makers present a picturesque scene. The long spacious room is literally a blaze of color. Rolls of bright bunting are heaped up waiting to be cut, while long lines of women operators are swiftly sewing the seams and putting the finishing touches to American and to forty-three foreign ensigns of different hues and patterns. The flags are cut out from measurements arranged on chalk lines and metal markers on the floor. Large stripes and certain designs can be more conveniently stitched in this way. Daily a section of the floor is covered at all hours with several different flags, with the men and women cutters at work. The final sewing is done on machines by the women. Each machine is run by a small electric motor of one-fourth horse-power. Owing to long service, the labor has become highly specialized, and the women are kept at work on the particular flags which they can make the best. Some excel in sewing on the stars, others in finishing certain other parts of the flag. Nearly all have been in the establishment for years. Their pay averages from $1.20 to $2 per day.

A great deal more time and labor is required to finish certain of these flags than is generally supposed. For instance, the President's flag requires the longest time of any to make, as it takes one woman a whole month to complete it. The flag consists of a blue ground with the coat of arms of the United States in the center. The life-sized eagle, with long outstretched wings, and other emblems, are all hand-sewed and involve the most patient work. The flag is made in two sizes, 10 feet by 14 feet and 3 feet by 5 feet. The silk used on this and other designs costs $9 a pound. The largest flag made is the United States ensign No. 1, 36 feet long by 19 feet wide, which costs $40.

The most difficult, expensive, and likewise consuming the longest time to make, are the foreign flags. This is especially true of the South American and certain others. These in most cases average 5 feet in diameter. The work is done by a half-dozen specially skilled hand device sewers, each having acquired the knack of making certain of the center designs to perfection, and continually kept on these respective flags. Every battleship carries forty-three foreign flags, 25 feet by 13 wide. A smaller size is also made. The weakest in point of power and smallest of the Latin nations have the most gorgeous and picture-bedecked ensigns. That of San Salvador is especially so, and requires much time and patient labor to complete. The half-tone representation of this hardly brings out the wealth of detail and elaborate sewing that is expended on it. For a center piece the San Salvador has a regular marine landscape, consisting of a belching volcano and a rising sun, set in a varied design of draped banners, cactus branches, cornucopias, and a swastika on the ground of a rayed diamond, with the date of the independence of the nation inscribed on the top. One hundred different pieces are used to form the center design. It takes one woman sixteen days to complete the San Salvador ensign, which costs $52.50. The most expensive ensign to make is the German, which, owing to the delicate scroll work of the large imperial eagle and royal crown, necessitating delicate, slow, and careful sewing, costs $56.50. The dragon flag of China consists of two hundred separate pieces. Twelve to fourteen days are ordinarily consumed in finishing this flag, which costs $51.75. The flag of Siam with the huge white elephant costs $38. The Mexican, with its center design of a large eagle holding a serpent in its bill, cost $39.50. The cheapest foreign flag made is the Moorish, which costs $21.

Last year 150,000 yards of bunting were used. This is all wool, 19 inches wide. Samples of English and Italian bunting have been tested in the past to compare with the American. The former lacked in tensile strength and was over-weight, and the red lost considerable color in the washing tests. The Italian filling was not up to standard, and likewise lost color. The warp and filling of the navy bunting now used has thirty-four threads to the inch, and is of light weight—a very desirable feature. The material is given both a chemical and physical test. For the former several strips are cut from a bolt, which are soaked and washed in soap and fresh water for twenty-four hours. The next day the same process is followed, using salt water. They are then exposed to the weather for ten days, thirty hours of which must be in the bright sunlight. This is for the color test. No fading or running of colors is tolerated. For tensile strength, a strip of the warp two inches wide is placed in a testing machine, and must have a tensile strength of sixty-five pounds, while two inches of the filling must sustain a forty-five-pound test.

The many thousands of stars are cut out by an ingenious machine, specially devised for this purpose, operated by a four-horse-power electric motor. Only a few years back the stars were cut out by hand. The machine has a plunger fitted with steel knives, the shape and size of the star. A single down stroke cuts out from fifty to one hundred at a time.

Pressing the foot on a pedal operates the machine. In all, eight different sizes of stars are used, each having a special die. Running the machine for only an hour a day furnishes enough stars to keep the women operators going for several days. The stars vary from fourteen inches in diameter to less than two. All completed flags are pressed by an electric ironer. A heading of flax raven canvas is sewed on, together with a distance lining of plaited hemp rope. This fiber will not kink or twist, and is specially made for flag purposes on board the naval prison ship at Boston. Wooden toggles for catching the loop are also put on, and the border stamped with the name of the flag and date of contract. After being critically inspected and passed by Master Flag-maker Malloy, the flags are delivered to the general storekeeper in the yard, where they are held until needed by commissioned ships.

HOW GLACIERS ARE STUDIED.

BY CHARLES WILES.

Despite the interest that has been taken especially in recent years in the study of glaciology, the thickness of but one of the world's glaciers has been accurately determined. This is one of the ice formations in the Tyrol, which has been pierced by the tedious process of hand drilling, and its depth from the formation on which it rests to the surface of the ice ascertained to be a little over 400 feet. The thickness of the great Piedmont glaciers, such as the Malaspina and Miles, and the Alpine glaciers in the Cascades of the United States and the Selkirks in British Columbia, have only been estimated by those who have made a study of them.

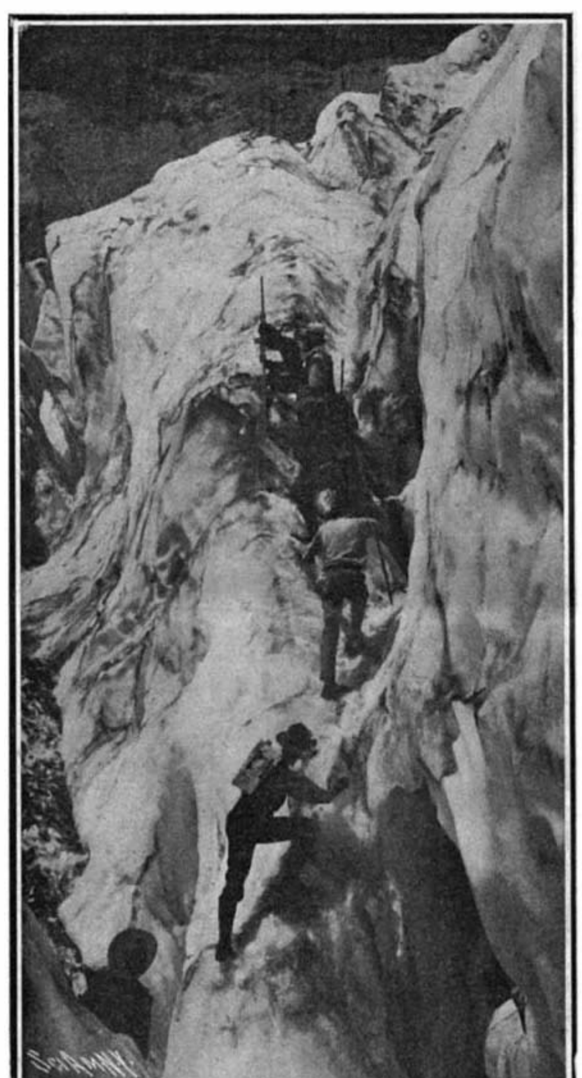

Photo. by A. Curtis.

A Hard Climb.

HOW GLACIERS ARE EXPLORED.

While scientific observation on other lines has been materially aided by funds advanced by institutions and individuals, glacial study in America has not had the support its importance merits, and much of the data we have of the great ice masses lying on the coast and mountain slopes of western America is due to the efforts of a few investigators, who in some instances have taken up the work unaided financially. Thus it happens that the surface dimensions and glacial flow or movement have embraced most of the information with which we are familiar. For example, the Nisqually, one of the largest on Mount Tacoma or Rainier, has been calculated to be at least 500 feet thick near its lower edge. A study of the ice wall at the point where it terminates in the Nisqually Valley would indicate that these figures are not exaggerated, and that the slope of the valley which is covered by the glacier may be more abrupt than is generally supposed. Should this be the case, the thickness at the bottom may be much more than the estimate given.

This lack of data in connection with glaciology is more noticeable for the reason that the glaciers, not only in the Alps but in the western portion of the United States and in British Columbia, have been the subject of careful study. The notable group on Mount Tacoma (Rainier) has formed an attractive series for scientists. As far back as 1857 at least one of the formations on Tacoma was known, but no authentic information was obtained until investigated by Prof. E. S. Emmons in 1870. In 1905 Prof. Le Conte, of the University of California, ascended the mountain, and with his associates devoted considerable time to a careful survey of the Nisqually glacier. The results of the investigation of this party proved of much value in adding to information on the subject, although, as stated, no measurements of the thickness of the ice could be secured except figures based on general estimates. The surface of the Nisqually was measured by the use of such well-known instruments as the theodolite, and its width and length accurately noted for what was probably the first time.

The movement of this glacier has been the subject of much attention among scientists, who have visited Mount Tacoma, on account of its shape and location. Lying in a valley inclosed by walls of lava formation, the glacier apparently has cut its way through the volcanic rock on which it originally rested, for the walls on either side rise above the ice surface to a height ranging between 1,000 and 1,500 feet. The incline of the glacier downward is at a very steep angle for the greater portion of its length. In fact, the head of this great river of ice in places is almost a vertical wall. Consequently, the downward pressure is enormous. In summer, when the lower portion disintegrates more rapidly on account of the rise in temperature, the fissures or crevasses in the surface are much more numerous. The movement of the ice mass in connection with the moraines is of such extent, that one can distinctly hear the sound produced by the cracking and grinding of the ice at a distance of a half mile from the gorge in which it lies. That the Nisqually is one of the most active glaciers in North America is shown by the fact that in a single day the lower portion has moved twenty-two inches. One of the most rapidly-moving glaciers thus far measured is the Mer de Glace in Switzerland, which has a record of thirty-five and one-half inches in twenty-four hours. Needless to say that the movement varies considerably, depending much upon the time of the year, as well as the bed on which the glacier rests. Should the formation change in character by the erosion of the ice, and the latter encounter a soft rock stratum, its downward movement may increase considerably, owing to the decrease in resistance to it. The width of the Nisqually from edge to edge is nearly 1,500 feet; its depth has been estimated at 500 feet. The crushing force of such a mass can only be imagined. Looking down into the abyss in which the glacier lies, the Niagara gorge seems of insignificant proportions in comparison.

The Nisqually is one of four large glaciers which form the upper ice cap of Mount Tacoma—a cap of such dimensions that at a distance of sixty miles the top of the mountain appears to be entirely covered with it. Like the Nisqually, each of the others forms the source of one of the most important rivers of the Northwest, this single mountain giving birth to the Nisqually, the Cowlitz, the Puyallup, and the White rivers. Including the smaller ice fields, Mount Tacoma contains no less than sixteen glaciers. Consequently it affords in itself a broad field for the study of glaciology.

As has already been stated, the surface of glaciers is measured by some of the methods usually employed in civil engineering. To ascertain the movement, however, a somewhat novel plan has been adopted in connection with the Tacoma glacier. Selecting suitable spots on the surface, holes are cut in the ice into which stakes are firmly driven. Care is taken, however, to set the stakes in a straight line at right angles with the length of the glacier. The stakes are placed at nearly equal distances apart, the line extending a considerable distance across the surface. Other stakes or base marks are made on the bank at the side of the glacier. The change in the position of the stakes after they have been driven aids in determining the glacial movement, for they not only show the total extent to which the ice mass has worked its way downward, but the more rapid movement of some portions than others, as the line of stakes is so irregular. For example, the stakes in the center may be considerably in front of those at the side, indicating that here the downward and forward pressure is greatest. Another method of ascertaining the movement is to substitute cairns of stone for the stakes, locating them with special relation to "monuments" on the bank, so that the movement can be gaged by their position after being erected.

Prof. Le Conte's party had a special opportunity to observe the extent of the crevasses in the Nisqually as well as the Cowlitz glaciers, since their investigations extended beyond the *névés* in each case. The trip up the mountain was made from Reese's camp in the Paradise Valley, which is bounded on one side by the Nisqually gorge. One of the principal routes taken in reaching the summit is up the head of this valley, skirting the precipices known as Mc-

Clure's rock and Gibraltar rock, the latter extending nearly to the head of the Nisqually glacier. The accompanying photographs give an idea of the ice climbs and snow crossings which the party encountered during its investigation.

While none of the larger crevasses could be precisely measured as to depth, it was the conclusion of the observers that few if any of those on Mount Tacoma exceed 150 feet in depth, although guides on the mountain claim to have come across fissures in the Cowlitz formation over a half mile in length. It is believed that the depth of these ice cracks in the Alps as well as in America is often grossly exaggerated, and that instead of being 300 or 500 feet as is sometimes stated, they seldom exceed 200, since the downward movement of the ice continually tends to force the walls of the crevasse together, overcoming the force which originally caused the disruption.

The Industrial Uses and Value of Alcohol.

BY HENRY HALE.

(*Continued from page 511.*)

The automobile in this country is but one way in which the internal combustion engine is finding favor as a substitute for steam, for animal power, and for human labor. A conservative estimate of the number of such motors in service in the United States at the beginning of the present year placed it at 300,000, including mechanism for operating small vessels as well as stationary engines. The rapidly expanding use of this form of power is shown by the present output of companies making a specialty of constructing so-called gas and gasoline engines. One plant located in Philadelphia is building about 1,200 engines this year, which will aggregate 20,000 horse-power. This is a branch of a German corporation which constructs liquid fuel motors ranging as high as 3,000 horse-power for an individual installation. The American orders of this company during 1906 will need a supply of at least 6,000,000 gallons of fuel for their operation. The Board of Commerce of Detroit, which is a notable manufacturing center for small motors, has made a canvass of the various companies, and has learned that during the present year they will complete mechanism for automobiles, marine use, and for pumping which will require at least 200,000 gallons of fuel daily when in operation. As a further indication of the expansion in the motor industry, two plants in Chicago have increased their facilities until they now have a combined capacity for building no less than 50,000 motors annually, ranging from 1 to 20 horse-power each.

As yet gasoline constitutes the staple fuel for the internal combustion engine in the United States. Therefore its properties compared with those of ethyl alcohol as a source of power are of no little interest. Fortunately, alcohol has already been employed for internal combustion motors to such an extent that its advantages or disadvantages can be correctly determined. In Germany a series of very exhaustive shop tests have recently been made with gasoline and alcohol with engines which varied in size from 10 to 30 horse-power. The results obtained showed that an engine of a given size—that is, a given cylinder capacity—produced an average of 20 per cent more power when run on alcohol than when operated with gasoline. This is due to the fact that it is possible to get a higher efficiency from alcohol, because it can be compressed to a much higher degree without danger of spontaneous combustion than is possible with gasoline. The thermal efficiency of the engine, that is, the degree of utilization of the heating value of the alcohol, is therefore much greater than it is with gasoline, the figures being about 21 per cent for gasoline as against 30 per cent or more for alcohol. The consumption of alcohol per horse-power at this test was practically the same in volume as when using gasoline—about one-eighth of one United States gallon per hour. This is as far as the shop tests made with such engines before shipment were carried.

Another test has been made by a chemist, a professor in a German university, the object being to determine the effect of the exhaust gases upon the interior portions of the engine and its connections, and the degree to which the atmospheric air would be contaminated if the exhaust gases, as might be the case, were puffed out into a room occupied by human beings. This was done with a view to using alcohol locomotives for transporting cars in mines instead of using horses, mules, or gasoline power. The results showed that these exhaust gases contained 20 per cent less obnoxious constituents than the exhaust gases from a gasoline engine. It was also shown that an alcohol engine produced about 30 per cent less constituents which tend to contaminate the air than a number of horses doing the same amount of work as the engine. In addition to this, the horses or mules will keep on fouling the air when they are doing no work at all, which, of course, is not the case with an alcohol engine when idle.

Tests have also been made of engines in actual service in this country by employing the two fuels under the same service conditions, the motors being of 10 and 15 horse-power. A few preliminary tests were made to compare the rate of evaporation and danger of explosion of gasoline and alcohol. First, a surface about six inches square was covered with equal volumes of gasoline and alcohol. The alcohol took twice as long to evaporate. Second, a small quantity of gasoline in a receiver placed in any part of an iron bucket had, at the end of a half hour, filled the bucket with explosive mixture, so that a lighted match placed anywhere in the bucket caused an explosion. The same experiment tried with alcohol failed entirely, although the alcohol was allowed to stand a longer time. There are two reasons for this. Even dilute mixtures of gasoline vapor and air are explosive, and gasoline vapor, being much heavier than air, diffuses upward very slowly, thus keeping the mixture near the liquid rich enough to be explosive.

The 10-horse-power engine was tested with alcohol in the same condition in which it had previously run on gasoline, without any change whatever. It developed 11 brake horse-power, as against 10 horse-power with gasoline, and consumed 1½ pints of alcohol per horse-power per hour. By increasing the compression of the engine, this consumption was reduced to 1.1 pints per horse-power per hour. There was no difficulty in starting the engine on alcohol, even when cold. This is particularly important to determine, as in the German engines it was necessary to start the engine on gasoline and turn on the alcohol after the engine had "warmed up," which took about two or three minutes. The 15-horse-power engine showed similar results, the power developed being 16.5 as against 15.2 with gasoline, while the spirit fuel consumption was 1.08 pints per brake horse-power per hour.

In this connection it may be added that alcohol has been substituted successfully for gasoline in a trial made with the engines of a United States submarine torpedo boat. A test of several hours' duration was made, during which an engine was connected to two full tanks, one containing gasoline and the other alcohol, in such a manner that either of the two fuels could be turned on or shut off. The engine was first started on gasoline, and after a half hour's run the gasoline was shut off and the alcohol turned on. There was no change then in the amount of power developed, but the fuel supply valve had to be opened a little more, increasing the consumption from 0.110 of a gallon to 0.130 of a gallon per horse power hour. The engine was shut down after a two-hour run, allowed to cool off, and was started on alcohol and run for another period of one hour. It was then taken apart, and the cylinder valves and interior portions of the engine were carefully examined by the engineer. It was shown that the parts exposed to the combustion were as free from rust or sediment as they generally are when using gasoline.

Referring again to Germany, in 1905 over one thousand engines were built in that country to utilize denaturized alcohol exclusively. They included motors for vehicles and boats, motors to drive farm machinery, motors for pumping water as well as for electric light plants, bakeries, and flour mills. All these are actuated on the same principle as the gas or gasoline engines. The alcohol is injected into the cylinder in the form of spray, being compressed by the piston on the return stroke. The contact points of the electric igniter extending to the interior of the cylinder to provide the spark which explodes the vapor.

The value of the alcohol motor in modern agriculture, especially on the extensive farms of the West, promises to be of great importance. With an abundant supply of raw material at hand, plants for distilling spirit can be erected wherever liquid fuel is needed, just as the grist mill supplied the neighborhood with flour in the old days. It is not necessary to transport it long distances by rail or water at so much extra expense for transportation, consequently the farm motor should become as much of a necessity as the plow and the harvester. The small stationary motor of one or two horse-power is sufficient to grind the feed, saw the wood, churn the butter, actuate the cream separator, and run the mill. The next improvement to the traction engine will doubtless be the substitution of internal combustion for steam, which means that all of the more arduous farm labor, such as plowing, harrowing, cultivating, harvesting, threshing, shocking corn, etc., can be accomplished even on small farms more rapidly and economically than by the employment of horse power.

One of the principal obstacles to the reclamation of the arid territory of the West has been the expense of operating machinery for pumping water where reservoirs could not be located to furnish an adequate supply by gravity. Many irrigation sites are at such a distance from petroleum wells, coal deposits, and woodland, that the cost of fuel for the pumping engines is prohibitive. As the sugar beet forms one of the staple crops of irrigated land, and, as already stated, yields a large percentage of alcohol, it is only necessary to raise a sufficient crop of these vegetables to insure a permanent supply of power for pumping and all other machinery required.

Correspondence.

Immunity of Mines from Earthquakes.

To the Editor of the SCIENTIFIC AMERICAN:

In corroboration of the statement of your correspondent, E. D. Guilbert, of San José, regarding the fact that earthquakes were not felt down in the mines at Honduras, I will state that the same phenomenon was experienced at the New Almaden quicksilver mines, near San José, where the workmen, 1,500 feet under ground, did not feel the shock, though buildings at the mouth of the mine were shaken down by it. Can you or any seismic expert explain this singular phenomenon? Furthermore, will you kindly publish the fact that this beautiful "city by the sea" has not been "wiped off the map" by a tidal wave at the time of the earthquake, as has been falsely stated by many eastern papers? There was no tidal wave, and very little damage was done by the earthquake, aside from chimneys being broken. Not one person in the city received any injury from it. CHARLES WITNEY.

Santa Cruz, Cal., June 13, 1906.

Earthquake-Proof Cemetery Monuments.

To the Editor of the SCIENTIFIC AMERICAN:

In enlarging her cemeteries, San Francisco might do well to adopt a custom I noticed in the South just before the earthquake, and whatever might befall her residences, her memorials of the dead could not be shaken down. In Rosehill, the cemetery of Macon, Georgia, a very beautiful and thriving city of 40,000 inhabitants, most of the tablets lie flat on the ground. A large proportion of them are plain brick and mortar slabs, of various sizes, those for adults being about 3 feet by 6, certainly not a durable or attractive style of architecture. Often a lot would contain a large number of these slabs, with a few of marble, and many of the later and more ornate of polished granite.

The stone slabs usually bear brief inscriptions, the brick rarely, though sometimes ornamented with vases and sea-shells. Among them are scattered monuments which, of course, are upright, and bear the usual inscriptions of loving remembrance. The later memorials are heavier slabs with more ornamentation, and most of them lie on the turf or are raised slightly above it. The general effect as one looks over the slopes is very pleasing, though of course the brick slabs have nothing to recommend them either of beauty or durability.

In my own mind I reasoned that the custom must have originated in war time, when labor and material were both wanting; but I was informed by Mr. Massonburg, the city clerk, that it bears date much earlier. He came from the Jamestown peninsula, in Virginia, sixty years ago, and noticed the same thing near there, and thinks it was brought from the old country by the earlier settlers of the colony. G. S. PAINE.

Winslow, Me., May 20, 1906.

The Panama Canal Problem.

To the Editor of the SCIENTIFIC AMERICAN:

Will you please inform me if it has ever been proposed to build a 30-foot earth dam at Gatun (for the Panama canal), maintaining this level to the foot of the northern slope of Culebra, with a 60-foot level through the cut, maintained by a masonry dam and single lock supplied with water from Gamboa basin through a side channel? It would necessitate a minimum level of 60 feet in the basin, with a reserve capacity above this level for the reception of the Chagres floods, controlled at the side channel by suitable flood gates.

On the Pacific slope dams with single locks would be necessary at Pedro Miguel and La Boca. The dam near Obispo would be comparatively inexpensive, as the artificial channel only would be encountered, probably with bedrock foundations at its bottom.

Locks in flight would be altogether avoided by this plan, and the Gamboa dam would serve the doubly valuable purpose mentioned, which with the creation of a great water power at this point would justify its erection.

If the maintenance of an 85-foot water level by an earth dam at Gatun is a feasible work in the opinion of some engineers, but contested by others, there would certainly be little room for differences of opinion concerning a 30-foot level dam. The efficiency of a canal of this type would doubtless be fully equal to that of sea-level construction, while the saving at Culebra and throughout the whole course of the canal would be enormous. The free sailing advantages of the 85-foot level type would also be secured, and a considerable item in land damages avoided. W. F. CLEVELAND.

Chicago, Ill., June 6, 1906.

[Among the many earlier studies of the Panama canal problem there was, we believe, a proposal to build a dam of moderate height at Gatun and a dam for a 60-foot summit level at Bohio. This plan is being suggested as an alternative to the 85-foot Gatun dam.—ED.]