will burn brightly for a minute or two. This is what has been possible for several winters on Doniphan Lake, Kansas, and on one of its tributary streams.

The fuel for these fires is natural gas, which bubbles up through the water the year round, but it is only during the very cold winter nights that it is thus temporarily stored under the ice in immense bubbles or pockets, sometimes ten to twenty square yards in extent. Puncture these bubbles with a chisel, apply a lighted match, and one has a roaring flame before which the skater may warm his benumbed fingers. The experimenter must be careful to stand between the wind and the jet of gas as he lights it, or he will have his clothing singed before he can get out of the way of his impromptu torch.

There are places where the gas supply is so abundant as to prevent the ice from forming, except on the very coldest nights. When such places are frozen over they remain covered only a few days, for the gas, coming from a considerable depth in the earth, is so warm that it soon melts a passageway through the ice and escapes. The present winter formed ice of fifteen inches thickness on the lake, and yet some of the areas of gas supply were not frozen over. Near the entrance of one of the creeks into the lake the water is quite shallow and the bottom may be readily seen. Here the gas has formed regular channels up through the mud, and out of these large bubbles of gas are discharged every few seconds.

Doniphan Lake is located about four miles north of Atchison, Kansas, and is a river lake; that is, it was formed from a bend of the Missouri River by the water taking a short cut across the narrow neck of the bend, thus leaving the old bed to be occupied by a beautiful horseshoe lake about five miles in length. This happened during the high waters of the spring and early summer of 1891.

Because the lake is thus comparatively recent in formation, some observers have contended that the gas which collects under the ice is only marsh gas. But the supply is too great to be accounted for in that manner. Were it marsh gas, it would rise more equally all over the lake, for the bottom is everywhere about the same. On the contrary, the gas is supplied only in certain localities, and the eastern arm of the lake is without gas. Besides, the places of discharge are the same the year round. On the Missouri side of the river are three other lakes of like formation: Mud, Sugar and Bean Lakes. These do not show gas except in occasional very small bubbles.

It is not surprising that natural gas should be found in eastern Kansas. A boring at Kansas City, about fifty-five miles south of Doniphan, gave a small supply of gas a few years ago. Ninety miles southwest of Kansas City, at Iola, Kansas, a gas well, in recent years, furnished seven million cubic feet of gas per day.

There is no doubt that the Doniphan gas is true natural gas, and comes from the interior rocks of the earth. The question of quantity can only be determined by prospecting. Should a "gusher" be struck here, it would be a great find, for St. Joseph, Mo., is only sixteen miles to the north, Atchison is practically on the field and Kansas City is less than sixty miles to the south.

## THE PUBLIC LANDS OF THE UNITED STATES.*

Nearly one-third of the whole United States, exclusive of Alaska, is still in the hands of the general government, the greater part of this being open to entry and settlement under the Homestead act. The great bulk of these vacant public lands lies within and west of the Rocky Mountain region, considerable areas, however, remaining in Florida, Alabama, Mississippi and the States west of the Mississippi River. The lands within the western half of the United States are, for the most part, within an arid climate, and although the soil when watered is very fertile, yet the scarcity of water supply renders it difficult, if not impossible, for the settler, unaided, to make a home.

During the past twenty or thirty years the development of agriculture by irrigation has proceeded rapidly, until at the present time nearly all of the easily available sources of water supply have been utilized. There remain, however, many large rivers whose flow has not been diminished by the diversion of water for irrigation, and also many opportunities for the construction of great reservoirs in which floods can be held until the season when water is required.

The construction of the great irrigation systems by which thousands of acres can be rendered susceptible of irrigation requires enormous capital. A number of large enterprises of this character have been built by corporations, but, as a rule, these have not been profitable. Nearly all of them are now bankrupt, owing to the difficulty of selling lands or water rights to persons who can successfully till the soil and pay the annual charges for maintenance.

Irrigation is an art which requires many years of practice, and the average farmer, coming from humid lands, meets with so many disappointments and failures that he is apt to become discouraged, and, with small means, is barely able to obtain subsistence, much less to make the payments required by his contract.

The canal systems have, as a rule, cost considerably more than anticipated, owing to unforeseen difficulties or accidents. The interest charges and cost of maintenance have eaten up the resources of the companies, so that the history of most enterprises of this character has been a series of financial disasters, although the systems, as a whole, from an engineering standpoint, have been good. The great question for the American people is how to utilize the vast area of vacant fertile land so that it shall be used for homes for future millions. With forethought and wise laws, it will be practicable for a population as large as that east of the Mississippi River to find homes in the West, but, with the haphazard methods prevailing and lack of systematic control, it is doubtful whether a small proportion of these can be accommodated.

The laws governing the public land were made to suit the conditions of the Ohio and Mississippi valleys, and the attempt to apply them in the arid West has been disastrous to the interests of the people as a whole, allowing favored individuals to grasp the scanty water supply and thus hold in tribute thousands of acres, preventing others from sharing in what should be the common property.

Only a small proportion of the vacant public lands can be irrigated, on account of the lack of sufficient water; but even this small amount, being widely scattered, will render possible a large population. The remaining land is, for the most part, valuable as grazing, although there are vast tracts originally covered with forests upon which trees will grow, if not wantonly destroyed. The public forests, however, have been recklessly pillaged and fires, set by accident or design, have destroyed timber and woodland of inestimable value in the future development of the country.

The land laws are confessedly poor and their enforcement necessarily weak. Everyone is apparently interested in obtaining what may be of momentary advantage or pleasure to himself, with utter disregard for the future. With the reckless destruction of the forests, it is believed by many that diminution of the water supply has followed.

The public lands being open to everyone and grazing permitted everywhere, it results that herds and flocks wander at will, pasturage being governed largely by questions of the supply of water for drinking. Most, if not all, of the springs have been seized upon by cattle companies, who, from this point of vantage, exclude others from the vicinity. Where water is comparatively abundant, there has been a tendency for the stock to increase to the limit of the food supply, and, as a result, the vegetation has been eaten so close that many of the more nutritious forage plants are said to have been exterminated from certain areas. Thus, from all sides the public lands are being plundered and their value reduced, while the man who would make a home is at continually greater and greater disadvantage, owing to the fact that, apparently, no one is charged with the duty of looking to the future and protecting the grazing, woods and water from injury.

Since the time of the revolution, the public lands have served as the outlet for the energies of the people. During the prevalence of hard times, men out of employment could go West, take up a homestead, and, by their own labor, secure a competence for their children. The public lands are still of enormous extent, and this condition might continue to prevail for many decades, but now has almost ceased, owing to lack of forethought in ascertaining the water supply and in protecting it so that all men might have opportunities of utilizing it to the fullest extent. The mischief in many localities is now past remedy, but in others it may be possible for the general government of the States to construct the necessary works by which the fertile arid lands can become the homes of many prosperous people.

The easily available sources of water supply have been taken by individuals or corporations. These have built ditches and canals by which several millions of acres have been brought under irrigation. The smaller enterprises have, as a rule, been successful, and, as in the case with the Mormons in Utah, the farmers dependent upon irrigation have been more prosperous than those of any other part of the United States. The large corporate enterprises have, as a rule, been financial failures, owing to the difficulty of selling their lands or water rights to farmers. There remain opportunities for the construction of many great irrigation systems requiring enormous capital; but since it is doubtful whether these can be made to pay a fair rate of interest, it is improbable that investors will risk their money.

The construction of these great canals and storage reservoirs is a matter of prime importance to the State and nation, as in the case of harbors, lighthouses and other works pertaining to navigation. Although these do not pay directly, yet their indirect benefit is such as to justify large annual expenditures. In the case of irrigation works there is no doubt but that the cost of reclamation will ultimately be returned, and possibly a small interest on the first investment, so that the government will, in the long run, be reimbursed.

Before the work of reclamation on a considerable scale can be undertaken, it is necessary to be fully informed of all the conditions, and to ascertain as nearly as possible what will be the probable water supply. Investigations of this character are being undertaken by the United States Geological Survey, maps prepared and systematic measurements of various streams being made. Not only is surface supply being ascertained, but a careful study is carried on of underground structure, in order to bring together data concerning the possibilities of obtaining water by pumping or through artesian flow. The results of these investigations are published from time to time in the annual reports of the Geological Survey and in special bulletins dealing with various phases of the subject, and known as the water supply and irrigation papers.

When all the water supply has been utilized that may be obtainable, it is probable that nine-tenths of the public land will still remain unirrigated. Much of this is valuable for grazing, and, if proper laws are enacted, such that farmers and cattle companies can be secured in their enjoyment of certain definite tracts, it will be possible to enormously increase the pastoral industries. A system of leasing must be adopted in the near future giving preference to the small farmer or settler, so that he may be induced to make a permanent home.

The public forests, so necessary for the growth and development of the country by furnishing timber and firewood and in protecting the water supply, should be held by the government and guarded from fire. The experience of other countries has shown that this can be done at relatively small expense and the timber used, the young growth being protected so that the supply is continually renewed. It is practicable to inaugurate a system of supervision which will be amply supported from the sale of timber. The forests, instead of being rapidly destroyed, will tend to increase in value. Before this can be done it is necessary that the people of the United States awake to the present conditions and give the matter of their heritage a proper and businesslike consideration.

* Abstract of two lectures delivered before the Franklin Institute, Philadelphia, by F. H. Newell, Hydrographer to the United States Geological Survey.

## LONDON'S UNDERGROUND ROAD.

The American companies obtained the entire contract to equip the London Underground Railway, including the electric locomotives, under the following guarantee: Efficiency of steam engine at full load, condensing, 92 per cent; efficiency of three-phase generators, without counting the current for exciting the field magnets, 95 per cent; average efficiency of transmission of current from the power house to the locomotives, including the loss in transforming the current from a high voltage to a low voltage under a full load, 90 per cent; efficiency of the locomotives under full load, 90 per cent.

The entire length of the new line is 5⅛ miles, and there will be ten stations between the two terminals. At each station there will be large electric elevators to carry the passengers to and from the street. The train service will be carried on by 32 trains of 7 cars each, the seating capacity of each train being 336 passengers. The average speed of the trains is to be 14 miles an hour, including 20-second stops at each station. The maximum speed between stations will be 30 miles an hour. The trains will be run at first on a 2½ minute headway. In order to obtain these speeds with the smallest expenditure of cost, an interesting expedient has been resorted to in the construction of the tunnels. Instead of building it on a level or with constant grades from station to station, the separate tunnels which carry the tracks are run in a series of dips. The train upon leaving a station will immediately start down an incline, so that gravity shall add to the acceleration of its speed. When it approaches a station it will run up-grade, which will stop it with little use of the brakes. Each train without the locomotive will weigh 105 long tons and with the locomotive 147 long tons, but with the dipping tracks only 100 horse power will be needed for each train.

## A METAL RUST PREVENTIVE OF 1402.

In an entertaining but little known book, entitled "Sir John Hawkwood," by John Temple-Leader and Giuseppe Marcotti, we find the following receipt for a metal polish and anti-rust: "Cut off all the legs of a goat from the knee downward, let them stay in the smoke for a day, then keep them fifteen or twenty-five days. When you require them, break the legs and take out the marrow from the bones and grease the arms (armour) with it, and they will always keep bright, even when wet."

Those of us who are fortunate enough to possess any armor find that vaseline is equally effective. It is not very generally known that one of the most famous captains of mercenary troops in Italy, in the fourteenth century, was an Englishman, Sir John Hawkwood.