the money for one month or for twelve; and for the same reason it seems an absurdity to sell electricity to the customer who uses it but a comparatively few hours a year at the same price at which you would sell it to the customer using it ten hours a day and three hundred days a year, when it is remembered that interest is the largest factor in cost, and the total amount of interest is the same with the customer using it but a few hours a year as it is with the customer using it practically all the year around.

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I have dwelt thus at length on the question of interest cost in operating a central station system, not alone for the purpose of pointing out to you its importance in connection with an electrical distribution system, but also to impress upon you its importance as a factor in cost; in fact, the most important factor in cost in any public service business which you may enter after leaving this institution. Most of the businesses presenting the greatest possibilities from the point of view of an engineering career are those requiring very large investment and having a comparatively small turnover or yearly income. Of necessity, in all enterprises of this character, the main factor of cost is interest, and if you intend following engineering as a profession, my advice to you would be to learn first the value of money, or, to put it another way, to learn the cost of money.

Before leaving this question of interest and its effect upon cost, I would draw your attention to the fact that while interest is by far the most important factor of cost, it is a constantly reducing amount per unit of maximum output in practically every central station system. When a system is first installed, it is the rule to make large enough investment in real estate and buildings to take care of many times the output obtained in the first year or so of operation. As a rule, the generating plant from the boilers to the switchboard is designed with only sufficient surplus to last a year or so. In the case of the distributing system the same course is followed as in the case of real estate and buildings, with a view to minimizing the ultimate investment. Mains are laid along each block facing, feeders are put in having a capacity far beyond the necessity of the moment; consequently interest cost is very high when a plant first starts, except, as I have stated, in the case of the machinery forming the generating plant itself. As the business increases from, year to year, the item of interest per unit of maximum output consequently will constantly decrease, owing to the fact that each additional unit of output following an increase of connected load increases the divisor by which the total interest is divided. The result is from year to year the interest cost of each additional unit of maximum output is a constantly reducing amount, and consequently the average interest cost of each unit of maximum output should, in a well regulated plant, grow less from year to year until the minimum interest cost per unit is reached. This minimum interest cost is reached when the capacity of the whole system and the total units of output at maximum load are identical, although of course it will always be necessary to have a certain margin of capacity over possible output, as a factor of safety.

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This same rule, although to a less extent, applies to the operating and general expense cost, that is, the cost other than interest. To particularize, the manager's salary and other administrative expenses do not increase in proportion to maximum output of station; therefore, the cost of administration per unit of output, if the business is in a healthy condition, must be from year to year reduced. There are a great many other expenses that are not directly in proportion to output, and these follow the same rule. In a well-run plant the percentage of operating expenses to gross receipts will stand even year after year, while the income per unit of output will be constantly reduced. This is an excellent evidence of the fact that the cost per unit of output is constantly being reduced, as, if it were not, the percentage of expenses to gross receipts would be increased in direct proportion to the reduction in price. Moreover, it should be borne in mind that there are many difficulties in the way of universal use of electric energy from a central station system. It is the rare exception to find a house not piped for gas and water. In the case of the latter it is almost invariably the rule that owners are compelled to pipe for water, under the sanitary code of the municipality. On the other hand, in a large residential district, it is the exception to find a house wired for electric light; consequently the output of current per foot of conductor is at the present time very low as compared with the output of gas per foot of gas pipe in any of the large cities. The expense of wiring (which must of necessity be borne by the householder) is large, and it is often a barrier to the adoption of electric illumination, but as the rule to wire houses becomes more general, the output per foot of main will constantly increase, and therefore the interest per unit of output per foot of main will constantly decrease. This same rule will apply in the case of expenses of taking care of and repairing the distribution system, although to not so great an extent.

If you will take into account these various factors constantly operating toward a reduction of operating and general expense cost, and interest cost, the conclusion must necessarily be forced upon you that the price at which current can be sold at a profit to-day is in no sense a measure of the income per unit which it will be necessary for central station managers to obtain in the future. In 1881-82 it was difficult to make both ends meet with an income of 25 cents per kilowatt hour, to-day there are many stations showing a substantial return on their investment whose average income does not exceed 7 cents per kilowatt hour, showing 70 per cent. reduction in price in less than two decades. How far this constant reduction in cost, followed by a constant reduction in selling price, will go, it is difficult to determine; but if so much has been accomplished during the first 20 years of the existence of the industry, is it too

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much to predict that in a far less time than the succeeding 20 years electric current for all purposes will be within the reach of the smallest householder and the poorest citizen? But few industries can parallel the record already obtained. If you will trace the history of the introduction of gas as an illuminant, you will find that it took a much longer time to establish it on a commercial basis than it has taken to establish most firmly the electric lighting industry. All the great improvements in gas, the introduction of water gas, the economizing in consumption by the use of the Welsbach burner, have all been made within the time of those before me, and yet, notwithstanding that when these gas improvements started, the electric lighting business was hardly conceived, and certainly had not advanced to a point where you could claim that it had passed the experimental stage—notwithstanding this, the cost of electrical energy has decreased so rapidly that to-day there are many large central station plants making handsome returns on their investments at a far lower average income per unit of light than the income obtained by the gas company in the same community. In making my calculations which have led me to this conclusion, I have assumed that 10,000 watts are equal to 1,000 feet of gas. This comparison holds good, provided an incandescent lamp of high economy is used as against the ordinary gas burner. To make a comparison between electric illumination and incandescent gas burners, such as the Welsbach burner, you must figure on the use of an arc lamp in the electric circuit instead of an incandescent lamp, which is certainly fair when it is remembered that incandescent gas burners are, as a rule, used in places where arc lamps should be used if electric illumination is employed.

With such brilliant results obtained in the past, the prospects of the central station industry are certainly most dazzling. While the growth of the business has been phenomenal, more especially since 1890, I think it can be conservatively stated that we have scarcely entered upon the threshold of the development which may be expected in the future. In very few cities in the United States can you find that electric illumination exceeds more than 20 per cent. of the total artificial illumination for which the citizens pay. If this be the state of affairs in connection with the use of electricity for illuminating purposes, and if you will bear in mind the many other purposes to which electricity can be adapted throughout a city and supplied to customers in small quantities, you may get some faint conception of the possible consumption of electrical energy in the not far distant future. Methods of producing it may change, but these methods cannot possibly go into use unless their adoption is justified by saving in the cost of production—a saving which must be sufficient to show a profit above the interest and depreciation on the new plant employed.

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It is within the realms of possibility that the present form of generating station may be entirely dispensed with. It has already been demonstrated experimentally that electrical energy may be produced direct from the coal itself without the intervention of the boiler, engine and dynamo machine. Whether this can be done commercially remains to be proved. Whatever changes may take place in generating methods, I should, were I not engaged in a business which affords so many remarkable surprises, be inclined to question the possibility of any further material change in the distributing system. Improvements in the translating devices, such as lamps, may add enormously to the capacity of the distributing system per unit of light; but it does seem to me that the system itself, as originally conceived, is to a large extent a permanency. Should any great improvements take place in the medium employed for turning electrical energy into light, the possible effect on cost, and consequently selling price, would be enormous.

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The proposal of Gov. Black, which has now become law, to depute to Cornell the care of a considerable tract of forest land, and the duty of demonstrating to Americans the theory, methods and profits of scientific forestry, has a curious appropriateness much commented on at the university, since two-thirds of the wealth of Cornell has been derived from the location and skillful management of forest lands, the net receipts from this source being to date \$4,112,000. In the course of twenty years management the university has thrice sold the timber on some pieces of land which it still holds, and received a larger price at the third sale than at the first. The conduct of this land business is so systematized that the treasurer of the university knows to a dot the amount of pine, hemlock, birch, maple, basswood and oak timber, even to the number of potential railroad ties, telegraph poles and fence posts on each fourth part of a quarter section owned by Cornell. Certainly, Cornell is rich in experience for the business side of a forestry experiment such as Gov. Black proposes. The university forest lands from which its endowment has been realized are in Wisconsin.

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Books may be called heavy when the qualifying term is not applied to their writers, but to the paper makers. It is falsifications in the paper that give it weight. Sulphate of baryta, the well known adulterate of white lead, does the work. A correspondent, writing to *The London Saturday Review*, gives the weight of certain books as: Miss Kingsley's "Travels in Africa," 3 pounds 5 ounces; "Tragedy of the Caesars," 3 pounds; Mahan's "Nelson" (1 vol.), 2 pounds 10 ounces; "Tennyson" (1 vol.), 2 pounds 6 ounces; "Life and Letters of Jowett" (1 vol.), 2 pounds 1 ounce. To handle these dumb-bell books, *The Saturday Review* advises that readers take lessons in athletics.

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THE LOCK OF THE DORTMUND-EMS CANAL AT HENRICHENBURG.

The Dortmund-Ems Canal, destined to connect the heart of German industry with the sea, was formally dedicated on April 1, and partially opened to commerce. After its completion, German coal will be transported to the harbors of the Ems at the same cost as the English coal which has hitherto forced back the treasures of our soil; our black diamonds will then be sold in the markets of the world, and the Kaiser Wilhelm Canal will enable the western part of the empire to exchange its coal and iron for the grain and wood of the East.

Many difficulties were encountered in cutting the canal, owing partly to the vast network of railroads in the coal region of Westphalia, but chiefly due to the insufficiency of moisture in the highlands, the latter not containing enough water to supply the many necessary sluices, at which it could be easily foreseen considerable traffic would occur.

[Illustration: *The lock of the Dortmund-ems canal at Henrichenburg.*]

For the modern engineer there are, however, no insurmountable obstacles. Instead of a line of ordinary locks, a single structure was erected sufficient for the needs of the entire region. This lock is situated at Henrichenburg, near Dortmund, and our illustration pictures it with its lock-chamber half raised.

The lock, which serves to overcome a difference in level of fifty-nine feet, raises vessels of 1,000 tons capacity with a velocity of 0.3 to 0.7 foot per second, and has been constructed after a new and astonishingly simple system.

The lock chamber, designed for the reception of the various vessels, is 229.60 feet in length and 28.864 feet in breadth and normally contains 8.2 feet of water. Under the sluice in a line with the long axis are five wells filled with water in which cylindrical floats are placed, connected to the bottom of the chamber by means of iron trellis-work. The floats are placed so deeply that, in their highest position, their upper edges are always submerged; they are, moreover, of such size that by means of their upward impulsion the chamber is held in equilibrium. Irrespective of the small differences of pressure which arise from the varying immersion of the framework, the lock will in all positions be in equilibrium. Since a vessel which enters the lock displaces a volume of water whose weight is equal to the weight of the vessel, a constant equilibrium will always be maintained and only a minimum force required to raise or lower the chamber. In order to move the lock-chamber up and down and to sustain it constantly in a horizontal position, nuts have been fixed to strong crossbeams, through which powerful screw-rods work.

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These rods are held in place by a massive framework of iron and are turned to the left or to the right by means of a small steam engine, placed at one side of the lock, which engine, by means of a longitudinal shaft, drives two cross shafts to which bevel wheels are attached. By this means the chamber is lowered and raised. The screw rods are so powerful that they sustain the entire weight of the lock chamber, and the pitch of the thread is such that spontaneous sliding or slipping is impossible, the chamber being, therefore, kept constantly in the desired position.

It is interesting to note that the hollow space in the screw rods is heated by steam during winter, thus preventing the formation of ice in the machinery.

During the eighties, locks for ships of 400 tons capacity were erected in England and France, at Anderton, Les Fontinettes and La Louviere. The lock at Henrichenburg, however, exceeds all its predecessors, not only in size, but also in security. At all events, the structure is a worthy memorial of the energy and genius of German engineers.—Illustrirte Zeitung.

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Paper hanging by machine is the latest achievement, according to a German contemporary, says The Engineer. The arrangement used for this purpose is provided with a rod upon which the roll of paper is placed. A paste receptacle with a brushing arrangement is attached in such a manner that the paste is applied automatically on the back of the paper. The end of the wall paper is fixed at the bottom of the wall and the implement rises on the wall and only needs to be set by one workman. While the wall paper unrolls and, provided with paste, is held against the wall, an elastic roller follows on the outside, which presses it firmly to the wall. When the wall paper has reached the top, the workman pulls a cord, whereby it is cut off from the remainder on the roll.

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THE AMERICAN “REGULAR.”

By the English correspondent of the London times on board the United states transport “Gussie.”

The “regular” of the United States is in many respects the least equipped foot soldier of my acquaintance. This was my reflection as I overhauled the kit of a private this morning on board the “Gussie.” There was not a single brush in his knapsack. I counted three in that of a Spanish foot soldier only a few weeks ago. The American knapsack is merely a canvas bag cut to the outward proportions of the European knapsack, but in practical features bearing affinity with the “rueckensack” of the Tyrolean chamois hunters, or pack-sack of the backwoodsmen of Canada and the

Adirondack Mountains. This knapsack of the American is not intended to be carried on any extended marches, although the total weight he is ever called upon to

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carry, including everything, is only 50 pounds, a good 12 pounds less than what is carried by the private of Germany. The men of this regiment, in heavy marching order, carry an overcoat with a cape, a blanket, the half of a shelter tent, and one wooden tent pole in two sections. The rifle could be used as a tent pole—so say men I talk with on the subject. On this expedition overcoats are a superfluity, and it is absurd that troops should be sent to the tropics in summer wearing exactly the same uniform they would be using throughout the winter on the frontiers of Canada. This war will, no doubt, produce a change after English models. At present the situation here is prevented from being painful because no marching has yet been attempted, and the commanding officers permit the most generous construction in the definition of what is a suitable uniform.

On the trip of this ship to Cuba, no officer or man has ever worn a tunic excepting at guard mounting inspection. The 50 men who went ashore near Cabanas on May 12 and pitched into some 500 Spaniards left their coats behind and fought in their blue flannel shirts. Of the officers, some wore a sword, some did not, though all carried a revolver. No orders were issued on the subject—it was left to individual taste, I have experienced hotter days at German maneuvers than on the coast of Cuba during the days we happened to be there, yet I have never noticed any disposition in the army of William II. to relax the severity of service even temporarily. My German friends sincerely believe that the black stock and the hot tunic are what has made Prussia a strong nation, and to disturb that superstition would be a thankless task.

In the way of clothing the American private carries a complete change of under-drawers, under-shirt, socks, laced boots and uniform trousers. My particular private was carrying a double allowance of socks, handkerchiefs, and underwear. He had a toothbrush and comb. That is the heavy marching order knapsack. For light marching, which is the usual manner, the man begins by spreading on the ground his half-tent, which is about the size of a traveling rug. On this he spreads his blanket, rolls it up tightly into a long narrow sausage, having first distributed along its length a pair of socks, a change of underwear, and the two sticks of his one tent pole. Then he brings the ends of this canvas roll together, not closely, as in the German army, but more like the ends of a horse-shoe, held by a rope which at the same time stops the ends of the roll tightly. When this horse shoe is slung over the man's shoulder, it does not press uncomfortably upon his chest. The total weight is distributed in the most convenient manner for marching.

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The packing of the man's things is strictly according to regulation, excepting only the single pocket in his knapsack, where he may carry what he chooses, as he chooses. His light canvas haversack is much like the English one, and his round, rather flat water flask is covered with canvas. It is made of tin, and the one I inspected was rusty inside. It would be better if of aluminum. In the haversack is a pannikin with a hinged handle that may be used as a saucepan. Over this fits a tin plate, and when the two are covering one another the handle of the pannikin fits over both by way of handle. It is an excellent arrangement, but should be of aluminum instead of a metal liable to rust. The most valuable part of this haversack is a big tin cup that can be used for a great variety of purposes, including cooking coffee. It is hung loose at the strap of the haversack. Of course each man has knife, fork and spoon, each in a leather case.

The cartridge belt contains 100 rounds, which are distributed all the way around the waist, there being a double row of them. The belt is remarkably light, being woven all in one operation. It is of cotton and partly some material which prevents shrinking or loosening. The belts have stood admirably the test put upon them for the last six days, when it has rained every day, on top of the ordinary heavy moisture usual at sea in the tropics. The test is the more interesting from their having been previously in a very dry country. Officers and men alike unite in praise of this cartridge belt. The particular private whom I was inspecting said he now carried 100 as easily as he formerly carried 50. This belt rests loosely on the hips, without any straps over the shoulders. It is eminently businesslike in appearance. The hat is the gray felt of South Africa, Australia, and every other part of the world where comfort and cost are consulted. No boots are blacked on expeditions of this kind. The men who form in line for guard duty have their tunics well brushed, but that may be due to extraneous assistance.

For fighting purposes, then, the United States private has nothing to keep clean excepting his rifle and bayonet. He carries no contrivances for polishing buttons, boots, or the dozen of bits of accouterment deemed essential to a good soldier in Europe. In Spain, for instance, the private, though he may have nothing in his haversack, will, nevertheless, carry a clumsy outfit of tools for making his uniform look imposing.

Now, as to discipline in the American army I cannot speak at present, for the war is yet too young. It may, however, be worth noting that in this particular regiment, while most complete liberty was allowed the men all the twelve days of the rail journey from San Francisco to Tampa, not a single case of drunkenness or any other breach of discipline was reported. Among the 105 men on this boat there has not in the past seven days been a single case of sickness of any

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kind or any occasion for punishing. The firing discipline during the three times we have been under fire has been excellent; the obedience of soldiers to their officers has been as prompt and intelligent as anything I have seen in Europe; and as to coolness under fire and accuracy of aim, what I have seen is most satisfactory. The men evidently regard their officers as soldiers of equal courage and superior technical knowledge. To the Yankee private "West Pointer" means what to the soldier of Prussia is conveyed by noble rank. In my intimate intercourse with officers and men aboard this ship I cannot recall an instance of an officer addressing a private otherwise than is usual when a gentleman issues an order. I have never heard an officer or noncommissioned officer curse a man. During the engagement of Cabanas the orders were issued as quietly as at any other time, and the men went about their work as steadily as bluejackets on a man-o'-war.

All this I note, because this is the first occasion that United States troops have been in action since the civil war, and because I have more than once heard European officers question the possibility of making an army out of elements different from those to which they were accustomed. I have heard Germans insist that unless the officer appears in uniform he cannot command the respect of his men. On this ship it would be frequently difficult to tell officers from men when the tunic is laid aside and shoulder straps are not seen. There are numberless points of resemblance between Tommy Atkins and the Yankee private; and the Sandhurst man has no difficulty in understanding the West Pointer. But to do this we must go a little beneath the surface and see things, not on the parade ground, but in actual war. For dress occasions the American uniform is far and away the ugliest and most useless of all the uniforms I know. The helmets and cocked hats are of the pattern affected by theatrical managers, the decorations tawdry, the swords absurd, the whole appearance indicative of a taste unmilitary and inartistic. The parade uniform has been designed by a lot of unsoldierly politicians and tailors about Washington. Their notion of military glory is confused with memories of St. Patrick's Day processions and Masonic installations. They have made the patient United States army a victim of their vulgar designs, and to-day at every European army maneuver one can pick out the American military attache by merely pointing to the most unsoldierly uniform on the field. On the battlefield, however, there are no political tailors, and the Washington dress regulations are ruthlessly disregarded.

* * * * *

STEERING GEAR OF NORTH GERMAN LLOYD STEAMERS "COBLENTZ," "MAINZ," AND "TRIER."

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The steering gear illustrated below, which has been fitted to a number of vessels in this country as well as on the three North German Lloyd steamers above named, is designed, primarily, to effect the distribution of the leverage more in proportion to the resistance of the rudder than exists in ordinary gears. The latter, as a rule, exert a uniform and decreasing, instead of an increasing, purchase on the rudder, in moving it from midgear to hard over. This important object is attained in the gear under notice chiefly through the arrangement of the quadrant and the spring buffers, which form an essential part of it, and of the tiller crosshead. The quadrant—which, as may be gathered from our illustration, has its main body formed of wrought steel, flanged and riveted, making an exceptionally strong design—works on its own center. It travels through 51 degrees in moving the tiller crosshead through 40 degrees, and in doing so increases the leverage over the rudder to an extent which is equivalent to a gain of 60 per cent. upon midgear position.

[Illustration: *Hand gear hard over.*]

[Illustration: *Hand gear amidships. Croom & ARTHUR'S steering gear.*]

Being carried on its own center, and not, as is usual, on the rudder stock, and with its rim supported on rollers, the quadrant does not impose upon the rudder pintles any of its own weight, thus diminishing the wear on these parts. This arrangement also keeps the quadrant always in good gear with its pinion, thereby allowing the teeth of both to be strengthened by shrouding, and rendering them exempt from the effects of sinking and slogger of the rudder stock as the pintles wear. The rack and pinions are of cast steel, as is also the tiller crosshead. The spring buffers, which, as has been said, form an essential part of the quadrant, are fitted with steel rollers at the point of contact with the crosshead, thereby reducing the friction to a minimum. The springs, by their compression, absorb any shock coming on the rudder, and greatly reduce the vibration when struck by a sea. They are made adjustable, and can be either steel or rubber.

Our illustrations show the arrangement of the gear as worked by hand at the rudder head, but of course gears are made having a steam steering engine as the major portion of the arrangement—the two cylinders being placed directly over the quadrant—thus securing the well known advantages attaching to a direct rudder head steering engine as compared with the engine situated amidship, with all the friction of parts, liability to breakage, etc., thereby entailed.

Whether with engine amidship or directly over the rudderhead, ample provision is made for putting the hand power into gear by means of a friction clutch within the standard upon which the hand wheels are mounted. The clutch is of large diameter and lined with hard wood, power and ready facility being provided by the hand lever—seen at the top of standard—and the screw which it operates, for shifting to in and out of gear.

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The patentees and makers of this type of gear are Messrs. Croom & Arthur, Victoria Dock, Leith, who, in addition to fitting it to the three North German Lloyd steamers named in the title—which are each of 3,200 tons, having an 8-inch rudder-stock—have applied it to the Hamburg and Australian liner Meissen of 5,200 tons and 10-inch rudder stock, and to the steamer Carisbrook of 1,724 tons, owned in Leith. On the latter vessel, which was the first fitted with it, the gear has been working for over two years, giving, we are told, entire satisfaction to the owners, who say the spring buffers undoubtedly reduce the vibration when the rudder is struck by a sea, and the arrangement of quadrant and tiller appears to give increase of power. Of the installation of this gear on board the three North German Lloyd vessels, the agents of that company say: “It has been working to our entire satisfaction. This system, on the whole, proves to have answered its purpose.” Considering the advantages claimed for the gear, this is satisfactory testimony. We are indebted to The London Engineer for the cuts and description.

* * * * *

COMBINED STEAM PUMPING AND MOTIVE POWER ENGINE.

We give herewith an illustration of a compact engine, designed by Messrs. Merryweather & Sons, of London, particularly for mining work, and already supplied to the Burma ruby mines, the Salamanca tin mines, and several mining companies in Brazil and other parts of South America. It is an arrangement of the Valiant steam pumping engine with a flywheel arranged to take a belt, and is so constructed that the pump can be readily thrown out of gear and the engine used to drive light machinery. The smaller size weighs only 7 cwt., including boiler, engine and pump complete, and can be run on its own wheels, or these can be detached and the machine carried by eight or ten men on shoulder poles passed through rings fitted on top of the boiler. Thus it can be easily transported up country, and has for this reason been found most useful for prospecting. For alluvial mining it will throw a powerful jet at 100 lb. to 120 lb. pressure, or by means of a belt will drive an experimental quartz crusher or stamp mill. The power developed is six horses, and the boiler will burn wood or other inferior fuel when coal is not obtainable. The pump will deliver 100 gallons per minute, on a short length of hose or piping, and will force water through three or four miles of piping on the level, or, on a short length, 35 gallons per minute against a head of 210 feet. The pump is made entirely of gun metal, with rubber valves, and has large suction and delivery branches. Air vessels are fitted, and the motion work is simple and strong. The boiler is Merryweather’s water tube type, and raises steam rapidly, while the fittings include feed pump, injector, safety valve, steam blast and an arrangement for feeding the boiler from the main pump in case of necessity.

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[Illustration: *Merryweather's pumping engine.*]

We are indebted to The London Engineer for the engraving and description.

* * * * *

Some romances and exaggerations of which the Pitch Lake, at Trinidad, has been the subject, are corrected by Mr. Albert Cronise, of Rochester, N.Y. Its area, height and distance from the sea have been overestimated, and a volcanic action has been ascribed to it which does not really exist. It is one mile from the landing place, is 138 feet above the sea level, is irregular, approximately round, and has an area of 109 acres. Its surface is a few feet higher than the ground immediately around it, having been lifted up by the pressure from below. The material of the lake is solid to a depth of several feet, except in a few spots in the center, where it remains soft, but usually not hot or boiling. But as the condition of the softest part varies, it may be that it boils sometimes. The surface of the lake is marked by fissures two or three feet wide and slightly depressed spots, all of which are filled with rainwater. In going about one has to pick his way among the larger puddles and jump many of the smaller connecting streams. Each of the hundreds of irregular portions separated by this network of fissures is said to have a slow revolving motion upon a horizontal axis at right angles to a line from the center of the lake, the surface moving toward the circumference. This motion is supposed to be caused by the great daily change in temperature, often amounting to 80 deg., and an unequal upward motion of the mass below, increasing toward the center of the lake. A few patches of shallow earth lying on the pitch, and covered with bushes and small trees, are scattered over the surface of the lake.

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The Gardeners' Chronicle announces that Mr. Fetisoff, an amateur horticulturist at Voronezh, Russia, has achieved what was believed to be impossible, the production of jet black roses. No details of the process have been received.

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