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.]