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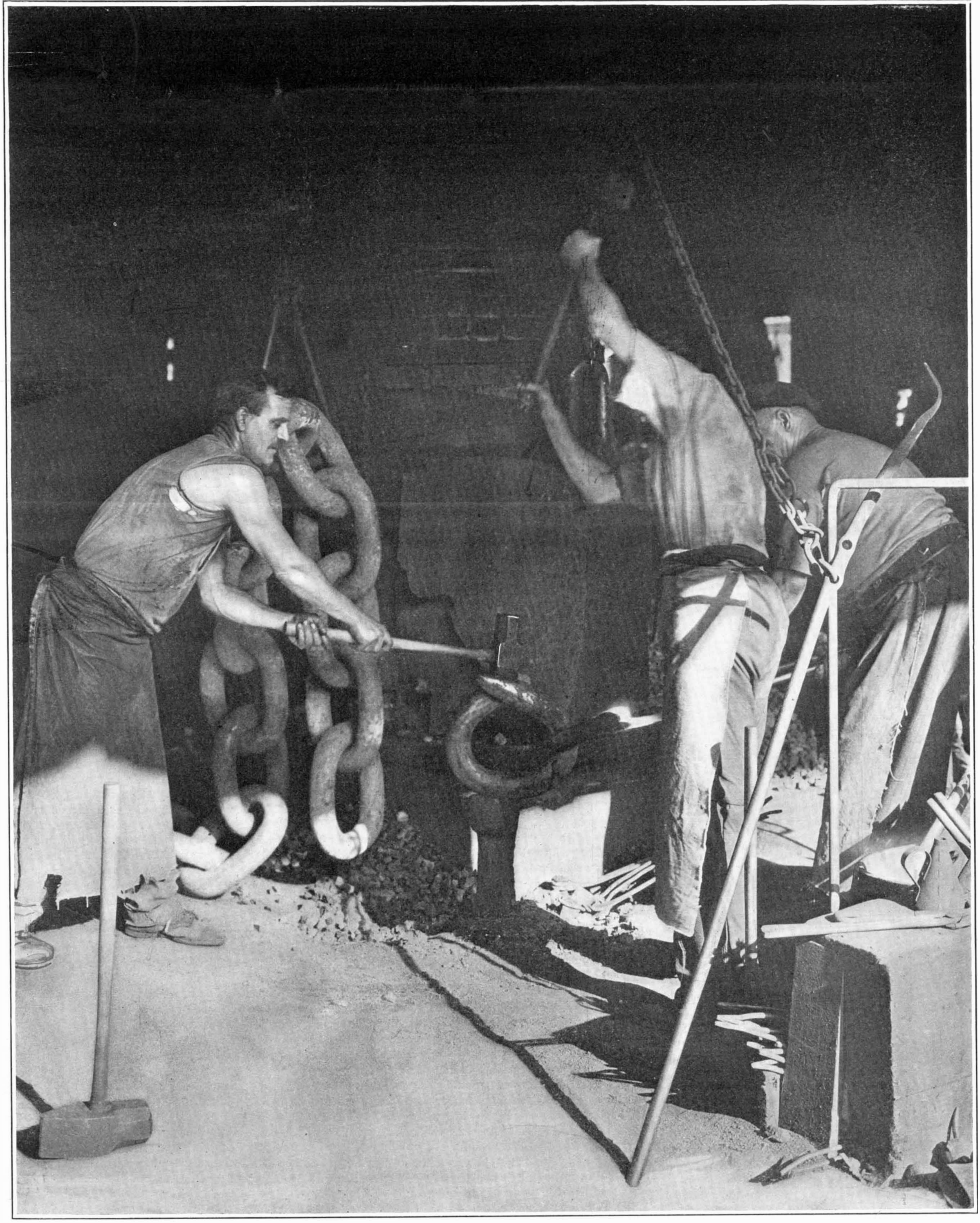


The allusions of story-writers to the forging of a chain are not fiction, for big chains are still forged by hand.

THE MANUFACTURE OF BIG CHAINS.—[See page 392.]

A Few Astronomical Events of the Past Fifty Years*

What Photography and the Spectroscope Have Revealed to Us

By Prof. E. E. Barnard

THE great Civil War between the North and South placed the Dearborn telescope in Chicago. Its original destination was the University of Mississippi, for which it had been ordered before the outbreak of the war, but the consequent impoverishment of the finances of the university prevented the final purchase of the instrument.

In connection with this statement an interesting question might be raised as to what effect this change of destination had on the subsequent history of the telescope. The instrument is famous through the double star work of Burnham and Hough. With it they discovered many of the most interesting of the double star systems. Had there been no war the telescope would have gone South. Would it have found there a Burnham to immortalize it? In all probability no. It has always been an active instrument. Even now, though giant telescopes have risen in the later years of its life that far surpass it in power, it is still an important instrument and not only keeps up the traditions of the older astronomy in the observations of double stars, but dressed in a new suit, as it were, and inspired by new accessories in the able hands of Prof. Fox, it resolutely faces some of the most important problems of the newer astronomy.

But my time will not allow me to dwell upon the career of this telescope which the fortunes of war so greatly affected. Its career has been a brilliant one and really began before the instrument was actually finished, for it was while testing the telescope before its final completion that the younger Clark discovered with it the companion to the great star Sirius. This discovery was of high importance, mainly because it verified a theory that had been held for some time that such a companion star must exist to account for the irregular motion of Sirius through space.

Let me linger here for a moment on some facts connected with this discovery, for they are pertinent now. Four years ago marked the semi-centennial of the finding of this important star. Its period of revolution about Sirius is very close to fifty years, and it has made a complete circuit about the great star since its discovery. The event, therefore, that we celebrate to-day synchronizes with the period of this wonderful star. Thus is the life history of the Dearborn telescope woven in with the motions of some of the stellar systems.

Even when one necessarily leaves out the wonderful work of the spectroscope, it is impossible, in the time allotted me, to more than briefly refer to a few of the remarkable things that have been done in the field of astronomy in the past fifty years. To recognize all of these, or even a considerable portion of them, would require a catalogue of events. Such a dry compilation would be tedious to make and would be far more tedious to listen to. I have, therefore, thought best to confine myself to a recitation of a few of the more interesting facts and to make no attempt to cover the growth of astronomy in general in the time. It is difficult to crowd fifty years of anything into twenty minutes of time!

The advance of astronomy in the last fifty years is due mostly to new methods of research and to increase in optical power, but mainly to new methods and new accessories, all of which, however, depend upon the telescope. It is pleasing to see that the reflecting telescope, which had been relegated to the amateur, has again come into its own. It has, from many points of view, become one of the most important instruments in astronomy. It more readily lends itself to these various accessories of research in some ways than the refractor and it is all supreme for photographing the nebulae. Nowhere is this fact so splendidly shown as at the Solar Observatory of the Carnegie Institution at Mount Wilson in Southern California, where Prof. Hale has erected the great 60-inch reflector, and where he is soon to have in operation a reflecting telescope of 100 inches aperture—a telescope over eight feet in diameter, the largest ever made. One of the most remarkable facts in connection with these two great instruments—along with others in use on Mount Wilson—is that they were made in the shops of the observatory in Pasadena. Some of these instruments, such as the great tower telescope, are unique, and show the wide diversity of Prof. Hale's genius in devising extraordinary and successful means of carrying out modern research.

The work of the great telescopes of the Yerkes and Lick observatories under the direction of Prof. Frost and Prof. Campbell, respectively, has been of the highest importance in the advancement of all branches of astronomy. A large part of the work with these great instruments is spectroscopic and hence out of the reach of my subject to-night. Both these telescopes have contributed greatly to double star astronomy in the hands of Prof. Burnham.

But if we speak of the progress of astronomy in the past fifty years, we must constantly refer to photography, for without it the progress would have been relatively small. It comes down really to a statement of what photography has done for astronomy. Photography as it was when the Dearborn Observatory was young could never have done much for astronomy. It has passed through two periods, the wet and dry processes. It was in the earlier period at that time, where the plate must remain wet throughout the process of making the negative, and was relatively very slow in its action. As the plate must remain wet, long exposures could not be given to overcome the want of sensitiveness. At that time, in the hands of Rutherford, it had pictured the surface of the Moon and had recorded the spots on the Sun. In both these cases there was plenty of light. It had had a try at the stars but with little success. It had attempted to show the great comet of 1858 but had made a failure of it. No one had even hoped that it could register the forms of the fainter nebulae. It had made no promise to the spectroscope, which itself was just beginning to awaken to the marvels of astronomy. In a word, it had not yet risen to be the "hand maid" of all the sciences and to become a science itself.

In the application of photography to almost every branch of astronomy the Harvard College Observatory, under the administration of Prof. E. C. Pickering, has attained to the very highest importance. The collection of photographs of the sky obtained there and at the Harvard Station at Arequipa covers the entire heavens many times over. In the case of the discovery of a nova (and many of the novae have been discovered there) its early history and the actual time of its appearance within close limits are always found on the plates of this one observatory. The entire history of a variable star can be traced back almost from day to day for many years and in some cases for over a quarter of a century. The great increase in the discovery of variable stars, as one example, is due almost entirely to the ease with which every part of the sky can be compared at different times—days or months or years apart—and thus any change in the light of the stars can be noted. It was by this means that Prof. Bailey of the Harvard College Observatory found that some of the great clusters of the sky contained many variable stars, the period of whose light changes was, in most cases, short and regular. In the cluster M 5 most of the variables have a period of about half a day. Their normal state is faint, from which condition they suddenly begin to brighten, like one awakening from sleep, and rise rapidly in an hour's time to their full brightness and then slowly sink to rest again—their active period being only a small part of their entire light change. A large number of these small stars range through about one magnitude, from 14½ to 13½ magnitude. If one watches this cluster on any one night with a powerful telescope he will see some of the stars in it increasing in brightness while others are fading to obscurity, as if in it were scattered a number of fireflies! But what does it all mean and what is the wonderful mechanism in the far depths of space that makes so many of these stars quickly awaken to life and then slowly sink to rest again? And why should their light variations and their periods be so nearly the same? Perhaps the most prolific of these clusters in variable stars are Omega Centauri and M 5. In each of these there are a hundred or more variables known.

Though no new worlds, in the ordinary sense, have been discovered, there have been added to the known worlds at least eight new moons, five to the planet Jupiter, one to Saturn and two to Mars. Five of these are due to the sensitive photographic plate. At least two of them have not yet been seen with the human eye.

The known asteroids, or small planets, which lie in a zone between the orbits of Mars and Jupiter, have increased rapidly until not far from a thousand are now known. The discovery of these small bodies since 1892, when Dr. Max Wolf first found one by the new process, has been almost wholly due to photography. New ones are constantly being found. Sometimes as many as five or six are shown on one plate.

The most interesting of these planets is Eros, whose mean distance is less than that of Mars and which can come within some thirteen millions of miles of the earth. This small planet has already given us a new and accurate value of the solar parallax and is destined at a favorable opposition to give a still more accurate value. A group of these small bodies has been found which have a mean distance greater than that of Jupiter. The smallness of many of these little planets thus found gives the impression that there must be many thousands of them, perhaps hundreds of thousands, ranging all the way from five hundred miles in diameter to the size of grains of sand.

Our knowledge of the Sun has increased tremendously in recent years. This has been due almost entirely to the spectroscope and to its application to the spectroheliograph. But this is being dealt with to-night by a master of the subject.

Perhaps the only department of astronomy not seriously affected by photography is that of the double stars, where the eye at the telescope is still greater than the photographic plate. The progress in double star work is due mainly to visual observations. In late years Aitken, of the Lick Observatory, has achieved remarkable success in this department of the older astronomy. But the sensitive plate is even trying to encroach on the work of the double star observer. The most interesting systems, however, with one or two exceptions, are at present beyond its reach.

The spectroscope has introduced to us a new class of double stars, whose periods in many cases are only a few hours or a few days, and which will never be seen separately with any telescope.

The development of planetary astronomy has not been in keeping with the rapid progress of the science in almost all other directions. This has been due mainly to the fact that, as in the case of the double stars, the magnifying power of the telescopic eyepiece is a necessary factor in the work. The direct image formed by the object glass must be magnified before the components of a close double star can be seen—and the close double stars in general are the most interesting. In the same way the unmagnified image of a planet is so small—even in the largest telescopes—that the surface features either cannot be seen or are so crowded together that they become one on the photograph. To overcome this difficulty the direct image of a planet must be magnified before it falls on the sensitive plate. Much progress has been made in this direction by the use of a secondary enlarging lens which projects an enlarged image of the planet directly on the plate. This process was first used with considerable success by Prof. W. H. Pickering at the temporary station of the Harvard University on Mount Wilson in 1889. Prof. Pickering secured fairly good enlarged images of Saturn and excellent ones of Jupiter at that time with the 13-inch Boyden telescope and a positive eyepiece to enlarge the image. The re advance in planetary photography, however, is due to Lampland at the Lowell Observatory, who has succeeded in making excellent enlarged photographs of the planets—especially of Mars. Similar work has also been carried out at Mount Wilson by Prof. Hale and at the Yerkes Observatory. I think undoubtedly that this class of work, which is of the very highest importance, is going to see its greatest perfection with the reflecting telescope—especially with reflecting telescopes of relatively great focal length supplemented by secondary enlarging mirrors and lenses.

Astronomers with visual telescopes are greatly indebted to color-filter photography, as adapted by Ritchey at the Yerkes Observatory to ordinary refractors, which from their nature were not intended for photography. The splendid photographs of the Moon and of the star clusters made by him with the 40-inch telescope were a great advance over earlier work with regular photographic telescopes.

This simple application of the color-filter and the isochromatic plate has made the 40-inch telescope one of the most important instruments for the determina-

*An address at the semi-centennial of the Dearborn Observatory. Reprinted from *Popular Astronomy*.

tion of the distances of the fixed stars. Photographic parallax work was first done with it by Dr. Frank Schlesinger, who showed the remarkable accuracy that could be obtained by this method. This work with the same instrument has since been carried on successively by Fox, Slocum and Mitchell. Dr. Lee, in conjunction with Prof. Van Biesbroeck, is prosecuting this work at the Yerkes Observatory with the greatest success. Van Maanen has also shown that parallax determinations made with the great 5-foot reflector of the Solar Observatory at Mount Wilson (a regular photographic telescope) are of the very highest accuracy. Astronomers now know quite accurately the distances of a large number of the fixed stars. In this way we find that it is not always the brightest stars that are nearest to us. A considerable percentage of the nearest stars are not visible to the naked eye.

There are perhaps (if we leave out the work of the spectroscope) no astronomical subjects that have been so vastly benefited by photography as the nebulae and comets—the comets and the nebulae, which at times look so much alike and at other times are so wonderfully different, and which have no relationship in reality. Indeed half the life of the Dearborn Observatory would cover most of this class of work. The brighter nebulae were pretty well known before this through the labors of Lord Rosse and others. Nor have we gained much in this line with the great visual telescopes that have come later. This can be said even more emphatically with respect to the comets. It is hardly too much to say that the bigger the telescope the less we have learned about these latter bodies. The comets and the nebulae were two subjects that the eye and the telescope alone could not do a great deal with, especially as the eye was not ordinarily supplemented by a skilled hand to draw what was actually seen. In reality the observer got much pleasure from his work, but he was not able, from the lack of artistic skill, to transmit what he saw to others. Furthermore, his eye lacked the power of seeing certain kinds of light in which the nebulae and comets were specially rich. He did not see all that was to be seen. In this perplexed condition there was given to him another eye that could not only see what he saw but much more, for it was especially sensitive to that other light with which the comets and the nebulae partly shine, and which combined with this power of seeing a hand more skillful than that of any artist that ever lived. This was the photographic plate.

But let us separate these two subjects for a time and deal with them independently. Our common interpreter for both is the photographic plate.

The ordinary photographic plate is sensitive to a region of the spectrum to which the eye is almost blind. Many of the nebulae shine mostly with this light and thus the photograph has a great advantage over the eye, for though seen but dimly they are bright to the photographic plate. Furthermore, the eye becomes wearied after long gazing and one cannot see more by looking longer. The reverse of this holds with the sensitive plate—the longer it looks the more it sees, for its action is cumulative and it may be given many hours exposure, bringing into view, successively, fainter portions of the object. Thus faint nebulosities whose light could never affect the eye, are finally shown as a clear and accurate picture which can be preserved and studied years afterwards for the detection of changes in these bodies. The photographic telescope, especially the portrait lens, has a very much larger field of view than the visual telescope, which is a very important factor in the study of the nebulae or comets and of the Milky Way. Vast masses of diffused and faint nebulous matter, covering large areas of the sky, are thus revealed. Much of this is too feebly luminous for the human eye ever to see. Some of this obscure matter appears to be nearer to us than the distant stars, for it obscures their light. There are other masses of it that seem to be entirely devoid of light whose presence is only known by the blotting out of the light of the stars in their direction. These feeble and widely extended nebulosities are found more especially in connection with the Milky Way. Some of the individual stars of the Pleiades are centers of condensation of what appears to be nebulous matter, and all that region of the sky is covered with streaky masses of feeble light. Are these great beds of luminous matter really gaseous? The spectroscope in recent years has thrown much doubt on some of it, though there are many of them whose gaseous condition it confirms.

We used to think of these nebulae as being at vast distances from us, much beyond the limits of our universe of stars. Photography has shown in many ways that though their distances must be great indeed, they are often well this side of the more distant stars, and that many of them—perhaps most of them—are within our stellar system, and are no farther away than some of the brighter stars.

In looking at the nebulae (such, for instance, as the great nebula of Orion) and at photographs of them, one is impressed with a sense of supreme quiet, where changes must be slow and majestic. But this serene condition would seem to be only apparent. Astronomers have found with the spectroscope that in reality the great nebula of Orion is a seething mass of gaseous matter where there is no rest and over whose vast bulk relative motions of several miles a second are constantly taking place.[1] But the eye, after careful years of watching, sees no change in the face of this sublime object. Thus we had come to the conclusion finally that the nebulae would not change perceptibly in the lifetime of an individual, and this in general seems to be true, but very recently Mr. E. P. Hubble of the Yerkes Observatory has found remarkable changes in the form of another, but insignificant nebula, N.G.C. 2261. This object is the finest example of the comet-like nebulae that exists. The change in its form shown by the photographs is real and the interval required to show it is only half a dozen years. This change in the form of a nebula seems to be unique and is very important.

Add to these facts the enormous radial velocities observed in some of these bodies—especially in the spiral nebulae—where motions of the order of a thousand kilometers per second have been found by Sliphe and others—and we begin to look upon these objects with an awakened interest that is almost sensational.

If these evidences of change stir our emotions, what must we say of the comets where utter transformations may take place in a few hours' time? These bodies, always mysterious, are sometimes the source of wonderful activity. Their stay with us is short and their period of activity is shorter still. Very few comets develop a tail and fewer still become visible to the naked eye. Bright comets are, therefore, always welcome visitors. They are even more remarkable than the nebulae in their preference for the photographic plate. A comet not visible to the naked eye, and which even in the telescope is faint and shows no tail, may present to the sensitive plate a long and elaborate tail full of structure and rapid changes. It may even discard that tail, which can be followed for days by photography as it drifts away, with a speed of many miles a second, and finally dissipates in space. In dealing with comets visually there is not only the lack of artistic skill in drawing what the observer sees—since accurate measurement with respect to a comet's tail as seen with the naked eye is not possible—but there is the further fact that he is blind to much of the light that some comets emit. There are really two sources of light in a comet. One is sunlight reflected to us, the other is light emitted by the comet itself. It is this last light which is peculiarly photographic and which must actuate all the changes in the features of a comet. Halley's comet, at its return in 1910, was in some respects a source of disappointment, though a beautiful and wonderful object to the naked eye. When it once became active, it presented few changes or peculiarities to the photographic plate, and there was little learned from it that would advance our knowledge of the physical condition of these bodies. But only two years before the advent of Halley's comet there appeared a small one (Morehouse's of 1908) which in the telescope was a rather insignificant affair, and which was only feebly visible to the naked eye for about one day. This object has given us a greater knowledge of the physical condition of these bodies than all other comets that have appeared. The photographic plate was especially sensitive to its light, while the eye was not. A bewildering amount of structure was shown in its tail, which was frequently twisted and distorted in its rapid changes. Several times the tail was discarded and new ones formed in a few hours' time. All of these remarkable peculiarities would have been wholly unknown had it not been for the photographic plate. Through the information thus gained from this comet and others that preceded it we have learned that though comets are dependent on the Sun for most of their activity, they really take a larger part in the formation of the tail and the direction of the streamers than we had previously given them credit for. These photographs show that perhaps electrical conditions have much to do with the phenomena of a comet's tail. They also suggest that other forces are at work in the interplanetary spaces than gravity alone.

Photography offers a ready means of determining the brightness of vast numbers of stars. But since the eye is sensitive to yellow and the photographic plate to blue light, and the stars are of all colors, large discrepancies are often found in comparing photographs of the stars with the sky. It is, however, possible to reconcile these differences and Prof. Parkhurst of the Yerkes Observatory and other astronomers are at present engaged in the important task of this reconciliation. Photographic magnitudes can, therefore, now be made strictly comparable with the visual.

Stebbins with his selenium photometer and others with photo-electric devices have been able to measure incredibly small changes in the light of the stars. Even the heat of the stars has been measured by Nichols and others by the delicate methods of research employed to-day.

Time forbids an account of the remarkable investigations of Kapteyn on the star streams of the sky. His work gives us an insight into the makeup of our stellar universe that is new and impressive, and of the utmost importance.

[1]This was long suspected by Vogel, and was proved by Fabry and Buisson by interferometer methods. It has recently been fully confirmed by Frost with the spectrograph.

How to Maintain Concrete Roads and Streets

Concrete roads, like all other types of pavements if they are to give their maximum service, must be properly maintained. The small amount of work and small expense necessary to maintain a well built concrete road in perfect repair should not be made an excuse for delaying the work, but rather an incentive to have it done immediately. Maintenance should be systematic and imperfections given immediate attention.

Cracks in concrete roads occasion no inconvenience whatever to traffic, and traffic will not injure the road at such a place if the crack is filled with tar and covered with sand. The crack should first be cleaned with a stiff wire broom and all loose particles of material removed. If the crack is too narrow to permit cleaning in this manner, it may be cleaned with an air jet from an automobile pump. Tar should then be poured into the crack in sufficient quantity just to flush over the edges and afterwards covered with coarse, dry sand.

Refined coal tar should be used, having a melting point (half inch cube method in water) of about 100 deg. Fahr. The tar should be heated from 225 to 250 deg. Fahr. at the time of application and may be applied by means of a sprinkling can with spray nozzle removed. Sand or screenings, thoroughly dried, graded from 1/8 to 1/4 inch, should be spread over the surface before the tar has cooled.

Where a small hole occurs, due to the displacement of a lump of clay or a piece of coal or wood, it should be thoroughly cleaned and filled with tar and stone chips. If the hole is two or three inches in size, it should first be wiped with the tar and stone chips put in; these are covered with more tar and sand and tamped into place.

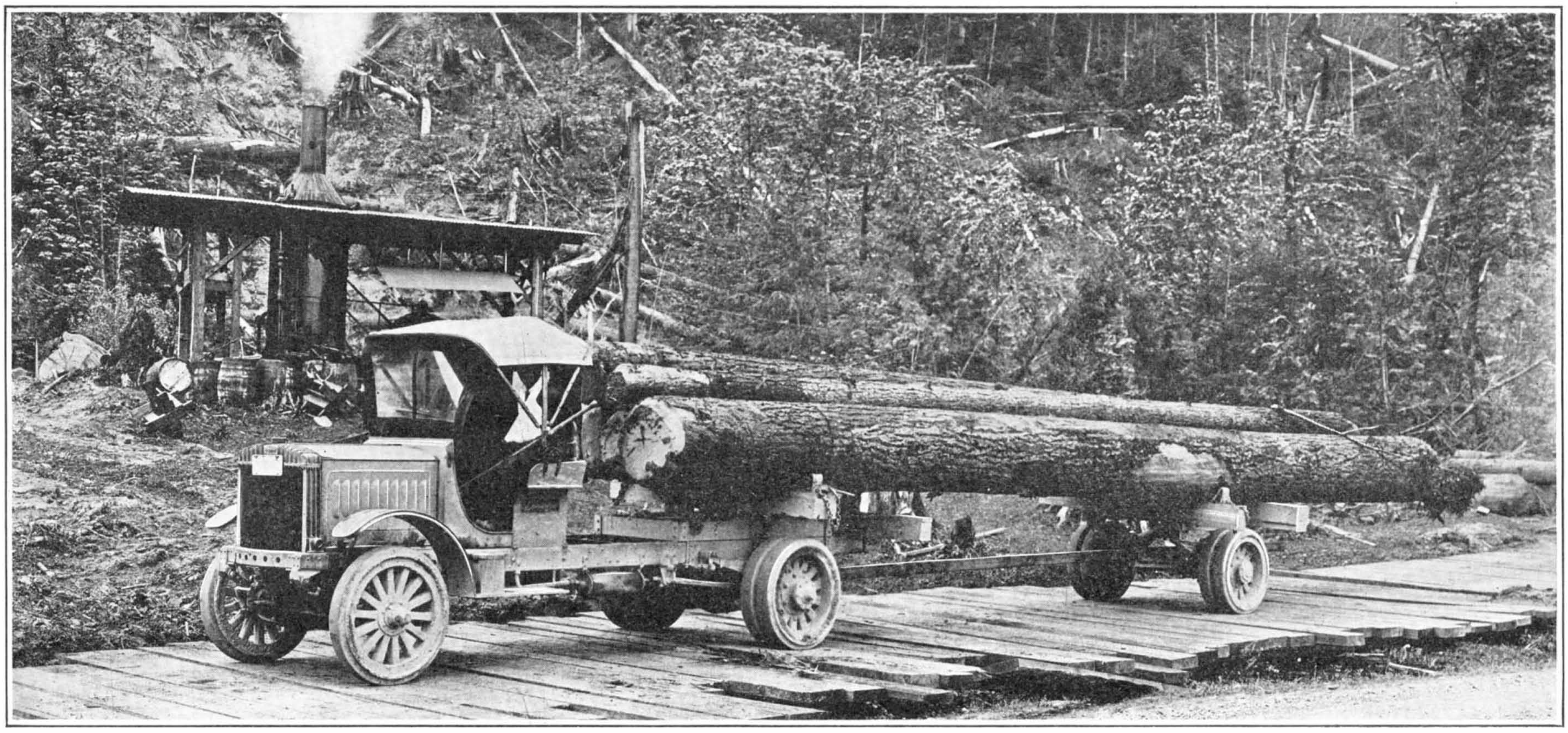
If for any cause the surface of the concrete has scaled and a slight depression formed, it can be coated with tar, stone chips added, these in turn covered with tar and the whole covered with sand and tamped into place.

If through neglect or other causes a hole of any considerable size and depth has formed in the surface of a concrete road, the concrete surrounding the edge should be cut away until the walls are made practically vertical and cut to a depth of at least three inches, or as much deeper as the hole may be. The hole should then be filled with water and stand for a few hours, after which the water should be removed, the sides washed with cement paste and the hole filled with concrete of as nearly the same materials and mixture as that in the original road. The surface should be finished with a wood float and brought to a true shape with the surrounding surface of the concrete, then covered so as to protect it from traffic. This may be done by the use of steel plates or pieces of plank, which should in turn be covered with moist earth or gravel. This will permit traffic to use the repaired portion of the road without injuring the concrete. On a wide street where there is sufficient room a barrel could be placed over the hole and traffic diverted around it.

If it is necessary to cut a hole through the entire thickness of the concrete slab, gravel should be placed in the sub-base and thoroughly rammed, so as to form a compacted base on which the new concrete will rest. Where water has been allowed to stand in such a place, it should be compacted after the water has been removed and just before laying the concrete.

The consistency of the concrete should be sufficiently stiff to require considerable tamping to bring water to the surface so that it may be possible to ram it thoroughly into place.

A new patch should be kept moist for at least four or five days and protected from traffic at least ten days. —*From a circular published by the Portland Cement Association.*



Powerful motor truck, fitted with a trailer, hauling a load of logs approximating 12 tons, containing 2,988 feet, board measure, from the forests to the sawmill.

Where the Motor Truck Has Displaced the Horse

Records Made Hauling Heavy Logs in Washington Forests

Out in the Yellow Fir forests of the State of Washington, motor trucks are making history in the hauling of big and unusually heavy logs. In the logging country of King County, right around Woodinville and Redmond, there is something like 250 million feet of lumber ready for cutting. In this section the Machine Mill Company is working near Woodinville, which is approximately 15 miles from Seattle, is located on the Machias River and also on the Northern Pacific Railroad. The photographs give a good idea of these cuttings. This is a comparatively small mill, cutting anywhere from 80 to 100 thousand feet of lumber a day, practically all of this being Yellow Fir. In size the logs measure anywhere from 16 inches to 6 feet in diameter at the butt, while the top runs anywhere from 14 inches to 5 feet.

To haul these logs on the motor truck owned by this company, a trailer was built to the company's order by a Seattle firm, this consisting of a heavy metal frame work mounted on a pair of regular truck wheels and having the regular rubber tires and the same bearings as the rear wheels of the truck. The trailer is connected to the truck by means of a round reach rod, which has a spring connection at the front and a variable connection at the rear.

On top of both the truck and the trailer are what is called a bunk. This is a kind of heavy wooden support for the log and is arranged with a clip at either side, so that the logs are held from rolling off. When it is desired to dump the logs, these clips can be released.

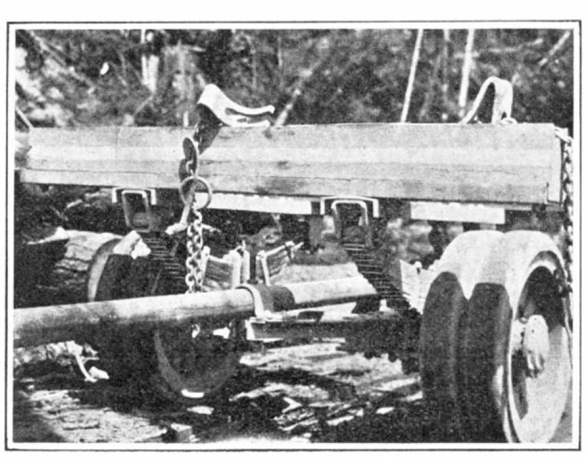
By means of the reach the length is adjusted so that approximately one-third of the weight is carried on the truck and two-thirds on the trailer. In this way it is possible to carry loads up to 12 tons total weight, although the truck chassis is rated at but 4 tons.

The average load runs about 2,600 feet board measure, although one of the illustrations shows almost 3,000 feet board measure have been carried. These figures, of course, are taken from the size of the small end of the log and represents the number of board feet which can be cut from the log, not the actual number of board feet in it. Neither is the bark nor the larger end figured in.

With this truck the timber is hauled from the woods over a made road the first part of the way, and then along a dirt road and again onto a made road at Lake Sammimish. Here it is dumped into the water from the dock edge and hauled by tug-boat through the lake into the Machias River and to the Machias Mill. After cutting, the lumber is shipped to all points in the Northwest by railroad.

The distance is 7½ miles, making the round trip 15 miles. On the average the truck makes 6 round trips with 2,500 feet as the load. However, they have gotten out 15,680 in one day. It is not practical to use teams on such a long haul, and with such heavy loads, so that the Machias Company is now getting out the timber which is not accessible, by either rail or water, and which could not be logged profitably without the use of the truck, or in fact, in any other way.

Despite the poor surface over which the truck is running continuously, including roads made from heavy boards with sharp edges and the poorest kind of dirt roads, also the tremendous loads which are being carried, the truck has shown up very well. At a little over 3,000 miles, the front tires had not yet begun to show wear; the rear tires looked as though they would just about go the guaranteed distance, while the tires on the trailer looked as though they might go 8,000 miles or a little better. This is rather unusual considering that the trailer loads have been more than double the truck load. The driver estimates the gasoline at approximately 4 miles per gallon, unusually high for the work done. The Machias truck is doing about 200 miles to the gallon of lubricating oil, although this also is a driver's estimate, no particularly accurate record being kept of these items.



A home-made trailer, built up from the rear wheels, tires and bearings of a four-ton truck.

Another truck which is doing excellent service for loggers is that operated by Smith & Olson. This company is now cutting timber (also Yellow Fir) in the neighborhood of Redmond, King County, Washington. After cutting, the logs are hauled by truck to railroad sidings, where they are loaded on special cars and shipped to another company which operates a sawmill. This truck operates under very unusual conditions also, the length of haul being only 1 1-10 miles or 2 2-10 to the round trip. This includes one very long and very steep hill, which always gave trouble with horses.

Formerly this company employed a number of four-horse teams which made approximately 5 trips a day when conditions were favorable, and hauled not more than 2,000 board feet per load. In this same work the truck averages 20 trips a day, and has done 21 and 22, hauling an average of 40,000 board feet and has hauled over 42,000. In this work it is replacing four of the four-horse teams, and requires only one driver, therefore replacing three teamsters. The trailer used in this instance is the back portion of an old motor truck which was sawed in two in the middle, the driving sprockets and chains removed, the springs reinforced, steel tires put on the wheels in place of rubber, and a bunk put on top of the framework for the logs to ride upon.

The average log hauled is about 30 feet long and measures 4 feet in diameter at the butt and about 35 inches at the top, although these logs vary all the way from 3 feet to 6 feet in their largest diameter. The average load is about 2,200 feet.

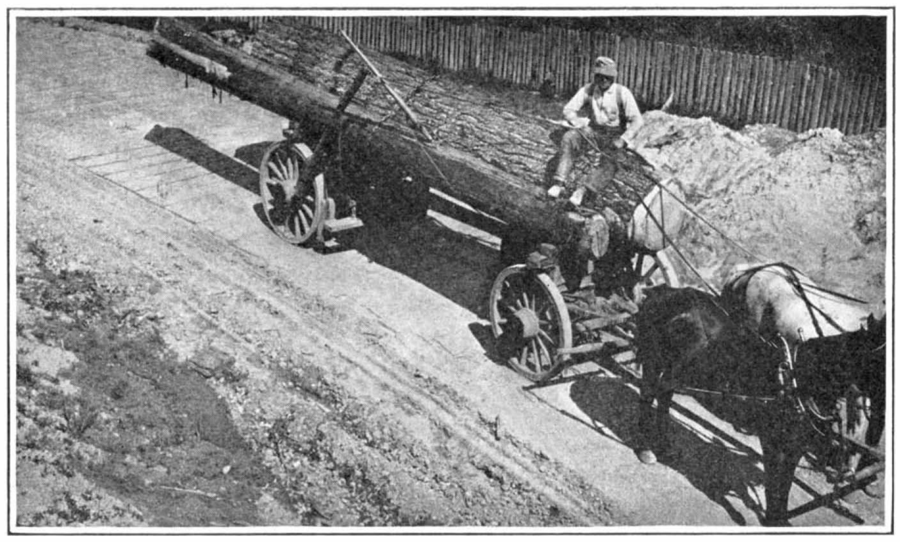
The driver on this truck also estimated his gasoline at 4 miles per gallon, and claimed to be doing 400 miles to the gallon of lubricating oil. No figures are available as to the tires in this instance.

In addition to these two instances described in detail other trucks of the same make are at work in logging service, and they are standing up unusually well under this hard, rough work, and are showing the logging men some things they never dreamed of in the way of a big day's hauling, as well as proving that motor trucks will move logs faster, farther, easier and cheaper, with less extra equipment, than any other power.

A New Portable Accumulator

Some weeks back I gave a few notes respecting some accumulator experiments made. Since then further investigations made show some results so satisfactory as to justify the claim for a new type of secondary storage cell that can be used for electric automobiles, also, now that the price of gasoline is becoming so high and the possibility of obtaining it so increasingly difficult, that the question now rises whether or not now is the time to introduce the electric automobile with a view to its usage as a vehicle for general commercial purposes. Up to the present, except for special private purposes, its use has been barred, from the fact of the heavy

The new way. The motor truck takes a load of 2,600 to 3,000 feet, and makes six fifteen-mile trips a day.



The old way. The horses haul a load of 1,000 feet, and make five trips of a mile and a half a day.

accumulators it has been compelled to carry, amounting to 35 per cent to 42 per cent of weight of vehicle, and with that only capable of 40 to 80 miles run on a 10-mile an hour average, with from 20 to 40 cells, which is, of course, entirely useless for general purposes; the average accumulator, with its enormous weight and limited capacity, being entirely out of the question, for with a discharge capacity of only from 10 to 20 watt-hours discharge per one pound cell (the usual type averaging only 12 to 16 watt hours per pound), very little can be done to produce an electric automobile that will answer commercial purposes. In fact, to-day there is no greater demand than for an accumulator with large capacity and small weight. Given its production, its stinking gasoline rival would be driven out of the field in very short time. Is there any chance of its production? is a question the worker has for long years been trying to answer. Researches made indicate there is, and in a very simple manner, and, to explain matters simply, it will be as well to give a short and brief detail of the chemical action in the ordinary type of storage battery. Here we have positive and negative elements of lead oxide and peroxide in lead antimony grids in an electrolyte of dilute H_2SO_4, which, according to most leading authorities, discharge and charge reactions are as follows:

"Charging" (positive plates):

$$PbSO_4 + H_2SO_4 + 2H_2O + \text{Aqua} = PbO_2 + 2H_2SO_4 + \text{Aqua}.$$

(Negative plates):

$$PbSO_4 + H_2 + \text{Aqua} = Pb + H_2SO_4 + \text{Aqua}.$$

"Discharging" (positive plates):

$$PbO_2 + H_2SO_4 + H_2 + \text{Aq} = PbSO_4 + 2H_2O + \text{Aq}.$$

(Negative plates):

$$Pb + H_2SO_4 + O + \text{Aq} = PbSO_4 + H_2O + \text{Aq}.$$

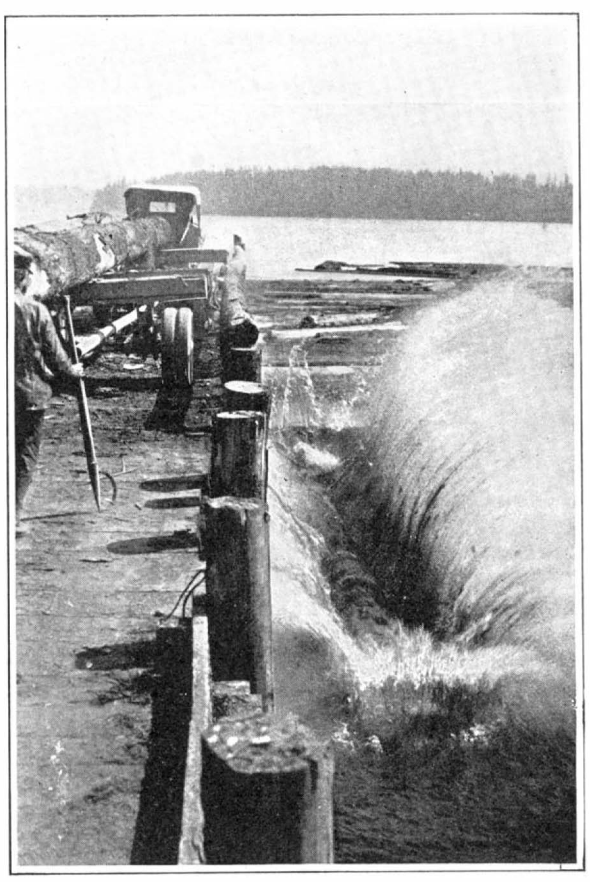
The writer himself does not hold with these claimed reactions, his opinion tending to the formation of plumbic hydride or combination of hydrogen and lead as the real positive element in the fully-charged plate.

All lead storage cells are more or less based on the fundamental reactions quoted, with exception, of course, of the Edison storage battery; and, by the way, can anyone say what the Edison storage battery really does consist of? Everyone, of course, knows the general detail given of nickel perforated rod grids, with oxide of iron and nickel in an electrolyte of caustic potash or soda; but how many know that there are really four types of Edison cell, as may be ascertained from the Edison patents? A brief description may be of interest to our readers:

Edison Patent 2490, 1901.—Positive, oxide of nickel; negative, ferrous oxide. Patent 1050, 1901.—Positive, nickel oxide and flake graphite; negative, ferrous oxide and flake graphite. Patent 20272, 1901.—Positive, nickel hydroxide and nickel oxide; negative, perforated plate of magnesium coated with electrolytic zinc, all in solution of caustic soda, with a later modification cell, as quoted above, and usually given in all authorities, viz., the ferrous and nickel oxide cell in caustic soda, the E.M.F. of all of these varying from 1.4 to 1.1 volts per cell, with a claimed rated discharge of 20 to 30 watt hours per pound weight, in practice never or rarely found, 18 to 21 being about the mark. The detail of the Edison cell has been given, as the Mayfield cell adopts certain features of the Edison in combination with the lead cell, and depends on reaction features common to both.

It will be remembered some weeks back, in speaking of accumulators in some notes given, a suggestion was made respecting the use of iron for charging + plates and $FeSO_4$ in combination with PbO for negative plates, for the purposes of facilities of charging where access to a primary source of supply could not be obtained, it is based on these suggestions that the present cell is developed.

Take an ordinary type lead cell with elements (both positive and negative grids) about an inch less in width than the cell itself: the positive element is of the usual type, but in the cell in the usual electrolyte of dilute sulphuric acid is placed a plate of thin iron, any old metal will do. This is attached by external connection to the positive plate, and the reaction between iron and positive plate is as follows: $Fe + H_2SO_4 = FeSO_4 + H_2H_2 + PbO_2 = PbO + H_2O$. Second phase: $PbO + H_2 = Pb + H_2O$. Third phase: $Pb + H_2 = PbH_2$ (hydrate of lead). If, however, a plate of corrugated or



Dumping logs into the water at the dock.

perforated lead is taken which may be quarter of the thickness of average type plate (thus reducing weight quarter) the plumbic hydrate plate is formed at once without any intermediate phase conditions; but it is best to use an ordinary formed lead oxide plate, from the fact that the gradual reduction of it to the elemental corrosion of metallic lead leaves it in a spongy porous condition, whereby a far larger surface is obtained than from the ordinary plain sheet lead itself, and so, therefore, materially increases its capacity.

The negative element is specially prepared by mixing with litharge an equal portion of ferrous oxide, making into a paste and filling the grid. By making the paste with sulphate of ammonia causes the mass to set quicker and harder, so that it no longer disintegrates when placed in solution. To first form the plate, it should be placed in a very weak solution of sulphuric acid in connection to a plate of iron; the hydrogen (nascent) will reduce the lead oxide (which in the initial stage does not matter, and also the ferrous oxide which is required. The ferrous oxide will reduce to pure metallic iron, which the moment it is raised from the solution will oxidize in the air (as pure metallic iron in presence of moisture immediately oxidizes), the oxidizing of the iron in contact with the reduced plumbic oxide. A catalytic action results which oxidizes the lead, so that it can be used as a negative element. Now whenever the cell is discharged, to change for what is the same thing chemically (convert the negative element to a condition for active service), all that is necessary is to raise the reduced oxide plate from its solution, when the air itself will oxidize the reduced iron and so the lead. Thus the negative plate is air oxidized by raising from its solution and exposing to the air for short time.

The positive element can be easily changed (or chemically converted) in very short time merely by attaching it to a plate of iron (to generate the nascent hydrogen), as iron is a universal article found in some shape or form in every village in every part of the world. One of the most essential constituents of the cell is easily obtained, and sulphuric acid can be obtained at almost every oil store in every civilized land. Thus, to sum up, the Mayfield cell is based on two fundamental features, the hydroxation of the positive plate by contact with metallic iron in any ordinary suitable electrolyte, such as dilute sulphuric acid, and the formation of the negative plate by air oxidization. In the formation of the positive plate there are reactions similar to the Edison cell, and in the negative plate similar to the negative.

As to figures determining the capacity and output of the Mayfield cell, the E.M.F. is the same as the lead; the discharge rate, as far as amperes are concerned, about 20 per cent higher (as there are in the positive plate no disintegrating materials to fear), and so a higher discharge can be permitted.

Theoretically, 1.1 pounds of zinc in sulphuric acid, with perfect depolarizing, should yield 1,000 watt-hours of energy, calling thus 1½ pounds (1.5 pounds). As the atomic weight of zinc is 65 to that of iron as 56, this works out a consumption of iron of about 1 pound for 1,000 watt-hour energy. Thus, total weight of cell works out for 1,000 watt-hour discharge, iron 1 pound, positive or negative elements 5 pounds, electrolyte 4 pounds, cell 1 pound, say 11 pounds; call it 12 pounds; or 80 watt-hours per 1-pound cell, against the Edison's 20 pounds. As the construction of the positive plate can be reduced in thickness by at least three quarters of normal type, a saving at least of 0.25 to 0.5 per cent in weight results.

Ordinary electric vehicles, with accumulator of 16 to 20 hours per 1-pound weight, run (lowest value) thirty miles, as the Mayfield cell has a capacity of 80 watt-hours. This gives $30 \times 4 = 120$ miles, and this, again, by the special formation of positive plate reducing the weight by half, raises the 120 to at least 250 to 300 miles. These are, of course, the highest theoretical figures. Reduce them all, therefore, by one half, and an accumulation is obtained that equals in weight, size, and portability those used in common electric vehicles, will run the same for six to eight times the length of time of ordinary type, and at the same time the cell itself requires no charging from ordinary electric mains or plant, but depends for its charging or chemical changes in its elements, brought about by normal simple chemical changes, produced from material easily found anywhere and everywhere. Any further information shall be pleased to give through our ordinary columns.—*C. Mayfield, in the English Mechanic.*

Bergson's Theory of Intellect and Reality—II*

Is Our Intellect Limited in Its Powers?

By Norman J. Symons

Concluded from SCIENTIFIC AMERICAN SUPPLEMENT No. 2136, Page 371, December 9, 1916

IT is here, however, that Bergson introduces his paradox. Granting, he says, that intellect handles novelty successfully, yet it only does so by representing the new situation as a combination of old familiar elements. It is this which we deny. The chemist may represent novelty and change simply as a rearrangement of old atoms. But this method of dealing with novelty is not typical of our intellect as a whole. The theory in short that intellect, throughout its operations, understands a new situation only by first resolving it into a combination of old elements represents an impossibility in practice and also a poor logical theory. We will take these points in order.

In every department of knowledge education consists above all in grasping certain universal principles and then learning to apply them to all sorts of varied situations. No one has shown this more clearly than Plato in a little dialogue called *Ion*. Whereas Ion says that he is a supreme critic of Homer but cannot interpret any other branch of literature, Plato points out that if his skill rested upon intellectual principles he should be able to apply it not only to Homer but also to other writers. It is the same in all other spheres. The future general learns certain general principles of strategy. His success in the field will depend upon his ability to apply these to ever fresh situations. Intellectuality consists, in short, in just this ability to apply general principles to varied and different situations. But does this imply that if a principle has been applied to one situation, the only possibility of applying it to different situations consists in analyzing all these into the same elements which formed the first, just as you may find the same bricks in the successive toy buildings which a child may erect? The answer is plain. Such an analysis would often be impossible in practice. The literary critic and the general interpret respectively all sorts of pieces of literature and strategical situations. And they do it by extending respectively the same principles to ever fresh circumstances. But the critic certainly never tries in interpreting fresh authors to reduce their works to a mere regrouping of the elements found in a first author; nor does the general have to represent a new strategical situation as a redistribution of the old elements occurring in a former situation, before he can understand it. The man, indeed, who could not apply a general principle to a fresh case without this laborious analysis would not be intelligent; he would be a rule-of-thumb kind of individual. If he were a general the day would have been lost before he began to get under way.

But if this ideal of explanation is impracticable, it is also false in theory. Intellectuality consists, it was said, in the ability to apply a single principle to a number of diverse situations. To do this, beneath the detailed differences of these situations, one must see some element of sameness. Logicians are fond of pointing to the aspect of thought which sees the one in the many, sameness in difference. But this ability to see a single principle involved in all sorts of different applications does not mean, as Bergson implies, that by analysis and artificial manipulation we must represent all the different situations as made up of the same or similar elements. To take this view is to misunderstand the whole nature of intellect; it is to lose sight of the fact that the unity of every concept or principle consists in its ability to unify a real manifold. If before we can extend a single principle to different situations, we must somehow get rid of all their differences, the cardinal function of thought will be destroyed. There will be no longer any differences left in which to see sameness.

Bergson's other point is that if intellect cannot understand real novelty still less can it produce it. It can only put old elements in a new order. It cannot, therefore, compare in this respect with life which creates new wholes only by creating new parts. This distinction also appears false; for intellect creates in just the same sense as life. The novelist who creates a work of fiction owes much to observation and experience. But even so, his finished work cannot be resolved into a mere regrouping of old empirical elements. His imagination creates new situations; and new characters which are not due to a mere fusion of different elements selected from actual personalities. For genius is creative; and it is also the highest form of intellect. In artistic production reason may be suffused with feeling. But the fact that the greatest works of art are the most rational shows that reason is the spring of the artist's activity. To be creative one need not fall back upon the irrational or amorphous.

But even in its more strictly logical operations intellect may be shown to be creative. As we get to know more about objects or situations their meaning expands for us continually. The most noteworthy instance of this is in inference. The conclusion grows out of the premises and it is itself in relation to them something new as was the case with Darwin's famous conclusion which grew out of years of studied observation. Now Bergson maintains that all our intellect can do in the way of producing novelty is to rearrange old pre-existent elements. But if we attend to the actual psychology of inference, is it not absurd to say that inference itself consists in associating a pre-existent conclusion with the premises? Nothing of the sort. There is nothing but an indivisible process of expansion whereby the conclusion, occurring for the first time within consciousness, grows out of the premises. Does not intellect, therefore, in the act of inference come very near to life itself, which, as Bergson says, creates new wholes only by creating also the parts into which they may be analyzed?

In these few remarks we have tried to show, as against Bergson, that intellect is creative like life and can also understand real novelty such as life produces. The other half of Bergson's theory of knowledge may also be shown to be inadequate. When intellect fails us, we are told, we should turn to instinct or intuition to learn the secret of life's operation. Upon this point great emphasis is laid. In at least three different passages of his work, "Creative Evolution," Bergson maintains that instinct is molded on the very form of life and if questioned would give up life's secret. The biologist more especially is counseled to lay aside intellect and fall back upon immediate intuition. As long, says Bergson, as we study life with that intellect which has been designed to grapple with matter, so long shall we tend to reduce life to a dead mechanism, letting its meaning slip between our fingers. To understand life we should install ourselves right within its flow rather than study it from without; and to do this we must renounce intellect and take our stand upon that divining sympathy which is expressed on its cognitive side in what we call instinct or intuition.

Upon this semi-mystical ideal of the interpretation of life Bergson has much to say. But if we are willing to descend from the exalted level upon which he often moves and probe more cautiously beneath the surface we shall see that it is not sufficient to hail instinct triumphantly as the key to life's meaning. Even an advocate of intuition, such as Bergson, may rightly be called upon to show in some detail why, life and intuition both being what they are, the latter is peculiarly adapted to understand the former. But it is in this detailed exposition that he appears to be lacking. It would be instructive to know, for instance, why, life being, in Bergson's opinion, characterized by radical contingency, inpredictability and the production of real novelty, intuition may be supposed to supply the key to its interpretation which intellect is said to lack. In the absence of any such explanation it may be shown that instinct or intuition is fundamentally unfitted to grasp life's essential nature. A comparison will make this clear.

It is the essentially mobile character of life upon which Bergson always insists. "Life in general," he says, "is mobility itself." It is a process constantly welling over upon itself, renewing itself endlessly, always progressive; in short, the very antithesis of the mechanical and stereotyped. Is it not, therefore, strange that he proposes to find in instinct the clue to its interpretation? For while life is opposed to mechanism, instinct, when passing into action, comes so close to automatism that it has been even resolved into compound reflex action. While life again is progressive, societies based upon instinct appear to stand still, incapable of further development. Such is admitted by Bergson to be the case with those admirably ordered but stereotyped societies into which bees or ants form themselves. How, then, can one hope to fathom life, the mobile and progressive, by an appeal to instinct, the immobile and stereotyped? Might it not be said, as against Bergson, who contends that instinct is molded on the very form of life, that where life has taken on the form of instinct it has also taken on something of the nature of a mechanism?

If instinct as a whole thus appears opposed to life, the logical character of the intuitive consciousness which guides instinctive action makes it unfitted to grasp the essential movement of life. For intuition cannot be generalized. The particular intuition which tells the organism how to behave in one situation will not tell it how to react in another and different situation. The same intuition, as Bergson notes, will not extend to a number of different objects. It applies only to one object or situation and often only to a restricted aspect of that. It is far otherwise with the principles which intellect employs. For intellectual principles are universal, one and the same principle being capable of being extended to a variety of different circumstances. This contrast between intuition and intellect brings out at once the logical defects of the former. If intellect working with one and the same concept or principle can interpret a variety of situations, it is because it is capable of seeing an element of sameness amid all the different situations. Conversely, if intuition is forever limited in its application to a single object or situation it is because the consciousness which works with intuition is radically incapable of seeing sameness in different situations. Dealing wholly with the specific and particular, it never attains to a grasp of the universal.

To make this admission is surely to put an end to the contention that in intuition we have an instrument which will reveal to us life's secret. For is not life, as we follow the process of its development in the genealogical tree of evolutionary descent, the very incarnation of the universe? Life, indeed, is the everlasting realization of the ideal of the one in the many. Throwing itself into endless species and individuals, it appears as their many different lives. That is one side of the matter, the aspect of difference and plurality. But there is also the aspect of unity and sameness. If that original vital impetus which first invaded the domain of inert matter has subsequently distributed the force of its impulsion along many and diverse paths so that the history of evolution is symbolized by a branching tree rather than by a chain, it is still one and the same life-force which is always at work. Everywhere we are struck by the infinite diversity of the forms which life has assumed, everywhere by the fact that all individual lives are but modes of the one over-individual universal life. Charged from the outset, as Bergson affirms, with the infinity of the diverse psychical potentialities of the species and individuals which were yet to be, life realized all its latent possibilities by branching in many different directions without sacrificing the unity of its original concentrated form. And if this method of development is essential, if it is the essence of life to develop like a sheaf as Bergson assures us, will it not also be true from a logical standpoint that life's process is the progressive realization of the one through the medium of the many? Life will be the supreme instance of that highest form of the universal which we call by the name of "concrete identity." Such being the logical character of life's development, in intuition which never grasps the universal, the one in the many, we shall never find the key to that process of life which, Bergson assures us, is life itself.

From this point we may return once again to intellect. Would it not seem that it is intellect and not intuition which is molded on the very form of life? If life develops essentially as a one-in-many, does not intellect which expands itself in experience into a thousand different concepts, while still remaining self-identical, do the same? And is not each of those principles into which our intellect progressively distills its being an illustration of life's nature; for each is a unity which embraces a real manifold even as life itself does. In intellect indeed we seem to have a prolongation in clear consciousness of the sub-conscious logic of life's

*Queens Quarterly.

essential process. Like life which, Bergson shows us, produces the same organs by different means, our intellect is marked by its ability to devise, upon occasion, fresh means to encompass the same ends. And if those infinitely subtle adaptations which the history of evolution exhibits cannot be explained mechanically but are due to a peculiar psychic force called life, that force seems in all respects nearer to intelligence than to instinct. We may grant that the intelligence which is life moves for the most part in the realm of the subconscious, that it does not in the lower reaches of evolution understand its own process. But in so far as it has explicitly evolved in man a self-conscious intellect it has also evolved a key to the interpretation of itself at large. If evolution has culminated in the intellect of man and if life is the mainspring of evolution, the whole history of organic development appears as a prolonged effort of life to supply a key to its own interpretation whereby it will stand clearly revealed to itself.

Our conclusion, therefore, is the opposite of that which Bergson advocates. It is intellect which is molded upon life and which, revealing to us the universal, the one-in-many, will also reveal to us the essential logic of life's self-development in organization. In the stereotyped and narrow character of instinct we shall never find a clue to life's nature. If Bergson's main contention thus appears mistaken, is there no value in his work? To answer this question we should first make certain distinctions and abstractions in relation to his contentions. Let us set aside his false conception of intellect as merely analytic, and of life as purely contingent, and abstract also from his belief that it is life in particular which intellect cannot comprehend. We shall then see that his contention, when separated from all which makes it unique and specific, is reducible to the position that there are some aspects of reality which our understanding cannot truly comprehend. With this statement, in its purely general form, we cordially agree. In so far, also, as Bergson's insistence upon intuition may be taken as meaning that intellect must be supplemented by other forms of consciousness, there again we must agree. We feel that nothing less than man's whole consciousness is needed to comprehend the problems of existence. Nor is this untrue in relation to the specific study of life. We have insisted that intellect is competent to reveal to us life's essential process, the logic which underlies its operations. But there is more in a thing than its essence, and there is more than logic in life. Feeling and emotion and sympathy may all find a place in this study. It is thus that we should understand Bergson's mistaken attempt to replace intellect by its mere opposite.

Nitrogen Oxides From Ammonia for the Lead Chamber Process*

It is rather remarkable that some details of processes for the oxidation of nitrogen, worked out in Germany, have been published since the beginning of the war. When the war broke out all the saltpeter available in Germany was requisitioned for the use of explosive works, which, of course, want nitric acid. But nitric acid is indispensable as well for the manufacture of sulphuric acid on the old lead chamber method, which was still the most extensively used method in Germany. Deprived of one of their raw materials, saltpeter, those works would have had to shut down unless they could make nitric acid without using saltpeter. Two other ways of making nitric acid or nitrogen oxides had been open for some time. The one, about which much has been written, is the oxidation of atmospheric nitrogen with the aid of the high temperature of the electric arc; that method has been successfully developed, but arcs are current wasters, and thus nitric acid and nitrolim industries only prosper in districts of cheap hydro-electric power. The other method, generally identified in recent decades with the name of Ostwald, was the oxidation of ammonia. The principle was well understood, technical applications of several processes were spoken of, but particulars were not published. In *Metall und Erz* of January 22, 1916, however, the director of some sulphuric acid works at Stolberg, near Aachen, in Rhenish Prussia, gave some particulars of the method he had introduced in his works. The first point of interest is that the gaseous ammonia is burnt by contact with red-hot platinum, and that the nitric oxide and other nitrogen oxides formed are sent directly into the lead chambers, there to effect the oxidation of the sulphur dioxide (from the roasting furnace) to sulphuric acid. Thus nitric acid is, in the new method, not first made and decomposed again into the oxides to oxidize the SO_2 in the chambers, but the nitrogen oxides resulting from the combustion of ammonia are at once utilized for the oxidation. The particular process applied is that of Frank and Caro. Mr. Schüphaus, who is an engineer, describes first the original plant, and then some improvements which were adopted in his works.

In the original plant the raw material started with was ammonia liquor, which was supplied in cylindrical receivers on trucks. The liquor was run into tanks—old boilers—fixed in the ground below the works flooring. From these tanks the liquor was forced by compressed air into mixing tanks in which the liquor and so much milk of lime were mixed under lively stirring that the liquid contained 2 or 3 per cent of ammonia. This liquid was then pressed into the top of a column apparatus or dephlegmator, consisting of six compartments, while steam at 0.3 atmosphere pressure entered into the bottom compartment. The gaseous ammonia escaped above, while the water flowed back into the dephlegmator. The gas flowed through two coolers in series containing a large number of vertical iron pipes, the ammonia passing through the pipes. The gaseous ammonia then entered two vessels half full of caustic soda lye, to be washed and freed of sulphureted hydrogen, phenol and other impurities; a false bottom separated the gas current in these vessels into a large number of fine gas jets, to secure intimate contact with the caustic soda. Leaving these washers, the gas was sent into a gas holder of small capacity, 5 cubic meters. The whole arrangements, liquor feed, steam pressure, cooling, etc., were so regulated that the liquid should boil only in the lower compartment of the dephlegmator, not in the top compartment, that water vapor should be condensed in the first cooler, but the temperature remain sufficiently high there to facilitate the evaporation of the ammonia, and that the gas holder should serve also as a pressure register to balance fluctuations in the ammonia pressure.

From the gas holder the gaseous ammonia was, and is, sent into the "combustion elements" apparatus, of which three were installed for the lead chambers of works producing 10,000 tons of a sulphuric acid of 60 per cent per year. Ammonia and air are mixed in correct proportions (secured by fans and by diaphragms and valves in the lines) and sent into the mixing chamber of a combustion unit, passing first through several layers of iron wire netting, which is provided to make the mixture uniform; the gases then strike the horizontal net of platinum gauze which acts as catalyst. This gauze is exceedingly fine, almost like a silk texture, and is held on either side by a pair of brass bars, silvered on their surface; the brass bars are connected with the current leads, which introduce currents of 125 or 150 amperes at 20 or 25 volts. At the temperature of the dark-red glow of the platinum (about 700 deg. Cent.) the ammonia is completely burnt to nitric oxide and water. The gases pass upward into a pyramidical hood of iron (lined inside with aluminium), and through an aluminium elbow into the pipe (common to the three units) entering the lead chambers. The aluminium lining is required lest iron oxide drop down upon the platinum gauze. The pipes are of iron, the fans of aluminium. The flanges in the ammonia conduits are packed with rubber, or oil and asbestos, or with a material called klingert; to keep the top of the dephlegmator gas-tight, a layer of 5 millimeters thickness of a very stiff paste of minium and oil is applied. To prevent saturation of the water of the gas holder with ammonia, oil is poured on the water; a slight percentage of ammonia in the water is desirable to prevent freezing; the oil also avoids losses of ammonia by evaporation from the annular space between the bell and the body of the gas holder. In the combustion apparatus the space just below the platinum gauze is water-jacketed, lest any ammonia should be decomposed by the heat before being burnt; otherwise nitrogen would escape unoxidized.

So far the original plant. There was trouble with the lime, which clogged the ports in the dephlegmator, and for this and for other reasons liquid ammonia of 25 per cent was substituted as raw material for the crude liquor. The plant was thus much simplified, the mixing tanks and the soda washers, as well as the settling tanks (in which the cooling water was cooled and clarified for re-use), becoming dispensable. The attendance was minimized, moreover, the ammonia feed alone requiring occasional adjustment by the man looking after the lead chamber. The Berlin-Anhaltische-Maschinenbau-A.G.—which manufactures and supplies the whole apparatus above described—has recently added a valve which automatically controls the bell of the gas holder, so that there is no need for any attendance at all. The use of liquid ammonia has another very essential advantage. When the liquor was used, the dephlegmator could deal with 5 cubic meters of liquid per 25 hours, which meant that the 2.5 per cent liquor could yield 125 kilogrammes of gaseous ammonia per day. By starting with liquid ammonia of 25 per cent the capacity was raised tenfold, to 1,250 kilogrammes. Now that amount of ammonia suffices to keep several lead chamber systems going, and one combustion unit has proved sufficient for producing 10,000 tons per annum of sulphuric acid of 60 per cent.

The nitrogen oxides were first introduced into the connection between the Glover tower and the main chamber, in order to become well mixed with the sulphurous oxides. With this arrangement, however, a long iron pipe (9 meters in length) was required for the nitric oxide, and the iron was attacked and stoppages arose. To avoid this the combustion units are now mounted close to the main lead chamber, and the iron pipe from the units ends in an earthenware pipe, which penetrates by about a foot into the chamber, being inclined, so that any condensed liquid will not come in contact with the walls of the chamber. Trouble has occasionally arisen from impurities in the liquid ammonia; although this material is very good on the whole, there is sometimes a little spongy iron oxide or iron hydroxide in it, which clogs the ports in the dephlegmator. In such a case the dephlegmator has to be taken to pieces, which causes an interruption of several hours. But as one dephlegmator is sufficient, such contingencies need not be feared when two such apparatus are installed.

For some reason the works were also disturbed by temporary failures of the electric current. Then the fans would stop, the gases from the lead chamber would rush back and would poison the platinum gauze, which had to be thoroughly cleaned with hot hydrochloric acid to become catalytically effective again. To obviate this disturbance a flap valve has been inserted into the air line; this valve (of thin sheet iron) floats as long as the fan is going and is sending air into the combustion chamber; when the fan stops, the valve closes, but the ammonia feed continues and keeps back the gases from the lead chamber. To meet other failures part of the nitrogen oxides is sent through a small tower apparatus in which sufficient nitric acid is prepared to help the plant over periods of disturbance.

Mr. Schüphaus mentions several other technical points of interest. As regards the economy of the process, he merely states that the amount of nitrogen wanted in the new process keeps within the limits of the nitrogen consumption on the former nitric acid working. Things may not be altogether satisfactory and as simple as they appear; but it is interesting to have such an account on the working of a new process. We hope to be able to give, later on, further particulars of the results obtained.

*Engineering.

Alloys for Thin Ornamental Castings

The alloys used in the making of thin ornamental castings for cash registers were described in a paper by R. S. B. Wallace, National Cash Register Company, presented to the American Institute of Metals at its meeting at Cleveland. Two classes of alloys are used, one for bronze finish parts and one for nickel-plated parts. For bronze finish, the alloy is:

Copper	86.0 per cent
Tin	1.5 per cent
Lead	11.0 per cent
Zinc	1.5 per cent

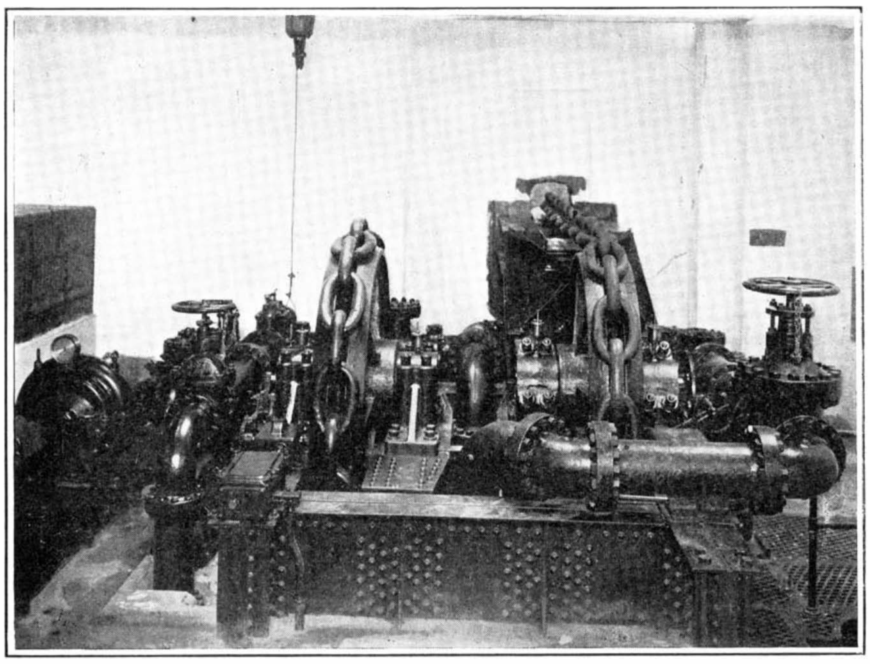
1/20 oz. of manganese-copper per lb. of copper.

For the nicked-plated parts the alloy is:

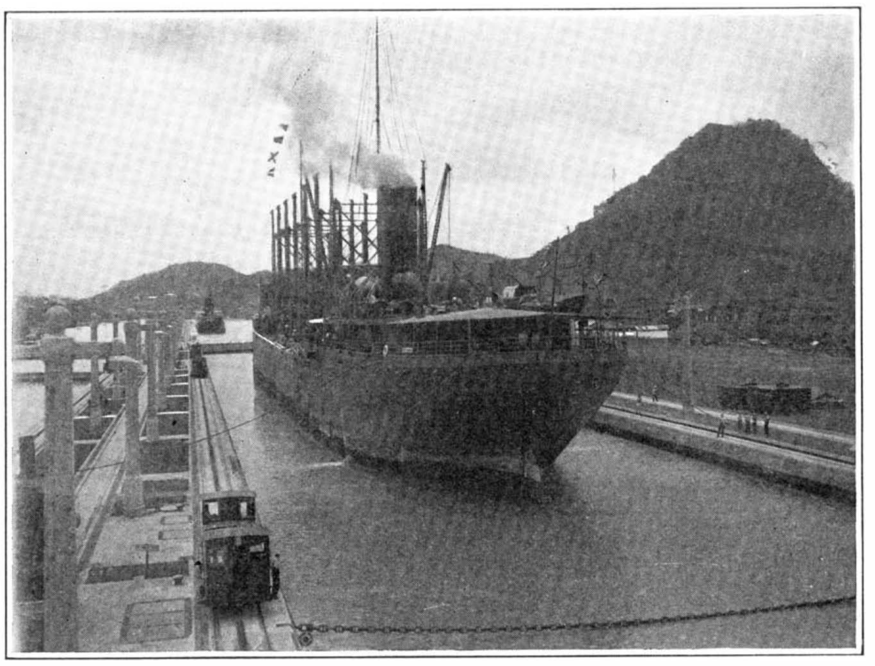
Copper	70.5 per cent
Zinc	26.5 per cent
Lead	2.0 per cent
Tin	1.0 per cent

In all mixtures the zinc, tin and lead are made into alloys which reduce the cost of weighing the necessary metals and eliminate the chances of error.

In melting the metal it must at all times be covered with charcoal. After the crucible has been placed in the furnace and the necessary coke around it, a few pounds of gates or scrap metal of the same composition required in the heat are placed in the bottom of the crucible, and the copper is placed across the top of the crucible at the same time. By the time the gates are melted the copper is ready to be placed in the crucible and as the copper melts it falls into the bath of metal made by the melting of the gates. After the metal has become properly melted the necessary alloy is added in proportion to the amount of copper.—*The Iron Age.*



Guard chain operating machinery at the Panama Canal.



A lock in the Panama Canal, showing guard chain.

The Manufacture of Big Chains

An Important Product That Is Still Made by Hand

In this day of machine manufacture, it will perhaps surprise some to learn that the making of big chains is largely, if not entirely, confined to methods dependent on hand labor. There are probably no big chains being made in the United States by the use of machinery. There are various appliances employed, but these are hand operated or personally controlled. Thus, the sledge hammer is an appliance, but it is swung by the smith. The steam hammer may also be employed, but the workman must be attentive to details. This situation appears to be due to two things. First, as the proverbial expression has it, a chain is no stronger than the weakest of its links. A hand-made chain is naturally made link by link. If the workmen are not only careful, but conscientious as to details, there is considerable opportunity for attention equivalent to continuous inspection. The making of big chains is largely an old-time blacksmith's job. The use of the steam hammer is perhaps the nearest approach to a purely machine operation. Doubtless, from this beginning the big chain will tend to become more and more a machine-made article. Second, it is understood that the adoption of machine methods in part would probably precipitate labor troubles.

Chains of smaller sizes, that is, chains of 1¼-inch size down, are frequently machine-made. Chains from the 2-inch size up, that is, chains used for mooring big naval and commercial vessels, are well-nigh exclusively made by hand apparently all over the world.

The size of a chain is measured, not by the length or breadth of the link, but the diameter of the round bar used in its manufacture. A chain may be made up of links whose welds are on the side, or of those whose welds are at one end. The units are *side-weld links* or *end-weld links*. Further, the links may be classed as *open links* or *stud links*. In the former case, the link is simply an elliptical or oval ring; in the latter, a cross-piece—the stud—is inserted in the opening. End-weld stud links are approved units for a high-class chain; so also are side-weld, open links.

Apparently, the trend of American opinion is to favor the link made with a stud and an end weld. English practice has hitherto rather favored the side weld, but now seems to show a disposition to accept the weld at the end. It is understood that 4½-inch chain has been made in England with links having end welds.

An American student of naval chains, Mr. John E. Otterson, favors the end weld for a variety of reasons. (1) He thinks that with this type of weld the stresses during use are more evenly distributed than with the side weld variety. And he believes that if the link should suffer deformation the stresses would continue to be better distributed. (2) He considers that the *form* of the end-weld link tends to resist a break in the plane of the weld. (3) Finally, he prefers the end-weld because chains of this type are more easily made.

In approved practice, the end weld is made by overlapping wedge-shaped terminals in such way that the plane of the weld lies in the long axis of the link.

A typical three-inch chain will be made up of links each containing 37 inches of bar. Such a piece of metal weighs about seventy-eight pounds. This piece of bar has its ends square, and is perfectly straight when the chainmaker receives it. He proceeds to heat now one end, now the other, in a coke fire. This heating up process is continued for about a quarter of an hour, an object of the workman being to have the hottest region at the half-way point. A special bending device is now used to bend the bar to the form of a U. The apparatus consists in part of a mandrel having the required U-shape, and secured to a flat slab. A long lever is pivoted at the turn of the mandrel, but on top of it, as the slab lies horizontal. This lever may be swung then in a horizontal plane. It is prolonged beyond the pivot and provided with a roller. The bar is laid against one side of the U mandrel in such way that it lies between the roller and the mandrel edge. The bar may be held against the mandrel by means of a screw operated by a lever. The bending operation is accomplished by securing the bar firmly against the mandrel and swinging the lever in the proper direction to make the roller bear against the bar and tend to roll on it toward the free end. The result is that the heated bar, with its softest spots at its center, will readily be bent round the mandrel. A couple of men may be required for this operation. Before reheating, the ends are "thrown in" slightly by hammering over the anvil. The bending, including this detail, occupies about two minutes. A second heating operation, occupying about three minutes, is now carried out. The ends of the bar are scarfed by the hammer, two minutes being required. When this work is completed we shall have a link open at one end and needing its sides bent more toward each other. A third heating is now given the work, the time required being about three minutes. The link is now closed in one minute's time, but the weld is not made. A fourth heating is now carried out, requiring two minutes, and the weld made, requiring also two minutes. If a stud is to be added, it could be set now without a further heating. It is, however, easier to do the work if heat is first applied. The setting of the stud is accomplished by holding the link so as to rest on one of its sides and then striking the opposite side. It is said that the heaviest blows of all are required in the setting of the stud.

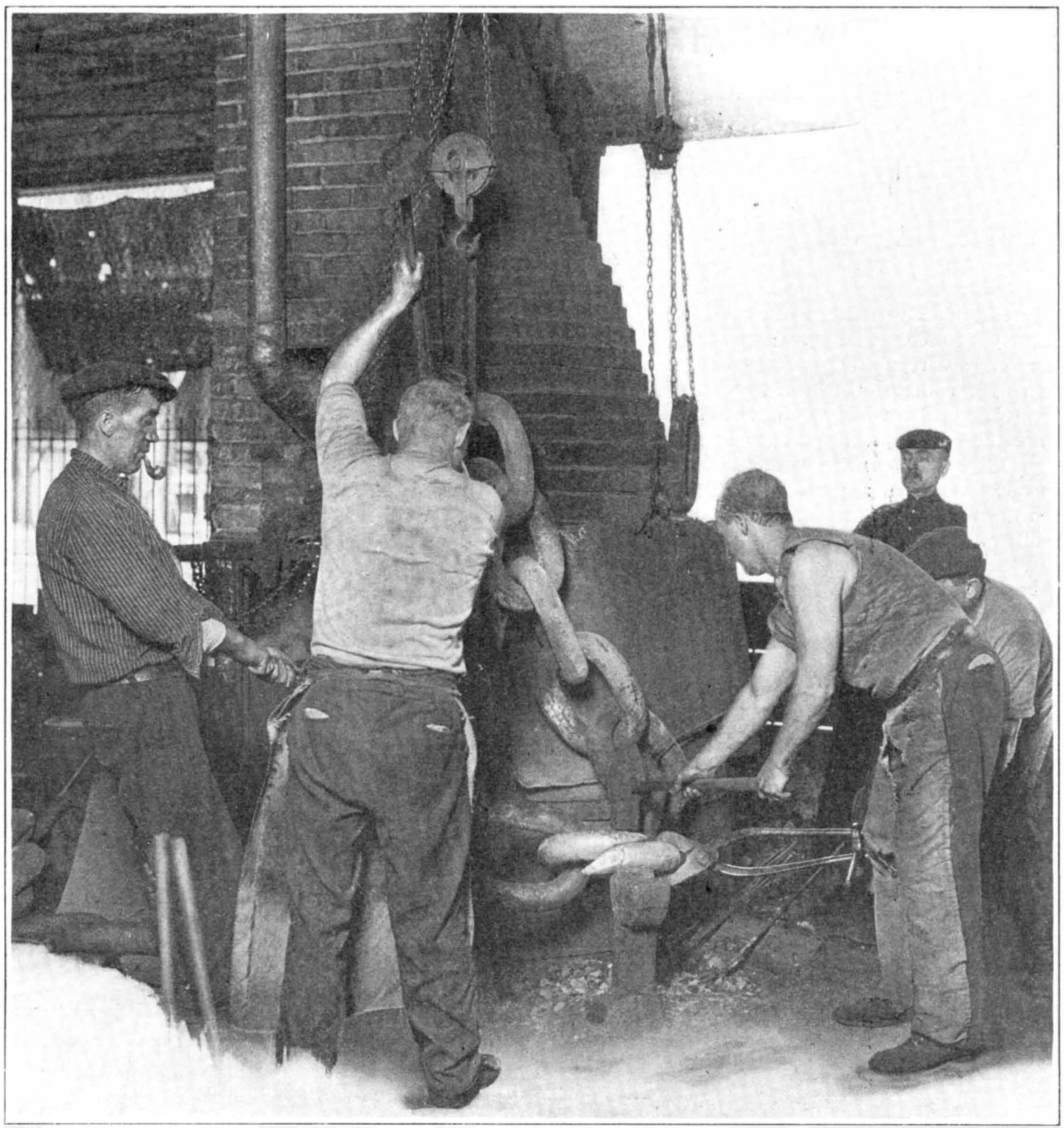
The heating of the work is, of course, very important. This is especially so when the heating for the weld is done, a temperature of about 1,700 deg. Fahr. being required. It seems that the custom has prevailed of doing all the heating with a single coke fire, and there is no question but that this time-honored method results in abundance of heat. At the same time the use of a single fire results in waste of time for some of the men in the crew. It has therefore been proposed to employ a central oil-fired furnace, in which the first and longest heating shall be done. In this furnace several bars could be heating simultaneously.

Experiments, having in view the use of the oil flame, were conducted in one of the New England States. In the earlier attempts the link was suspended so as to extend down into the body of the small fire chamber, but the result was damaged metal. This difficulty seems to have arisen because of insufficient realization of the precise way in which the combustion went on in an oil furnace. Ordinarily, a large chamber is required to accommodate the flames of combustion. Wherever oxygen and the fuel gases are combining, there we have a region in which highly heated ferrous metal is likely to suffer oxidation. To avoid this result it is necessary to put the work far enough away to provide a sufficient intervening space for complete combustion, or else to cut the work off entirely from contact with the flames. The former alternative was tried, it seems, and found effective. That is to say, the opening through which the link was let down was surrounded by a kind of inclosing wall of brick which was carried up a space. In this way was provided a heating chamber through which the highly heated flames went, but only after they had pretty well finished with their activity of combining with oxygen. Certain comparative tests of oil and coke heated links were made. Five oil-heated links were tested to destruction, and also five coke-heated links, all being of three-inch iron. The result was somewhat in favor of the coke-heated links. The average breaking stress of the oil-heated links was 528,796 pounds, and of the coke heated, 541,356 pounds.

It is quite usual to set the stud by hand, as already described. It has been recommended, however, that the hydraulic press will give better results, the link being held in suitable dies, as this method permits a certain amount of exact standardization of the external form of the link. This is desirable, since identical behavior in use may then be depended upon with greater reason in cases where the chain has to pass over sheaves and the like. The use of press and dies would constitute another step in the direction of mechanical manufacture.

The heat treatment of chains is undoubtedly important. Apparently, however, this matter has not been given adequate attention. It seems that it is not customary—at least not customary in the United States—to heat-treat big chains prior to putting them into service. It is the practice, however, to give a heat treatment after the lapse of six or twelve months. Undoubtedly, the effect of the welding heat, combined with the other heats given in manufacture, tends to produce enlarged crystals, and a concomitant weakening of the metal. The mechanical working due to the use of the sledge has more or less beneficial result; but this must be unevenly distributed, and probably does not penetrate far. In general, mechanical treatment should not be depended upon to break up the large crystals and produce an even, fine texture, and the associated strength. Heat treatment is the one thing which may be so managed as to produce even effects throughout the mass.

The Panama Canal has in use a large total amount of big chain. Lengths are loosely stretched across the lock chambers for the purpose of preventing injury in case a ship is uncontrollably carried on toward the lock gates. The recommendation was made with reference to these chains to the general effect that subsequently to the strains consequent upon the performance of such duty the chain involved should be given a heat treatment. It is understood that the Boston Navy Yard now has a large special furnace, by means of which



Starting to weld a link in a big chain cable.

chains are heat-treated prior to service. Undoubtedly, such chains are initially stronger than they would otherwise be.

However, Mr. E. B. Morgan, in effect, claims that use often produces a condition in the metal of the link which leads to failure, and which it is not possible to reach or correct by means of heat treatment. Apparently, his studies were confined to quite small chains, but this should not hinder us from weighing his conclusions. He found, it seems, that chains sometimes failed suddenly upon occasions when the load was far below the rated strength. It appears also that upon examination these sudden failures were generally discovered to be due not to poor weld, nor to one in which the metal had "burnt." Nor were many of these failures to be ascribed to the weakening of some part of a link because of the effects of abrasion. He came to the conclusion that the failures were, in general, due to overstresses—not at the time of failure, but prior to it. He thinks that the fibers are more or less broken up by loads in excess of the elastic limit. The cure is, then, to use only the safe loads that may be imposed without thus overstressing the metal. He finds that such loads for hand-made wrought-iron chain made up of short links should be less than general practice permits. Apparently, he thinks the loads should be decidedly less than 14 per cent of the breaking strength.

The material which goes into the best chains is some form of iron rather than steel. Apparently, *puddled iron* is a favorite material. However, it is recommended that the iron should not be refined to the point where it has almost become a puddled steel. Such ultra refinement is understood to produce a tendency to brittleness. Norway or Swedish iron is also considered good material. Iron, it appears, is preferred to steel, partly, at least, because it is thought to be capable of a better weld.

It would seem that there is no satisfactory method of ascertaining whether the welds are sufficiently perfect and that the chain contains no flaws other than the proof testing of the chain. There is a difficulty here. If the proof test be made severe, with the object of making sure, we are apt to overstrain the metal at some points. If, as Mr. Morgan thinks, we are unable to restore by heat treatment material which has been stressed beyond the elastic limit, then the recommendation to anneal after proof testing would seem to fall short of attaining the result of nullifying the ill effects of the proof test. We are, at this juncture, at a point where experts have perhaps not come to a complete agreement. A gentleman who had the responsibility of inspecting chain for the Panama Canal says: "It would be safe practice to anneal chains after proof stresses have been applied, and in order to maintain a state of toughness, the annealing should be repeated after there have been overstraining loads on the chain." Another expert says: "It is plainly seen that the commonly used safe loads on chain are such as to strain the fibers to the elastic limit. This is why chains get brittle and break. This is why they need frequent annealing." Both these experts seem to rely on annealing as a cure for overstraining. Mr. Morgan questions this.

The fender chains at Panama are used on the upstream side of the upper guard gates, and of the intermediate and safety gates of the two upper lock chambers of the Gatun locks; and at similar situations at the Pedro Miguel and Miraflores locks. There are at the lower end of each flight of locks certain guard gates which miter in an opposite direction from the regular gates. The duty of these gates is to keep water from entering the chamber between them and the operating ites below when water is being pumped from this chamber in order to make possible the repair or painting of the lower lock gates. Fender chains are also used in front of these guard gates. For the whole canal, twenty-four fender chains are required.

The chains are stretched from the top of one wall to the top of the wall opposite. A groove is arranged in the bottom of the lock chambers to receive the chain when it is fully slacked. Some such disposal of the chain is necessary or advisable when a ship needs to pass. After the vessel has gone by, the chain is drawn up to normal position. The lifting and lowering is accomplished by machinery, the necessary apparatus being installed in suitable chambers or wells arranged in the side walls of the lock chambers. A typical machine consists in part of a system of cylinders and a train of sheaves. The cylinder device is hydraulically operated. One foot of movement of the cylinder apparatus corresponds to four feet by the chain. There are two cylinders and one plunger. These are arranged vertically. A forty-inch cylinder is secured in a fixed position. So also is a twenty-five-inch plunger. Thus, there are two parts out of the three in immovable positions. The other cylinder, thirty-eight inches in diameter, moves up and down within the fixed cylinder and over the fixed plunger. By pumping water into the larger cylinder, the smaller one is forced downwards. The effect of this movement is to lift the chain in the lock chamber. By forcing water into the smaller or movable cylinder, it is elevated. The result is that chain is paid out. The stroke is 21½ feet. As there are two machines working simultaneously upon opposite ends of one chain, it is possible to shorten or lengthen a chain 192 feet.

These machines operate in such a way as to provide an accumulating resistance in case they are borne against by a ship. This is necessary in order to prevent damage to chain and vessel which would undoubtedly occur if the chain were to rigidly resist at the beginning with its full strength.

What Is Karaya Gum?

DURING the last ten years a constantly increasing amount of this little-known gum has been imported into this country from India. It is known in the trade as karaya or kadaya gum, and is used extensively as a substitute for tragacanth. For a long time its botanical origin was in doubt, but it is now definitely known that it is the product of *Sterculia urens* Roxb., a tree of the cola nut family of plants. It has an extensive range of growth in northwestern India, Assam, Behar, the east and west Peninsula and in Ceylon. The tree is said to be very common in Konken, in the Bombay Presidency, and that Khandesh supplies the largest quantities of the gum to the Bombay markets.

Sterculia urens is a fine tree, forty feet or upward in height, with five-lobed, hand-shaped leaves, which yield a mucilaginous substance. The seeds, which are enclosed in a dry pod covered with stiff, bristly, stinging hairs, are used as an article of food among the natives of India. The bark is astringent and is used medicinally. The wood is soft and valuable for a great variety of purposes. Aside from the fact that the trunk produces a valuable gum, every part of the tree is useful. The living trees exude large quantities of gum which is variously known as karai, katira, katila, kadaya, karaya, kuteera, kutera, and kutira. According to some authors, it is also called kawali, pandruk, loli, gula, kahu, penari, and veley-putali. A gum similar in all respects to that produced by *Sterculia urens* and often mixed with that obtained from the latter, is produced by two other trees, *Sterculia villosa* and *Cochlospermum gossypum*. This gum belongs to the tragacanth series and in the powdered state is commonly mistaken for true gum tragacanth. In the whole condition it may be described as irregular, rounded, translucent lumps of a pale buff color; it never occurs in ribbon-like bands like true tragacanth. As an article of food or medicine it is distinctly inferior, but it is considerably cheaper and for this reason it has been used rather extensively in place of tragacanth, which is now selling for several dollars a pound; gum karaya in the whole state is now quoted at from 12 to 18 cents per pound, and the powdered gum for 16 to 24 cents. In India karaya gum is used extensively as a substitute for tragacanth, for making sweetmeats and also locally in the treatment of throat affections. In this country it is employed as an emulsifying agent, for which it is equal to tragacanth. Large quantities are used in ice creams and other foods. The gum is soluble in cold water, forms a tasteless mucilage, and is non-poisonous. The poorer grades are used exclusively by the calico-printers.

Cadmium in Spelter

SLABS of spelter as supplied by the smelter are not of exactly uniform composition, as the kettle into which the metal is received from the furnace holds a relatively small quantity, and the impurities passing over with the zinc vary in amount in different parts of the furnace, according to the temperature of the retort. To insure uniformity the zinc should be remelted in large pots or furnaces before being cast into slabs for delivery. Spelter free from cadmium can only be obtained by single smelting when the ore is free from cadmium, but by redistilling common spelter with proper control of the temperature, and separating the first distillate, a high-grade spelter, low in cadmium, is easily produced. It is stated that excessive prices have recently been paid for American high-grade spelter, which is merely redistilled common spelter. Zinc free from cadmium is easily obtained electrolytically, but the electrolytic process is commercially applicable only under limited favorable conditions. Cadmium is deleterious in zinc to be used for slush castings, and is objectionable in cartridge brass, but for brass that is to be cast and machined, the adverse effect of cadmium is probably overestimated, and may be non-existent.—*W. R. Ingalls, Inst. of Metals, September, 1916. From note in Jour. of Soc. of Chem. Ind.*

The Conifer Leaf Oil Industry*

The Species Used and Methods of Production Employed

By A. W. Schorger

THE production of oils from the leaves or needles of various conifers is a small but fairly old industry in the United States. According to the best estimates obtainable, the value of the oils produced annually from this source amounts to approximately $50,000. The leaves of only a few species of conifers are regularly distilled for their oils, since it is only for these oils that a steady demand has been created.

The principal species employed are the black spruce (*Picea mariana*, Mill.), white spruce (*Picea canadensis*, Mill.), eastern hemlock (*Tsuga canadensis*, Linn.), red juniper (*Juniperus virginiana*, Linn.), and arbor vitae (*Thuja Occidentalis*, Linn.). The oils of white spruce, black spruce, and hemlock are very similar in composition. No attempt appears to be made to keep the leaves of the latter species separate, and for practical purposes a distinction between them seems unnecessary.

The annual consumption of spruce and hemlock oil is estimated at 40,000 to 50,000 pounds. It is quoted at $0.45 to $0.60 per pound. The leaf oil of the red juniper is used largely in insecticides, the annual consumption being 15,000 to 20,000 pounds. The prices of the oils from the various native conifers are approximately the same as that given above. The oil of *Pinus picea*, imported from Europe, is sold at about $4 per pound, but the annual demand is below 50 pounds.

YIELDS OF OIL FROM VARIOUS SPECIES.

The oil is found in longitudinal ducts running through needles. The number and size of the oil ducts vary greatly with the different species, and on these factors the yield of oil is largely dependent. The number of oil ducts may vary from one to ten. Naturally the species containing numerous ducts of large size will give the largest yield of oil. This assumption has been verified in the various species examined.

The long leaf pine needle contains five large oil ducts, the average yield of oil being 0.42 per cent, while the lodgepole pine needle contains two oil ducts, the average yield of oil being only 0.16 per cent. In all cases the yields are given in per cent of the weight of the green leaves.

The approximate yields and principal constituents of the various species are given in Table I.

PROPERTIES, COMPOSITION AND USES.

As a general rule the oils have a pleasant odor, resembling the fragrance of coniferous forests. Occasionally the freshly distilled oils have a disagreeable odor that frequently improves with age.

The oils are composed mainly of terpenes, terpene alcohols and their esters, and sequiterpenes. (See Table I.) Among the terpenes, pinene and limonene are ordinarily present. The attractive odor of the oils is due mainly to borneol and its acetic ester. In general, the more highly prized oils contain large amounts of borneol, both free and combined. Spruce and hemlock oil contains 35 to 50 per cent of these constituents. The popular Siberian needle oil, of which 5,000 to 10,000 pounds are imported, contains from 29 to 39 per cent bornyl acetate. Among the sesquiterpenes cadinene occurs most commonly. Thujone is a characteristic constituent of thuja oil from *Thuja plicata* and *Thuja occidentalis*.

It is difficult to obtain direct information on the purposes for which the various oils are employed. A large amount of correspondence addressed to manufacturers purported to use these oils in their products afforded very little information. Information on the uses to which the oils are put was obtained mainly from dealers and distillers of the oil.

The spruce and hemlock oils are extensively employed as a perfume in greases and shoe blackenings. It is also used in considerable quantities in liniments and other medicinal preparations.

Cedar oil from *Juniperus virginiana* is employed mainly in insecticides. Thuja oil from *Thuja occidentalis* is used in insecticides and liniments. Various native and foreign oils are employed medicinally, as inhalations for lung diseases, and as additions to baths and ointments in rheumatic afflictions. Various perfumes contain certain amounts of needle oils whose value consists in having a so-called "ozonizing" effect. The oil of *Pinus montana* mixed with chloroform is used in quantity as an embrocation. In Europe, especially, the finer needle oils are used extensively as perfumes in soaps.

**Metallurgical and Chemical Engineering.*

DISTILLERS OF OIL.

The greater portion of the oil is distilled by small farmers in New England during the winter months when the farm work is slack. In 1912 a company in Seattle, Wash., was engaged in the distillation of the leaf oil of red cedar (*Thuja plicata*) on an extensive scale. The branches, three quarters inch or less in diameter, were delivered in Seattle in bundles of 100 pounds at a contract price of $4.50 to $5.50 per ton, depending on their oil content. The material was packed in the stills and distilled with steam at a pressure of 40 to 90 pounds for three to five hours, the distillation being discontinued when the amount of oil coming over did not exceed 10 cubic centimeters in five minutes.

The average yield of oil was about one per cent of the weight of the green material. Young trees contained the largest amount of oil, and the leaves were richest in January, February and March. The oil had a market value of $0.40 per pound, but this was scarcely sufficient to cover the cost of production. Most of the oil was employed in the manufacture of an insecticide called "Mothine." This was a dry powder containing about 35 per cent of cedar oil and 65 per cent of an absorbent made by nitrating the finely ground shells of peach pits.

Attempts have been made at various times to utilize pine needles for the production of fiber after the oil had been removed by distillation. The most ambitious attempts in this direction were made by C. M. and O. C. Terrell of Grants Pass, Ore., who obtained patents covering methods and apparatus. The plant, described by Brown,[1] utilized leaves systematically picked from young trees of the Western yellow pine. The stills consisted of wooden tanks with steam connections, and had a daily capacity of 2,000 pounds, from which ten pounds of oil were obtained. After suitable treatment the spent needles produced a long, tough fiber that could be woven into fabrics or made into mattresses when mixed with hair.

FOREST SERVICE INVESTIGATIONS.

The large amount of lumber cut from coniferous woods renders available large quantities of needles and twigs that at the present time are not only a sheer waste, but are frequently the cause of destructive forest fires. If a sufficient market could be created for the oils a great economic advance in management would be effected. At present, however, the demand and price for oils of this type do not warrant their manufacture on a large scale.

The leaves of a number of the most important Western and Southern conifers were distilled to determine the yield and chemical composition of the oil. Samples of these oils were sent to various manufacturers for practical tests. The most promising oils, judged from odor, were those of long leaf pine and Western yellow pine. Unfortunately in nearly all the oils the ester content was low and their odors did not surpass those of the already firmly established spruce and hemlock oils. There appears to be an increasing utilization of conifer leaf oils, and the creation of a demand for new oils, as well as the extension of markets for the common ones, may be anticipated. It is frequently difficult, however, to introduce a new oil on the market, even though it may have decided merit.

PRINCIPLES OF DISTILLATION.

The oil is removed from the leaves by the familiar method of steam distillation, usually at atmospheric pressure. As the steam passes upward through the needles the oil volatilizes and the mixed vapors pass together into a cooling apparatus, where condensation takes place. The condensation products soon separate into a layer of oil and water, owing to their immiscibility and difference in specific gravity.

[1]SCIENTIFIC AMERICAN, 84,344 (1901).

FACTORS INFLUENCING YIELD OF OIL.

Steam distillation under pressure is more rapid and produces more oil than distillation at ordinary pressure. When steam at atmospheric pressure is employed a greater yield is obtained if the needles are cut into small pieces. In this way the oil ducts are more exposed to the action of the steam and more material can be placed in the still. Experiments have shown that a still will hold 25 to 50 per cent more material when it is finely cut.

The largest yields are obtained from young trees. In New England cedar oil is distilled almost entirely from small trees growing in old pastures and abandoned fields. All trees growing in the open contain more oil than those in a normal forest stand. The season of the year also appears to have a considerable effect, the data available essentially agreeing in that the most oil is obtained during the winter and spring months. The leaves of the Western red cedar (*Thuja plicata*) were richest in January, February and March; the leaves of incense cedar were richer in February and November than during the intervening summer months.

THE STILL AND ITS OPERATION.

The experimental still used by the Forest Service was constructed in three parts. The cylindrical body of the still for holding the needles was 3 feet 6 inches in height by 2 feet 3 inches in diameter, and was made of 16 B. W. G. copper. The ends were flanged out and provided with iron rings 1¾ inches wide. The cover of the still and the top of the heating vessel were similarly flanged and provided with rings. The cover and base were fastened to the cylinder with malleable iron clamps.

In order to support the needles the inner base of the cylinder was provided with lugs upon which rested a removable frame covered with 20-mesh No. 25 B. W. G. brass wire. The exterior of the still was covered with several layers of asbestos in order to reduce radiation of heat and condensation of the vapors.

The heating vessel containing the water was 3 feet in diameter and 2 feet 1 inch high, and was constructed of 11-gage copper. This vessel was provided with a ½-inch water gage and a funnel attached to a hand lever stop for introducing water when necessary.

The condenser consisted of 20 feet of 1¼-inch copper tubing wound in a coil of 1½ feet internal diameter, placed in a galvanized iron tank 2 feet in diameter by 2½ feet deep. The condenser was connected to the still with an 8-foot copper pipe, in two sections, 2 inches in diameter.

A two-gallon aspirator bottle, having a brass siphon, served as a receiver.

The material to be distilled was first passed through a feed cutter, the needles and twigs being cut into lengths of one half to one inch. When the chopped material was well packed into the still the charge varied from 350 to 500 pounds, depending upon the species. By filling the cylinder ahead of the rising column of steam, the needles are decidedly more compressible.

The distillation was continued at the rate of 2½ gallons per hour. At the end of seven to eight hours the quantity of oil fell to 5 to 6 cubic centimeters per hour, and the distillation was then considered complete.

TABLE I

	Yield of Oil	Sp. Gr.†	Principal Constituents
Red pine (P. resinosa)	0.10 } ?	....	....
Pitch pine (P. rigida)	0.10 }	....	....
White pine (P. strobus)	0.10	0.9012	α—pinene
*Longleaf pine (P. palustris)	0.40	0.8829-0.8849	Camphene, β—pinene, borneol, cadinene
*Cuban pine (P. heterophylla)	0.27	0.8877-0.8894	Camphene, β—pinene, borneol, cadinene
*Western yellow pine (P. ponderosa)	0.08	0.8718-0.8849	α—pinene, dipentene, borneol
*Sugar pine (P. lambertiana)	0.09	0.8676-0.8738	α—pinene, β—pinene, dipentene, borneol
*Digger pine (P. sabiniana)	0.09	0.8517-0.8566	α—pinene, limonene
*Lodgepole pine (P. contorta)	0.23	0.8690	Phellandrene, β—pinene
*Red fir (Abies magnifica)	0.15	0.8665	Phellandrene, β—pinene, borneol
*White fir (Abies concolor)	0.13	0.8720-0.8777	α—pinene, β—pinene, phellandrene, borneol
*Douglas fir (Pseudotsuga taxifolia)	0.16	0.8727-0.8759	α—pinene, β—pinene, limonene, borneol
Red spruce (Picea rubens)	0.20	0.9539 at 16 deg.	Borneol, bornyl acetate
Black spruce (Picea mariana)	0.60	0.9274 at 19 deg.	Bornyl acetate, terpenes
White spruce (Picea canadensis)	0.10	0.9216	Bornyl acetate, limonene (?)
Hemlock (Tsuga canadensis)	0.40	0.9288 at 20 deg.	α—pinene, bornyl acetate
Balsam fir (Abies balsamea) Miller	...	0.8881 at 20 deg.	α—pinene, bornyl acetate
White cedar (Thuja occidentalis)	0.50	0.915 -0.930	α—pinene, fenchone, thujone, borneol
Western red cedar (T. plicata)	1.00	0.9305 at 25 deg.	Thujone, pinene
*Incense cedar (Lib. decurrens)	0.23	0.8655-0.8733	α—pinene, limonene, borneol, librocedrene
Red juniper (Juniperus virginiana)	0.20	0.887 -0.900	α—pinene, limonene, borneol, cadinene
Tamarack (Larix laricina)	0.15	0.8816	α—pinene, bornyl acetate

*Examined by author. †At 15 deg. unless otherwise stated.

The oils are dried and filtered through cotton baton or fine muslin, and are then ready for market. Sometimes they are subsequently rectified by dealers.

The small distillers usually employ apparatus constructed partly of wood. The leaves are placed in rectangular or cylindrical wooden tanks, while steam is introduced from a separate generator. The simple apparatus used by a New England distiller of cedar leaf oil will serve as a type of the stills frequently employed. His description is the following: "A steam-tight box, 3 feet by 4 feet and 3½ feet deep, with a boiler-plate bottom, is set on a rock furnace. Inside of this box is a grating 4 inches above the bottom to hold the cedar up to the top of the grating; a pipe from the top of the box 10 feet long carries off the steam. This steam pipe runs nearly its entire length through a trough of water kept cold by running water. The condensed steam drops into a glass jar covered with cloth for a strainer."

Force of Impact Between Vehicles in a Moving Train of Cars*

By Walter V. Turner

In connection with the subject of design of an efficient brake for a heavily loaded freight car, I wish to touch upon the effects of slack action encountered in a train on level track, and first establish the necessity for an efficient brake for the loaded car when on level track as well as to emphasize the necessity for such a brake in descending heavy grades. By the way of an approach to the subject, I will repeat certain parts of a paper read before the St. Louis Railway Club at a recent meeting which will convey an idea of the forces that may be set up between the different cars of a train by the action of the air brake. Many of the readers may wonder how it is that a draft gear member, a yoke, for instance, should be broken in service on a car weighing, say, 160,000 pounds, loaded, when upon an examination the yoke reveals no particular defect and yokes of an identical size, when pulled on a testing machine, require a force averaging between 200,000 and 300,000 pounds to rupture them; in other words, a force far exceeding the weight of the vehicle upon which the yoke was broken?

The illustration and formula shows what the force of impact may be for a difference in velocity of only one mile per hour between two cars when the impact takes place in 1/100 of a second—a reasonable time for impact, but something difficult of exact determination.

A purely elastic impact has been chosen as basis for this curve for mathematical simplicity. When two lead balls come together the impact is inelastic, that is, the coefficient of restitution is approximately zero. In other words, the surfaces of contact have zero tendency to return to the contour obtaining before impact takes place. On the other hand, two hard steel, ivory or glass balls have very nearly purely elastic impact. That is, the coefficient of restitution is approximately unity, by which is meant the surfaces compressed during impact would, like a spring, return practically all the energy used in compressing them and would return very nearly to the exact contour it had before impact. The F. t. used in making the curve of the figure attached is the summation of the product of all instantaneous values of the force and time of impact. The force ranges from nothing at the beginning of the impact to its maximum at the end of the full time of impact in the case of inelastic impact. In the case of elastic impact the maximum force occurs at the midpoint of the time and tapers down to zero again at the end of the full time of impact. According to this, if the force aries directly with the time, the time to give the maximum force shown in the curve need be only 2/100 of a second instead of one. The maximum force is the one with which we are most greatly concerned in the case of a collision between cars, and, other things being equal, it does not make any difference to the intensity of the blow whether the elasticity, in the way of restitution, is great or small, but it makes a vast difference in the case of a train of cars in the way of causing a final velocity for the following car much less than that of the leading car. That is, when the elasticity, or coefficient of restitution is zero, the two cars will move on after impact with the same velocity, i. e., zero velocity difference. But the velocity difference after impact will be greater as the coefficient of restitution approaches unity. In other words, the greater the elasticity the greater its recoil or "kick back," and therefore the greater accumulative velocity difference between succeeding cars and, correspondingly, the greater will be each collision as the slack action passes on through the train.

In this connection it is impossible to dissociate the two phases of elasticity—the one involving restitution of form and energy and the other involving the modulus of elasticity, or unit stress (force per unit area) per unit elongation within the elastic limits. Every substance, lead as well as steel, has an elastic limit, but this limit, for substances of low moduli of elasticity, is so far below the stresses involved in the every day world that, in the case of lead, for instance, the elasticity is practically zero. That is to say, a stress which might be applied to a piece of steel without giving it a permanent set, i. e., carrying it beyond the point (the elastic limit) from which it would begin to fail to return to its original shape upon removing the stress, would permanently deform a piece of lead or a piece of rubber which, contrary to the popular conception, is of low elasticity. Rubber is elastic in the popular sense that a very small force will stretch or elongate it a great deal, but it is inelastic in a mechanical sense that a comparatively small stress will take it beyond the elastic limit and break it.

As the elasticity of a substance is greater, the elongation for a certain stress is less and the "give" or "cushioning" effect of a blow is less. Therefore, the stress caused by impact must run up higher in value as the elasticity is greater in order to total an impulse equal and opposite to that of the blow. All of this may be summarized in saying that in dropping from the same height two balls of equal mass, one of rubber and one of steel, against a steel bed plate, the steel ball, being the more elastic in the mechanical sense, will deliver the greater force against the bed plate.

Just what degree of elasticity exists when two cars come together it is impossible to say. It is true that the elasticity, or coefficient of restitution, is less for friction draft gear than it is for spring draft gear and a condition of zero elasticity would be the ideal, having in mind for the measure of this elasticity a time interval approaching that of the impact, for, obviously, after the blow has taken place, it is indispensable that the draft gear resume, rather quickly, its initial position in order to be ready for a succeeding impact.

The assumption of a velocity difference of one mile per hour for the formula shown is very conservative. With an empty car braked at 60 per cent having a rigging efficiency of 85 per cent and a brake shoe friction of 15 per cent the retardation set up is

$$0.60 \times 0.85 \times 0.15 = 7.65 \%$$

Which means a rate of change of velocity of 0.0765×22 M. P. H. per second $= 1.68$ M. P. H. per second.

This because 22 miles per hour per second represents 100 per cent retardation, namely that due to gravity, or 32.2 feet per second, per second. For a fully loaded car the retardation is only one quarter of this, or

$$0.25 \times 1.68 = 0.42 \text{ M. P. H. per second.}$$

The difference in change of velocity between the empty and loaded car is

$$1.68 - 0.42 = 1.26 \text{ M. P. H. for every second.}$$

Now if a ten pound brake pipe reduction be made instead of twenty pounds, giving seventeen or eighteen pounds cylinder pressure instead of fifty pounds, the braking force will be about one third its full value, and the velocity change per second will be about one third the above value, 1.26/3 or 42 M. P. H. In order that a velocity difference of one mile per hour be set up it would be necessary that this difference in retardation between empty and loaded cars continue for only 1/0.42 or 2.4 seconds, and that $0.42 \times 1.467 \times 2.4 \div 2 = 7.4$ feet of slack obtain to permit this velocity difference and the impact due to such difference. That is, with an average of one foot of slack per car, and with the slack bunched between a string of loads ahead and empty cars behind, due to a ten pound reduction just having been completed, at the brake valve, in about 2.5 seconds time the eighth empty would be jerking on the seven empties ahead which had just run out on the string of loads. This eighth empty would be running at about one mile per hour slower than the car ahead at the instant of impact, and the blow due to impact would be something over 200,000 pounds. From the curve a car weight of 40,000 pounds would give an impact of only about 100,000 pounds—provided the second car which affords the impact is of the same weight.

But when an anchor of ten or more times the weight of the first car affords the impact, the force of impact becomes twice the value given by the curve. In the illustration used seven empties and the loads ahead provide the anchor against which the eighth empty jerks. By the time the sixteenth empty runs out the velocity difference is twice the one computed, other things being equal, and therefore the blow of impact is doubled, that is, 400,000 pounds. Hence it becomes plain why a draft gear yoke, capable of sustaining the weight of its own car, or even a number of such cars, if suspended vertically, is so easily broken in service. The illustration also shows why it is so many damaging shocks due to slack action occur every day, and it is amazing that more of them are not experienced with the great diversity in car loading, train make up, brake equipment, brake maintenance, etc.

Brake maintenance is mentioned along with brake equipment, for it is easy to see that short piston travel on empty cars accentuates the difference in retardation in a mixed train, and also variable piston travel in a train uniformly made up of all empties or all loads sets up surges or slack action in exactly the same way as pointed out in the illustration.

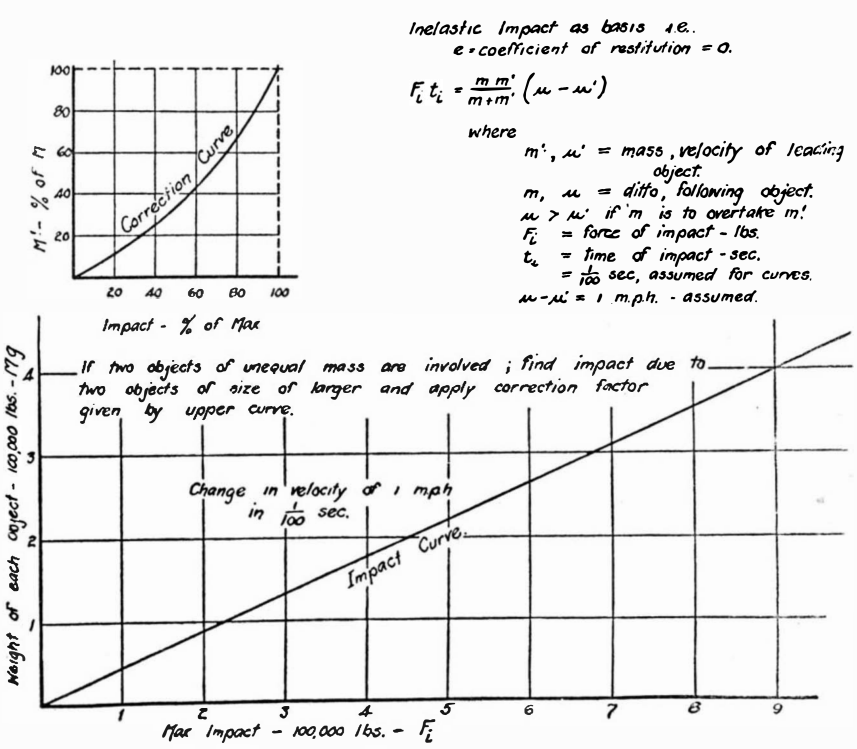


Diagram showing force of impact between two cars.

Experiments in the Cultivation of the Cork Tree in Sardinia

A Sicilian journal, *I Nuovi Annali di Agricoltura Siciliana*, has lately published some interesting notes on the experiments made by Signor G. Cusmano, an inspector in the service of the Government penal settlements in the island of Sardinia, in the cultivation of the cork tree. The possibility of grafting slips of this tree on the evergreen oak was suggested by the botanical similarity of the two plants, and also by the latter's greater longevity. The experiments were made in 1913 at Sarcidano (province of Cagliari), and at Mamoni (province of Sassari). A large number of standards of the evergreen oak, about 3 ft. high and eight to ten years old, were grafted with shoots and with buds of the cork plant. These grafts were successful, and the operation repeated on a more extensive scale in the forest of evergreen oak of Castiados, in the province of Cagliari, was equally satisfactory. It was found that the best results were obtained from buds inserted on the stem and not on the branches of the tree. Besides yielding a more abundant and superior quality of bark, it is claimed that the life of a tree as a cork producer can be doubled, and the value of the forests of evergreen oak considerably enhanced, by adopting this method. It is estimated that during a life of 300 years such a tree would yield from 30 to 37 harvests of bark, as compared with the cork tree, which in 150 years can only be stripped 15 to 17 times. At the present time the timber of the extensive forests of the evergreen oak in Sardinia are only used for the production of charcoal, but if transformed by this method of grafting into cork forests, each tree might yield 50 kilogrammes, to the value of 40 francs (about 1 cwt., worth 32s.), of excellent bark at each stripping, thus making these forests permanently valuable.

*Railway and Locomotive Engineering.

The Intermittent Annual Growth of Woody Plants*

And Some Effects of Geographic or Climatic Variations

By Dr. A. B. Stout, Director of the Laboratories, New York Botanical Garden

WITH most woody perennials the extent of annual growth in the elongation of branches for several years previous to one's observations may readily be traced by the more or less well defined zones of bud scale scars, by the branching, and by differences in the color and maturity of the bark. Also with deciduous trees and shrubs the fact that only the new growth bears leaves makes it easy to determine the extent of elongation while a season of growth is in progress.

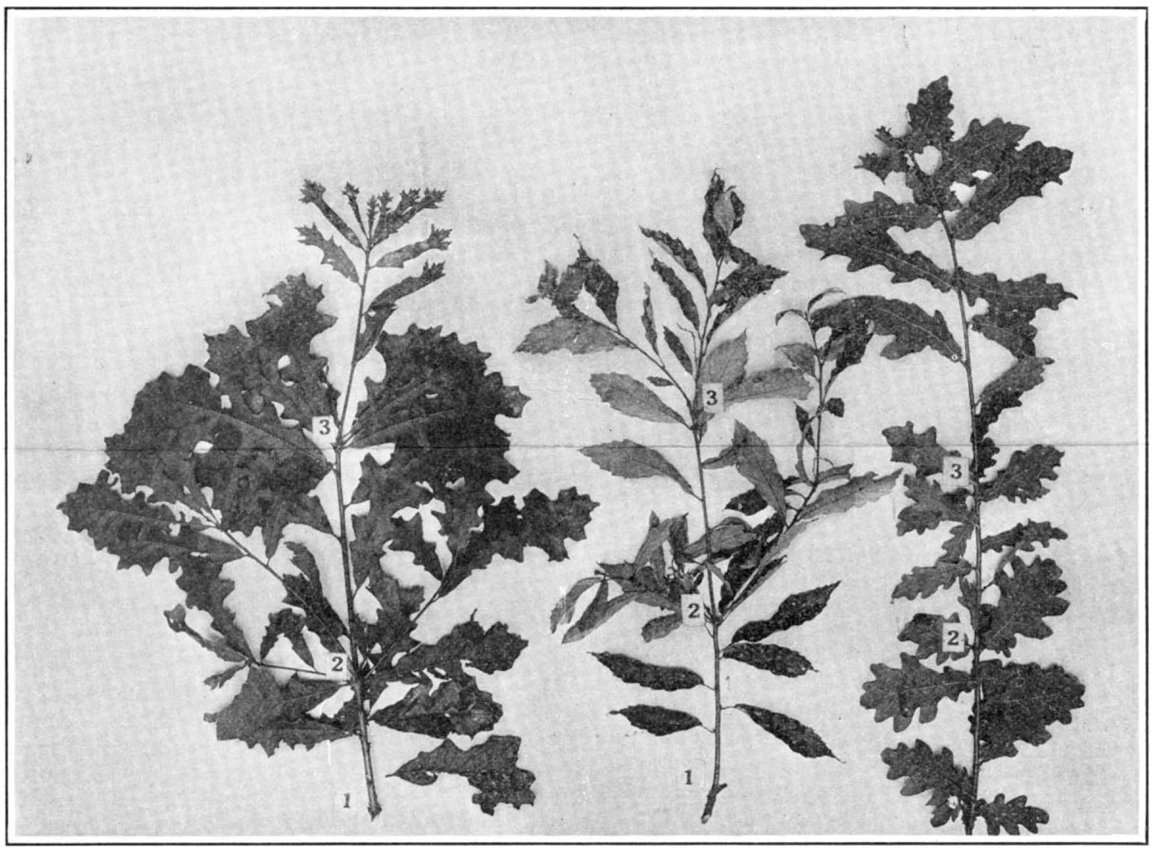
Among trees and shrubs of temperate regions the rule of annual development in respect to elongation of branches may be stated as follows: In spring various terminal and lateral buds shed their scales and the seasonal elongation of shoots from these buds is a rather continuous process of growth. There is, however, considerable variation in the length of the period of elongation. With most species of *Catalpa* growth is continuous until late in summer and ceases scarcely in time for the proper ripening of wood and buds to withstand winter conditions. With some woody plants, for instance sumach, the growing period is so prolonged that the ends of twigs, unable to endure winter conditions, are killed, giving what is called an indeterminate woody growth. Perhaps the opposite extreme is seen in hard maple in which the period of continuous growth as a rule is so short that long before mid-summer has arrived the elongation of twigs has ceased and winter buds are formed, the latter as a rule remaining dormant (as far as active elongation is concerned) during the greater part of the summer.

A modification of this type of annual growth is often seen in the development of lateral branches from the new growth. Such branches arise in the axils of new leaves and give what may be called a deliquescent annual growth. This is often seen in young vigorously growing trees or shrubs and in the growth of sprouts from living stumps of trees. In such cases the growth of terminal and lateral branches may be practically continuous, quite as it is in branched herbaceous plants. The tulip tree exhibits, quite generally, this mode of growth. In the older and flower-bearing trees of this species this development may bring to maturity flowers on lateral branches of the new growth, thus giving two periods of bloom. The principal crop of flowers is produced from main terminal buds of the new growth and is followed some few weeks later by a smaller second crop developed from certain lateral buds on the new growth.

A further variation in the annual growth of branches, often to be observed, is what may be called the intermittent elongation of a main branch. This is well illustrated by the behavior of several species of oaks. The first period of elongation extends only over a few weeks of early spring and is general for all branches developing on the tree. Then a rather brief period of dormancy ensues after which terminal buds, and often lateral buds as well, resume growth. If the terminal alone develop, the seasonal growth for the twig is unbranched or excurrent; if laterals also develop the seasonal growth for the branch is deliquescent. The particular point of interest is that such seasonal growth is intermittent or discontinuous and involves the resumption of growth by fully formed winter buds during the same season in which these have been formed.

The new growth of such branches is usually conspicuous, at least during the early stages when the leaves are expanding. Of *Quercus palustris*, for example, during the greater part of July of the past summer, there were many trees growing in the New York Botanical Garden which possessed thousands of branches with newly developing twigs. The lighter green of the new crop of leaves was in marked contrast to the darker green of the earlier growth. With *Quercus rubra* the new crop of leaves on such branches was of a bright red color, so conspicuous in contrast to the green of the older leaves as to be most noticeable. By the middle of August, however, the appearance of these leaves was quite indistinguishable from that of the leaves of the first period of growth. However, in such cases closer examination revealed certain differences in the segments of the branches quite comparable to those existing between the growth of different years.

It does not appear that we have in our language an appropriate name for the new shoots or segments which develop in the second (or later) period of intermittent seasonal growth. The peasant folk of Germany long ago observed such branches, and noting that these frequently appeared about St. John's day they became accustomed to use the term "Johannistrieb" for such a shoot; the term thus signifying a shoot that makes its appearance in midsummer.



From left to right, branches of Quercus lyrata, Quercus glandulifera and Quercus "Golden Oak," showing three periods of annual growth as indicated.

The phenomenon of intermittent annual growth has been especially noticeable during the past summer on various trees and shrubs in and about the New York Botanical Garden. Young and old trees of *Quercus palustris* have exhibited such growth most abundantly. Young trees of *Quercus rubra* have shown a strong tendency toward such growth. The writer has observed especially forty-seven trees of this species growing along one of the avenues near the Garden. These are all young trees averaging about thirty feet in height. Thirty-six of these trees exhibited intermittent seasonal growth. The number of branches per tree which resumed growth varied from one to perhaps a hundred, but in most cases there were less than ten. Most of these were from a terminal bud giving an excurrent seasonal growth for the twig concerned; in all such cases the buds were not forced into growth by any evident injury. In some cases, however, the newer growth was from lateral buds (on new growth) which had been, so to speak, forced into development by injury of the terminal bud above. In a few of the tree tops the new growth extended slightly in among the telephone and electric wires strung above; here the swaying of the branches among the wires cut off many of the uppermost tips and led to the development of lateral branches during the second period of growth. No second period of growth was observed on any old trees of *Quercus rubra*.

During the past summer intermittent seasonal growth has also been frequent in the elm, the wild cherry, and in old as well as young trees of the apple. It has been occasional in various other trees and in shrubs such as the beach plum, the bayberry and the American holly. As far as the writer's observation goes, intermittent annual growth is limited to those species which have a short period of growth during early spring. However, not all woody plants of such a habit have exhibited resumption of growth during the past season.

On some woody plants growing in the Garden there have been three periods of growth, giving three well-marked segments all bearing leaves but in other respects apparently quite as distinct as the different segments of single continuous growth of three successive years. Three cases of such growth are shown in the accompanying plate. At the right is a branch of the variety known as "golden oak" which made an excurrent elongation involving three periods of growth all of the past season. Even the last period of growth was completed by the middle of August. At the middle of the plate is a branch of *Quercus glandulifera*, and at the left is a branch of *Quercus lyrata*, and in these the third period of growth was in progress when the photograph was taken on September 2nd. The photograph of *Quercus glandulifera* shows the flowers present at that time on the third segment of growth, and shows fairly well that each segment begins and ends in short internodes and is also delimited by zones of bud-scale scars. The development of lateral branches from the new growth giving a deliquescent annual growth is also well shown. In *Quercus lyrata* the leaves on the first segment of growth were dead or dying and were in autumnal colors, some had already fallen and one dropped off as the branch was about to be photographed; on the third segment of growth, however, very young leaves were just appearing. There is some indication that in this species winter-killing occurred in such branches of the previous year's growth. The branches shown are quite representative of the growth made by the trees in question during the past summer. The resumption of growth for the third time was also observed in *Quercus palustris* and *Ulmus americana*.

It is apparent that the intermittent seasonal growth of twigs is in many respects similar to the alternation of growth occurring from year to year. During the past season the spring was late and the entire spring and summer, until the middle of August, was unusual in respect to the number of cloudy, rainy days, to the high total precipitation, and to the lack of any extended periods of hot and dry weather. The entire season was favorable for excessive and continuous growth of all vegetation, and much of such growth has been noticeable. For this season, at least, the intermittent seasonal growth noted above has been, in a sense, the development of buds that had become dormant, giving, in a year of rather unusually favorable conditions for continuous growth, resumption of growth for two or more periods of elongation.

It should be noted that the habit of intermittent seasonal growth is very definitely fixed in various oaks growing in certain localities. Some varieties, especially developed at the famous Späth nurseries near Berlin, Germany, are noteworthy in that the first period of growth gives pure green leaves, while the second (the Johannistrieb) bears variegated leaves. These varieties, and evidently the parent species as well, produce under the climatic conditions of Germany, constantly year after year, the two crops of leaves. In these cases the habit seems to be in a large degree independent of the minor variations within the seasons.

Journal of the New York Botanical Garden.

The facts in general suggest that intermittent seasonal growth in a woody plant may be due to more favorable growing conditions than those to which the species has been subjected in its past history. Such growth is most noticeable in species in which the first period of growth is of short duration and limited to very early spring; this suggests that such species may have been adapted to a shorter growing period than now exists in such a climate as that about New York City. Still it is to be recognized that not all species having a short period of growth exhibit intermittent seasonal growth and also that it is not alone species of more northerly range that are subject to intermittent growth; it seems, at least to a certain degree, that there are variations which are to be recognized as specific.

It would be of considerable interest to have data on the behavior, throughout their range, of species, such as *Quercus palustris*, *Q. lyrata* and *Q. rubra*, which, under the climatic conditions of New York City, exhibit intermittent annual growth. In fact the whole question of geographic or climatic variation of species with reference to the particular habit or type of annual growth is of considerable interest. The relation of the various types of growth to rapidity of growth, to susceptibility to winter injury, and to development of wood are moreover practical problems of forestry. The culture in botanical gardens, in arboreta, and in nurseries of numerous native and introduced species affords especial opportunity for the comparison of the behavior of these species under different conditions. During the past summer a start has been made in the study of the growth of the woody species in the New York Botanical Garden with special reference to the various problems involved.

Measuring Wind Forces*

DEVICES in use for measuring the wind pressure against plane or curved surfaces consist generally of a two-armed wind-mill carrying the surfaces in question, actuated by weights and connected with the beam of a balance. The velocity of rotation in still air is observed, and from this is calculated the force exerted upon the surfaces by a wind of known velocity. But in this way is obtained only the absolute value of the horizontal and vertical components of this force, with no indication either of its direction, of its point of application, or of its effective strength—all matters of great interest in the study, for instance, of the effect of the shape and inclination of the exposed surface upon the center of pressure of a wind of given velocity.

The Giessen indicator, which we describe herewith, has been awarded first prize in a competition, held under the combined auspices of the German ministry and several German technical associations, with the view of elaborating an instrument for the measurement of these items. It makes possible the separate determination of all components, and consequently of the direction and the point of application of the wind force upon the surface under discussion.

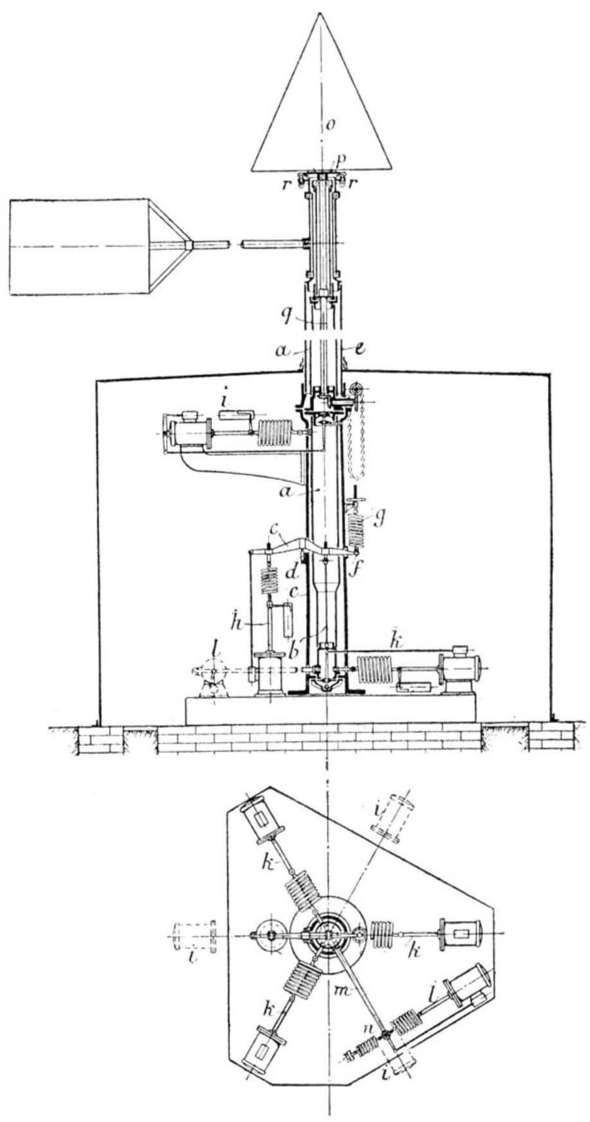
The apparatus (Figs. 1 and 2) consists of a tubular column, *a*, housed in a tube, *e*, which protects it against all direct wind action. The tube, *a*, is supported by means of a rod, *b*, connected with a lever, *c*, which in turn rests upon two springs outside the external tube, *e*. One of these, *g*, is adjusted to balance exactly the dead weight of the tube and the testing surface which it carries; the other, *h*, then measures the force of the vertical movement caused in the tube by the pressure of the wind.

The horizontal forces of this wind, and the oscillatory elements of the tube, *a*, under its pressure, are determined by two groups of three springs each, *k* and *i*, attached to the tube, *a*—the first group at a certain height above the foot of the apparatus, the second at this foot. Finally the forces of torsion resulting from application of the wind force are measured by a spring *l*, operated by the lever arm, *m;* a second spring, *n*, prevents all play of this arm, holding *l* in a state of constant tension.

At its upper end the tube carries a small plate, *p*, upon which is fixed the surface *o* being tested. This plate can be given any position desired with reference to *a* by means of a shank, *o*, fixed to *p* and adjusted from outside the tube. On the other hand, this plate, *p*, can be rigidly fixed to *a* by means of the screws, *r*. These pass through holes in a socket which is provided with a little vane in such a way as to make it possible to maintain the testing surface in any desired relation with the direction of the wind.

The apparatus measures directly the vertical force transmitted by the tube, as well as the torsion forces. Horizontal forces, on the other hand, whose directions and intensities vary with the direction of the wind, are decomposed into three components at angles of 120 degrees with each other.

In measuring these components, since the movements of the tube naturally are of small amplitude (one millimeter, more or less), it is necessary, in order to secure accurate measurement, to use an auxiliary and automatic connection which shall at once measure and record the movements in question. This is represented in Fig. 3. It consists of a small compressed air cylinder in which moves a piston, *g*, directly connected with the spring, *b*. The latter, which we suppose to be attached to the tube, *a*, of the previous figures, represents any one of the springs of those figures. The lever, *c*, which moves with the tube, is joined to the rod, *d;* and this rod operates the valve, *e*, of the air cylinder, which can slide back and forth in the valve-box *f*. Finally the piston-rod, *g*, is joined to a recording needle, which is displaced upon the drum, *h*, with every movement of the piston.



Figs. 1 and 2.—Elevation and plan views of the Giessen indicator.

A displacement of the foot of the tube to the left, for instance, pulls the valve, *e*, in the same direction, establishing the left-hand connection and admitting air to the left-hand face of the piston. This then advances to the right, stretching the spring, *b*, until the tension is just sufficient to pull the tube in the same direction back to its original position. This movement returns the valve *e* to its initial central and neutral location, arresting the displacement of the piston, *g*, by shutting off the supply of compressed air. Displacement of the tube in the opposite direction similarly brings about admission of the air through the right hand valve to the right of the piston, and a movement of this piston to the left, relieving the tension in the spring sufficiently to permit the return of the tube to normal position. In each case the amplitude of the piston movement, which, of course, measures the variation in tension of the spring, and through it the force of the wind, is recorded upon the drum.

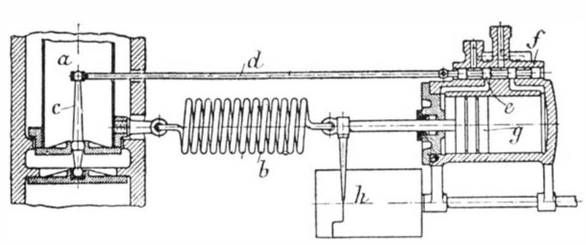


Fig. 3.—Auxiliary automatic recording device.

In the indicator represented in Figs. 1 and 2 all of the springs, *h*, *i*, *k*, and *l*, are provided with this attachment, and are so placed that the return of the tube, *a*, in the direction contrary to the tension of the springs is effected without the latter ever being under compression, or even completely relaxed. The very slight play of one millimeter in every direction which the tube enjoys is sufficient to generate rapidly and without oscillation the movements of the pistons which work these springs.

*Translated from *Le Genie Civil*, for the SCIENTIFIC AMERICAN SUPPLEMENT.

Sound Waves and Zones of Silence

The problem of the propagation of the noises of gunfire and of the existence of zones of silence, says le Genie Civil, continues to interest the scientists and even the general public. M. Esclangon, at a recent meeting of the Académie des Sciences, presented the following note upon this phenomenon and its possible explanation.

THE question of the distance at which gun-fire is audible has been much discussed of late, but it seems that up to the present the precise nature of the problem has not been sufficiently defined. The noises in question can be grouped in three classes. The first category, A, includes those caused by the rapid expansion of gas at the mouth of the barrel—the report, properly so-called, of the shot. The second, B, comprises sounds coming from the aerial wake of projectiles with an initial velocity greater than that of sound, a condition quite ordinary in the use of modern artillery. The third category, C, takes in the sound caused by the explosion of the projectile. We do not here speak of the whistling effect, which is not strictly a detonation at all, and of which the range is very limited.

Near the front, detonations of all three types are plainly to be heard; but as the distance increases some of them disappear. Now those possessing dominant acoustic importance are the ones caused by the aerial wake of the projectile. The detonations belonging in classes A and C are ordinarily entirely inaudible at a distance of 30 kilometers; but those of class B, on the contrary, are carried to very considerable distances—in the case of the largest projectiles as much as 50, 100, even 200 kilometers. So that when noises are heard at such distances from the front, it is seldom indeed that the cannon themselves have anything to do with the matter.

These conclusions, the results of actual observation, are not in agreement with certain explanations that have been offered of the zones of silence. Notably must that explanation based upon propagation of sound through the ground be rejected, since now the noises heard at a great distance from the front correspond to centers of disturbance having their seat in the atmosphere, often at very high altitudes.

While the effective and habitual existence of the zones of silence remains still to be clearly demonstrated, it is by no means impossible, and in our opinion the explanation is simple enough. It is known that the atmosphere is the seat of considerable perturbations, which vary according to meteorological conditions. Especially does the wind frequently change in velocity and direction as we go further up. Now careful calculations make it clear that, under the meteorological conditions actually known to exist, a caustic distortion of the sound waves issuing from a given point, quite analogous to the well known optical effect of that name, is entirely possible. It is plain that to an observer located upon such a caustic, the intensity of the sound would be considerably strengthened. Certain sounds are therefore perceptible at certain points, although at much less distances from their origin they may be inaudible.

We mention an example of the existence of sonant caustics. If above a layer of still air there lies a layer whose velocity increases with its altitude, the sound waves issuing from a point on the surface of the earth possess an envelope which meets the ground again. This, of course, leads to zones of reinforcement, but not in every direction from the point of origin. The layer of thermal inversion, located at about 13,000 meters, and possessing a special circulation independent of the rather variable movements of the lower atmosphere, is perhaps a particularly frequent cause of zones of silence or, more exactly, of zones of reinforcement.

For sounds B, due to the aerial wake of projectiles, and which we have recognized as of by far the greatest consequence, the problem is really a trifle more complicated; for these sound waves do not issue from the same point in all directions. Nevertheless, the existence is quite possible of caustics depending simultaneously upon the meteorological conditions and upon the trajectory of the projectile.

The Problem of Life[*]

And the Economic Waste of Sickness and Premature Death

By Norman Bridge, A.M., M.D. Los Angeles

THROUGHOUT our years, from youth to age, we are individually prone to miscalculate the economies of our lives. We have aspirations and ambitions. We would get on in the world. We can earn so much. It will cost so much for food and shelter, for clothes and warmth, for schooling and for luxuries. We must have certain embellishments. A watch is an ornament and will usefully mark the time—it will cost one, or a hundred dollars. And we must have fine clothes and feathers and jewels and amusements—we must play as well as work. Will our earnings compass all these?

Our calculations are based on the theory that these are all the elements, and that we shall continue to be here and able to work. We do not allow that perhaps we may fall sick, and find all our plans go wrong. So we provide no surplusage.

But we know that the pianist who loses a finger must change his occupation. We know that the chief oarsman who has the colic, or has eaten or drank too much, loses the race. To the engineman a spell of dizziness may cause a collision of trains; and the fame of a general, and the issue of a battle, may be lost by an attack of headache.

The problem is the same for every child. The career of your boy is at the mercy of your neighbor's boy who plays with him, and who has a throat diphtheria. So he is at the mercy of a slight blow on the back or the hip, which may disable him with joint tuberculosis, and make him a dependent for life instead of a power in the world. Or he may have an infected lung, or pleura, that knocks all your calculations awry; that transforms him from one who would lift to one who must lean all his life.

In planning our own and our children's lives we usually fail to make any calculation that health may break down, and that the individual may become a liability instead of an asset to his family and the community. If we could be compelled always to consider this vital interest, it would amount to the greatest single reform in society, for it would keep us and our children away from many of the pitfalls of physical calamity. The economics of health, sickness and premature death are at once the most needed and most neglected subjects of our study.

We covet good health because it means longer life, which is the world's desire, and the first impulse of the normal human heart. Good health makes us forget the terrors of death. Pain and suffering, doubtless, are great discipline for us, but we always hate them and always must. Sickness handicaps us and blights our prospects and hopes for the joys we think we are entitled to. So in our quiet, sane moments we are ashamed of such of our foibles and our sins as bring on sickness; for this reason we try, some of the time, to lop off these and to keep well.

Less often do we consider the economic reasons for trying to keep well, yet they are among the most vital reasons of all. We not only neglect the calculation, we are often a little ashamed to broach the subject when it involves our friends and our families; it seems mercenary and ignoble. A man will warn his son to avoid carelessness and foolishness that might make him sick or handicap him for life; he will say, "If you get sick you'll have to go to bed, take disagreeable medicine, and be kept from pleasures—and you might die." He may warn the youth that if he gets sick his mother must nurse him, and that may make her sick, but not a word about the inability of the family to bear the expense of sickness. Yet this may be the chief reason. Unable to afford a nurse, the mother nurses the family invalids and becomes one of them herself.

In an active practice of medicine of several decades, and with some familiarity with the life of many hundreds of families, I recall hardly an instance among lay people in which the caution for health's sake was frankly urged on economic grounds. And when it has been so urged it has usually been spoken of under the breath, as though it were a shame to put life and health on so sordid a basis.

But the economic basis is a most vital one, and money is our call on the world for the munitions that fight off sickness and death; for it is a fight, and a continuing one, till death takes us; comfort, health, refuge from sickness and death, are often found by means of this potent thing called money.

Sickness and early death are the greatest drains on the resources of most of us—and more than any one influence handicap us, personally and in families, in our search for the things of life that are of paramount value. Sickness is our greatest pauperizer, as health is our greatest asset; and we usually ignore both of these truths.

The actuaries have made it easy for us to state, with some approach to accuracy, the money value of health, the loss to the community from sickness through loss of earning time, and from the expense that must be paid in cash. They have also shown us the vast public loss from child mortality. Not only is all sickness expensive, but epidemics have destroyed nations and peoples, have led to the defeat of armies, and have interrupted and postponed for centuries great public works that have been needed in the development of society and the safety of states. The Panama Canal is one of them.

There can be no doubt that the figures are fairly correct as to the ultimate cost and the loss to the individual and the public from these calamities, but the loss appears to be largely in the cutting off of possible future gains rather than from loss of so much cash out of pocket (except sickness expense); and so the public is slow to believe wholeheartedly in the figures.

The pecuniary worth, potential and prospective, of an individual at different ages is given by Fisher as follows:

At birth	$90
At 5 years	950
At 10 years	2,000
At 20 years	4,000
At 30 years	4,100
At 40 years	2,900
At 80 years minus	700

The value of life is figured on the possible earning power through the years that are promised for the individual, so the value of the younger members is high; that of middle life is a diminishing amount; while the aged have less than nothing of value in this sort.

The annual cost of illness and death in the United States is conservatively placed at $460,000,000; let us add $500,000,000 for loss of earnings by the victims, and we have a total of $960,000,000.

According to the most thorough survey of Pittsburgh, covering the experience of typhoid fever for thirty-five years, Mr. F. E. Wing found that the cases lasted in disability an average of over thirty-four days, and that the cost to the community of each death was $6,000.[1] In four years the cost on this basis was $9,000,000. In October, 1907, before the filtration plant for the city water was finished, there were 593 cases. In October, 1908, after the plant was in use, there were ninety-six cases. Assuming that the 497 cases shown to be avoidable suffered a mortality of 10 per cent, which is a fair estimate, there were forty-nine deaths in one month, costing the community $294,000. At this rate the saving to the public would cover the cost of the filtration plant in nineteen months.

The loss by preventable or postponable deaths, the country over, is probably many million dollars yearly. Fisher, some years ago, figured out the economic saving throughout the country, if needless sickness, deaths and fatigue could be prevented, as 1,500 millions of dollars annually. Nobody knows, or can know exactly, what proportion of deaths is preventable or postponable, but every student of the subject is sure that a very large proportion are preventable—or rather are capable of being postponed to a later time of life. Especially is this true of the deaths of infants and children. Much of the average increase of the span of life among enlightened peoples, from about 33 to 45 or more years, has unquestionably been due to the saving of child lives.

For a long time evidence has been accumulating that the average life is growing longer. Two hundred years ago the gain was 4 or 5 years in a century; one hundred years ago it was nearly 10 years per century; now it is at least 50 per cent more than this, or in excess of 15 years per century, in this country.

We may postulate, and we ought to assert, that the great purpose of public effort should be to make the world a better place to live in. That is a broad, simple, general proposition that is understandable. It is axiomatic.

What constitutes making the community a better place to live in? What must every community do to this end? Many things may be necessary, and they will vary with local conditions, but they all tend and must tend in the final analysis to one aim, and that is the prolongation of the average human life. If human life is growing shorter, the world is a worse place; if growing longer, it is a better place.

The shortening of the average means more deaths in early years; lengthening it means fewer child deaths and more people reaching adult and advanced age; more people spared for the productive years of life. Longevity is fostered in all ages by good health and freedom from accidents and infections. These conditions connote longevity and the cutting out of the money losses of sickness, disablement, and death of prospective bread winners, otherwise the children.

With increase in average longevity the race is maintained numerically by a lower birth rate, and this invariably follows. A lower average birth rate means more vigorous mothers; fewer women destroyed in early life by excessive child bearing. Other things being equal, smaller families mean more vigorous children. High death rate among children means high birth rate. This usually means poverty, and may mean degradation. The child-bearing adults are sometimes so depressed in body and spirit by hard labor, by sickness and death about them, that all their higher ambitions are destroyed; and this *is* degradation.

A late review[2] quotes some very meaningful statistics on this subject which, while possibly not entirely accurate for all of the countries considered, are doubtless comparatively correct. It says that of 21 countries, outside of America, 11 have an average longevity of over 50 years; the other 10 under 50 years. The 11 have an average birth rate of 24.9 annually per thousand people, and a death rate of 14.08. The 10 have analogous figures of 36.2 and 22.5. Russia has the highest birth and death rate—45 and 28.3 respectively, with a longevity of only 27.8 years, and an annual increase in population of 16.7 per cent. On the other hand, Australia has very low birth and death rates, and the highest longevity. The rates are birth 27.5, death 10.8, longevity 56, and natural increase 16.7—exactly the same as Russia. The writer compares Austria-Hungary with Great Britain. The former has a birth rate of 31.7, death rate 21.2, longevity 38.3 years, and annual increase of 10.5 per cent; while the figures for Great Britain are birth 24.4, death 14.2, longevity 53.8, and annual increase 10.2 per cent. The increase being so similar in the countries compared with each other, he infers some natural law maintaining a fixed relation of births to the deaths in a community. It is a logical conclusion, but the law is in part physiologic. It is not wholly some recondite "law" of unaided nature that lessens the births as the death rate falls. Other causes are a widespread reduction of marriages, especially of early ones, and a more or less extensive resort to methods of limiting the size of families—which it is a crime under our laws to teach others how to practice. Whether or not it is wicked, or how wicked soever it is, the practical fact is that people discover methods and resort to them.

As people prosper, are more effective, live longer, become rich, educated and refined, the death rate decreases; so does the birth rate. Large families come to the few among this class who covet them, or believe, on religious grounds, that they ought to have them; but mainly they come to the poor, simple, uneducated, natural folk who love children and believe that God sends them, and these people are the stalwart ones who are forever rising in the scale of world values, and are becoming the controlling factors of society. This class itself degenerates later; and their descendants give place finally to like people as they were at the beginning, and so the wheel revolves.

[*]Delivered at the Central Presbyterian Church of Rochester, N. Y., on the occasion of the meeting of the American Public Health Association and the annual conference of the Sanitary Officers of the State of New York, September 8, 1915.

[1]Irving Fisher gave to the International Congress on Tuberculosis the actual cost of each death by tuberculosis as $8,000.

[2]Editorial, *North American Review*, August, 1915.

With such percentages of annual increase in population as have been noted, the nations will some day reach the limit of convenient existence. Famine, pestilence and war have, in the ages past, kept the race numerically within living bounds. With world fellowship and means of transportation increasing, and the increase of land production due to improved agriculture, famines will decrease; with pestilential epidemics coming steadily under more control with a promise of suppression of most of them, the sweeping mortality of plagues is becoming less common. When the combined food products of the earth are insufficient for the mouths that are to be fed, what will happen?

Speculation may be unprofitable, but it is a safe guess that the diminishing birth rate will, so far from destroying the race, actually save it in such circumstances. Nor will the progressive reduction of births endanger the existence of the race. With the refinements and luxury of the many who will live in that far-off time, there will always be more of the humble, simple, clean and physically strong people who will preserve the race from destruction, until the approach of the end of the habitable life of the earth. That will be millions of years in the future, and I believe that even then the human race will progressively adjust itself to the oncoming severe conditions, and live ages after we short-sighted people would naturally guess that the last man must die.

With increased longevity, life is easier, and easier because of it. Life for all the people can be easier only by reason of more substance, that is, less useless expense, less waste of energy. This means stable governments, stable and fixed conditions of living, continued through many generations; good public and personal hygiene long continued; constant watchfulness to guard against dangers of all sorts. It means in general, peace and plenty. Longevity is increased by conservation of the powers of the individual, and the lessening of forced hard work for long periods, especially by women and children. It is increased by regular, moderate work, and by wholesome attention, not with soul-breaking intensity, to all the serious problems of life. But too much luxury and idleness tend to rather early degeneration of the tissues of the body, and so a shortening of the average longevity.

Moral suasion will probably never produce the greatest progress for the betterment of mankind through improved health conditions. Nor will the example of the small minority of excellent people who lead hygienic lives accomplish enough, although it will do much.

It is necessary, and will always be necessary, for an endless campaign of education among the people, most of whom are heedless and indifferent to the dangers of accidents and infections, and harm to others. Laws and ordinances will be necessary, and their faithful execution more necessary. Political effort and agitation must be continued, so that a majority of the people will support all sane health measures. The force of law must be felt by the people of all classes, especially the careless and indifferent, to prevent them from making themselves sick, to the public loss, and from endangering their neighbors. It is unsafe to live in a community where the moderate precautions of a sane public hygiene can be defied by any man or family with impunity.

In the last few decades one European state has signally illustrated this truth. During the last few years the length of the average human life has been increasing in Europe as a whole at the rate of nearly seventeen years per century; in Prussia the gain has been at the rate of twenty-seven years. Why is this? It is certainly not accident or any one fortuitous circumstance that has done it. It is probably due to the frank obedience of the people to the health rules of a forceful government. The rules have been formulated by experts for the preservation of the health and lives of the people; and all classes have obeyed with hardly a question. If there has been a question of the authority of the state in these matters, it has been hushed in a sentiment of loyalty to the Fatherland.

America is learning slowly that government is an instrument of force; it is learning a better respect for law, especially when the law is for the protection of all the people. The old doctrine is passing that every man has a right to do anything he likes, regardless of his neighbors, unless *he* can see that he is doing them some distinct harm. The bugbear of paternalism is also passing, and the mass of the people in the most progressive communities will not tolerate the logical results of the notion that there is no need of public hygiene.

It is only by a study of well-recorded facts bearing on the public health that we may surely know whether or not we are harming our neighbors. Prussia illustrates the effect of militarism, as applied to the preservation of health, and shows the value of *compelling* people to avoid infection, carelessness and excesses that tend to sickness and death.

Will better public health, gained by methods that may seem militaristic, develop in the people that sort of vigor and virility that will tend to a martial attitude toward other nations and threaten or produce war? Such a suspicion is groundless, even childish. Wars are brought about by human selfishness, jealousy, egoism, suspicion and hate between peoples and rulers of peoples. All methods for better health, whether forceful or otherwise, are for the benefit of the nation employing them and tend to peace; never toward war against another nation, unless that nation violates flagrantly the health interests of its neighbors.

We have, in this country, done a few things that show that we are becoming awake to the need of public and private hygiene. In some of our large cities we have, within a few years, lowered our annual death rate from twenty per thousand of population to fourteen or lower, largely as a result of the most constant watchfulness and insistence on health regulations. Here are a few of the measures that have brought down the death rate and raised the average age of the people:

1.—By improvement in milk supply in cities and towns, the amount of bad milk sold has been reduced often to less than one tenth of the former figure. This gain has been made at the cost of stringent ordinances, constant watchfulness of the milk supply, daily laboratory examinations of the milk, frequent inspections of farms, herds and dairies, and frequent and merciless prosecutions. And the struggle goes on for still better hygiene and economic conditions of milk supply—and there is need enough for it. Rochester (N. Y.) is wasting a half million dollars annually in the way her milk is delivered to her people.

2.—Diphtheria antitoxin, and the almost universal use of it in cases of this disease, has materially lowered the death rate. The cost has been a campaign of education of the medical profession and public as to the life-saving value of the measure; the supply of the article free for the poor; the examination of throat specimens at public cost, and the insistence on scrupulosity in the manufacture of antitoxin.

3.—Improvement in water supply for urban and rural populations, often at enormous expense to the public, has cost strenuous political, educational and social campaigns to induce the governments to vote the appropriations. For the effect of this measure on the death records we need only to look at the typhoid mortality of two cities, before and after. These are Chicago and Philadelphia; the drainage canal in the former, and the filter plant in the latter.

4.—The destruction of mosquitoes in the prevention of malaria and yellow fever. These fevers have been among the most destructive and expensive in all history. It is impossible to compute the annual cost of them to the world before the mosquito discoveries, but it must have been scores of millions. The cost of mosquito destruction has been high; but it is a trifle compared with the cost of the diseases they produced. The control of plague and cholera constitutes a similar story. Like yellow fever, they often occur in epidemics. We know their microbic causes, and have learned how to stamp out the epidemics, and, to a degree, how to prevent them. Dr. Blue, the head of our Federal Health Service, has shown us how these ends are attained; and our Dr. Strong, the hero of Mukden, has, in that city with a terrific epidemic of pulmonary plague, accomplished one of the most brilliant feats of control in all history.

5.—Tenement house inspection and the prevention of overcrowding is a good measure that has met with less popular opposition than many other reforms.

6.—The regular inspection of schools by medically educated experts eliminates children capable of spreading infection, and helps toward the relief of those handicapped by disorders that are correctible. This measure is being adopted by most progressive cities, often in the face of strong and persistent opposition. It is subject to few drawbacks, and almost free from abuse. It is increasingly popular, and ought to be.

7.—Scientific midwifery among the poor at the hands of selected dispensary physicians and visiting nurses, and instructions to poor and ignorant mothers in the care and feeding of their babies (with free milk, if necessary). By means of these and similar measures, New York City has, within a few years, reduced its death rate among children under one year of age by more than 30 per cent. This record will be repeated by many other cities and by the more advanced country regions. But it will probably be a long day before we can match New Zealand, which has the lowest infant mortality in the world.

The poor people have, of course, accepted these benefits gladly, but the public has required vast argument before voting the needed money. With such a record before it, the public is guilty of a flagrant waste of its own substance and of constructive manslaughter, if it refuses to supply the funds.

8.—Visiting nurses for ordinary sickness, in cities, instructing and helping families that need it, prevent a lot of sickness, and they hasten recovery in many cases, and so cut down the cost of such calamities. The governing bodies of cities are usually slow to discover the value of this measure.

9.—Vaccination against smallpox and typhoid fever. That against smallpox, notwithstanding bitter opposition, has for many years been so general that a considerable immunity among the people seems to have been established; and that against typhoid fever will before many years, if we can bring the facts to the knowledge of the people, become very common—with the result that typhoid will become a rare disease in the general community, as it is now in the armies of the enlightened world.

10.—The pure food and drug laws now in force in this country have contributed to better health among the people, as they have repressed certain forms of unfair dealing and fraud among manufacturers and merchants. This reform was bitterly opposed in Congress and the Legislatures for many years by certain powerful business interests.

11.—The regulation and partial suppression of the use of alcohol has cut out a great amount of useless expense to the people, as it has reduced the amount of sickness. This is the verdict of the statisticians generally, notwithstanding the contention to the contrary by some good men. I believe that no woman has made such contention. We have undertaken, by Federal law, to suppress the popular use of opium and cocaine, except in cases of known and necessitous sickness. And public sentiment will not allow this law to be repealed. We have made no large attempts at reducing the use of tobacco, except for children. Tobacco has been shown to increase the death rate, and the habit is a money-eater. Besides being very costly, it is probably the most grotesquely curious habit of the human race: speaking generally, no one ever began the use of tobacco because he, by himself, at first desired it. Probably a thousand million dollars annually is spent because of the tobacco habit.

12.—The fashion for fresh air, outdoor sleeping, and athletics, among students and the young generally is a powerful aid to hygiene, and has lessened the death rate. Let us pray that the fashion will not change. Draughts of fresh air do not cause colds; these are due to some derangement of the body health. And all the advantages of a flood of fresh air are gained by a moderate amount of it, if it is kept in motion; hence electric fans and a lesser coal bill are in order.

13.—Taking some tuberculous patients off the street where they are careless with their sputum, and sending them to proper sanatoriums, not only helps them, but protects the public. Thousands of such patients are now in such places, where under watchful care they harm nobody, and have some chance of recovery themselves. Hundreds of sanatoriums, State, municipal and private, have been built and are operated at great expense, but the saving of life has much more than covered the cost. The public education as to the dangers from careless spitting has returned more value to the public than the cost of all the sanatoriums. But this education is not more than a quarter accomplished. The propaganda must be kept up until all the people know and remember the facts.

14.—The cure of hookworm disease is one of the greatest gains. We are amazed that a few cents' worth (less than one day's wage of a laboring man) of a harmless medicine could cure so destructive and costly a disease. It is now within the possibilities to make uncinariasis a rare disease, and incapable of wearing out a single patient. In Porto Rico 89,000 people were cured at a cost of 54 cents each.

Other reforms must follow, and a great and united popular sentiment push forward all such as can minimize the sickness of mankind, so that there shall be a constantly increasing number of people who will escape death until overtaken by the unavoidable degeneration of tissue due to age. Even some of these degenerations will doubtless be found preventable or postponable to a later time in life than they usually now occur.

Here are a few of the things to hope for:

(*a*) More educated health officers, and more education for them in universities. They must be sane people, men and women—certainly women as well as men!—who know how to get along with other people; who can usually get the laws carried out with the least

friction; and who respect the rights of the people while loyal to the law; who are jealous of the rights of the weak and helpless; and who do not have an excess of official dignity, with projecting elbows. Such are people capable of proposing new and better health regulations than we have; and they can convince the majority of their constituents of the necessity of progress, and of the value of the reforms they propose. Many health officers, like other public servants, are autocratic, uncompromising and apparently anxious to show and use their authority. Neither the cause nor the public good needs such servants. People in authority, when obliged to use their power in ways likely to be displeasing to the people affected, should always regret, and act as though they regretted, to use their power with severity—and then use it politely if firmly, and only after persuasion. This is the hand within the velvet glove that usually accomplishes the difficult object with thanks rather than execration from the public.

(*b*) Improvement in the hygiene of rural life and rural schools. Both are disgracefully below the standard in cities. Country life ought to be the healthiest life of all; and country schools can, with only moderate industry, be made as wholesome as any school in the metropolis. The movement by two great organizations, the American Medical Association and the National Educational Association, to further this purpose ought to have our hearty encouragement. It is a profitable measure and means health and wealth for the whole country. It has not kept pace with the progress in the conveniences of country life, such as better roads, automobiles, telephones and free mail delivery. The country people are lamentably neglected in the matter of hospital care and expert nursing. A few of our States have awakened to the necessity of enabling counties to provide proper hospitals and nurses for rural communities. This movement ought to be advanced by every means possible.

(*c*) We should teach early and late the value of keeping the physical body up to normal vigor all the time. It wards off sicknesses and helps us to weather them when they are unavoidable, and it often keeps us out of the expensive hands of doctors and nurses. Early diagnosis of apparently trifling ailments is important. Severe diseases are thereby often prevented. This is what the school inspection doctors do for the children. In sickness, procrastination is one of the most expensive and dangerous of our indulgences.

(*d*) We need to make a more vigorous campaign against flies, mosquitoes and vermin. Swatting the fly is good, but it is a makeshift. We must destroy the breeding places of flies and mosquitoes. We know the methods of doing this, and it is infinitely cheaper than our burden from the unlimited breeding of these pests. But one careless and indifferent family in a neighborhood can furnish breeding places for the flies and mosquitoes for the town, and nothing will do effectively but an ordinance requiring the health officer to declare all such places to be nuisances, and to compel their abatement. This, with public sentiment to sustain the officer, would reduce these insects to a trifling inconvenience. And one popular and successful movement that could enact such an ordinance and cause its effective enforcement would mean a general interest in public health that is equal to other reforms that would give the community a nation-wide, enviable reputation, and insure the lowest death rate.

The importance of body vermin in spreading infectious diseases has been emphasized by recent studies in typhus fever. Certain of the warring nations of Europe are profitably carrying out extensive measures for scrubbing the bodies of their soldiers, and disinfecting their clothing by heat.

We might profitably increase our facilities for free baths for the poor in cities. The bath house might have facilities for heating safely and quickly each bather's clothing while he is in the bath. The self-respecting bathers would probably resent the suggestion of vermin in their clothing, but they would not object to the disinfection if told that their clothes might contain tubercle or typhoid bacilli, and that the oven would not harm the garments.

(*e*) We ought to make a larger effort to lessen the spread and havoc of the venereal diseases. The economic loss to the nation from them is beyond computation. The results are great suffering, disabling complications that are sometimes mortal, blindness, insanity, barrenness, locomotor ataxia, aneurysms, loss of service and other multiplied calamities. The list is long and sickening. And the diseases are widespread, especially in cities. In New York in one year the number of cases was about 4.5 per cent of the whole population.

We have done a few things to lessen them a little, mostly working around the edges of the problem, as it were, without attacking it in the direction of its greatest menace. We have to some degree banished the promiscuous drinking cup in public places, on railroad trains, and where numbers of people are employed. This helps a little, and is a good object lesson in hygiene.

We have advised against promiscuous lip kissing, with small result to change a fashion.

We have encouraged the use of domestic and toilet facilities that tend to lessen the spread of the diseases.

We are, with admirable unanimity, successfully fighting against segregation and official examination of prostitutes. This will remove somewhat the temptation to men and boys toward the dark ways—with a fatuous sense of safety that never exists.

We have reduced somewhat the use of alcoholics, for these have led countless thousands of men and boys to contract these diseases, who otherwise would have had enough caution, self-respect and resolution to avoid exposure to them.

We have begun to get over our cowardice and prudery, and to give a few boys and girls some slight knowledge of sex hygiene, and how to avoid these infections.

We have, by an admirable addition to the principles of medical ethics, unlimbered the tongues and courage of physicians who can and will, better than formerly, protect women known to them to be in danger through expected marriage. The certificates of perfect health before marriage that a few clergymen are demanding will do a little good, but not much, because of accommodating physicians and careless examinations by those unskilled.

Surgeons, in treating these diseases, are more cautious than formerly to avoid infection, by the use of rubber gloves and other devices.

We have seen most of a certain class of doctors shamed against further spreading of that abominable physiologic heresy that the health of any man requires sexual indulgence. Their subsidence has undoubtedly lessened a little the spread of these diseases, as it has lessened the degradation of man.

We are more and more providing quick and efficient hospital and dispensary care for the poor who are overtaken by these infections, for this is humane, and is a protection to the community. Every such patient is a constant menace to the people about him.

Lastly, we are preaching the gospel of a single standard of morality for men and women alike. This is right as well as righteous, and will do good as far as it goes; but with a present record of 60 per cent of syphilitic women, having received the infection from their husbands, it is to be feared that it will not for many years greatly influence the spread of venereal diseases. Not one per cent of syphilitic men receive the infection from their wives.

Probably the most effective means within our power to lessen greatly the spread of these diseases is the general education of the young of both sexes as to their nature, their baneful effects and the way to avoid them. But this measure, clearly the right of every boy and girl to have for their own protection, and much desired by them, is strongly opposed by many good people for reasons that seem to me utterly inadequate and even nonsensical. May the wisdom of these sensitive people, the love of their kind, their respect for essential purity and the rights of the young so increase that they may come to know that whatever knowledge is necessary in order to be healthy and avoid death is proper for young and old alike; and that not forever shall the best youths of our land be allowed by their ignorance to go blindly to their destruction.

(*f*) Finally, and never to be forgotten, the progress we have made in cutting down the death rate has been due to the results of scientific research during the last few decades. But for this research we would still have a death rate in our cities of twenty to twenty-four per thousand annually instead of fourteen or less. In this progressive work the pathologists of America have had a great part.

The wonderful results so far achieved are a promise of greater yet to come, and tuberculosis, cancer, diabetes, pneumonia and other destroyers of mankind will yet be conquered. The public health weather vane points to more endowment of research, and that is what we most need. The workers are ready, but the public says the endowments are expensive. That is true, but the beneficial results are one hundredfold greater than the cost.

The promise of further reduction in the death rate is in two factors only: the more efficient use of the knowledge which research has already given us, and of the new knowledge which further research is bound to produce. On this progress we pin our faith, in the calm certainty that it will not fail us.

High Versus Low Antennae in Radio Telegraphy and Telephony

THROUGH a regrettable typographical error the author of the *Bulletin* of the Engineering Experiment Station of the University of Wisconsin, referred to in the above article, which appeared in the SCIENTIFIC AMERICAN SUPPLEMENT of November 11, was given as Professor Edward Baker, whereas it should have been Professor Edward Bennett.

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Table of Contents