tute so characteristic a feature of the high Alps: arm-chair-like recesses in the mountain slope, frequently arranged in groups all backing towards a central peak or an axial ridge and separated by sharply serrate spurs. Valley troughs are also considered, and these as well as the Kahre are referred to glacial erosion under conditions that are critically specified. Among many important conclusions are the following: The high Alps, rising above the snow-line of the glacial period, owe their form largely to the destructive processes of that time. Whole ranges, 100 kilometers long, exhibit sharp high-mountain forms, with corries and serrate spurs, although they bear no glaciers at present. If it had not been for the glacial period, these ranges would to-day have the rounded forms appropriate to mountains of middle height. During the most extensive glaciation, the Swiss ice-fields stood so high—even over the forelands towards the Jura—that they were above the level of the snow-line; the slope of the snowy surface was gentle and the movement of the ice-streams in the larger valleys must have been slow. The trough form that obtains in all the strongly glaciated valleys—with over-deepened floors and over-steepened walls—is due to erosion by glaciers of medium size, whose surface did not rise above the trough walls, but whose movement must have been relatively rapid because their surface slope was strong. Ice-scouring during maximum glaciation reached far up the mountain slopes above the trough walls, but was without great influence on form. A level of extensive erosion is seen in the high Alps, coincident with the snow line of the glacial period; the peaks that rose above this level were actively consumed by weathering, while the surrounding valleys were smothered in heavy but slow-moving ice.

NEW ZEALAND.

The ninth volume of the *Bibliothek der Länderkunde*, entitled 'Neuseeland' by R. von Lendenfeld (Berlin, Schall, 1900, 186 p., 24 pl. and fig., map), is a very attractive volume from which one may gain a clear impression of the country dealt with. Limiting this note to sections of a physiographic nature, mention may be made of Banks peninsula, a dissected volcanic group, standing in front of the Canterbury plains, with which it is connected by long tangential sand reefs. A tunnel cut through one of the volcanic slopes has disclosed 174 different layers; lava, loose or compact, conglomerate, and weathered soil. The Canterbury plains, composed of recent fluviatile deposits brought from the mountainous background, have a gentle slope seawards; the flooded rivers build up their surface with coarser deposits near the mountains and finer deposits near the shore; as their channels become clogged, the water deserts them for new courses, thus the whole surface is slowly aggrading. The account of the fiords of the southwest coast mentions their numerous waterfalls, but one must read between the lines to see that the falls leap forward from hanging valleys, such as now appear to be characteristic of strongly glaciated mountains. A striking example of such a valley seems to be shown in the plate of Mitre peak, Milford sound (fiord). The volume has a good index, but the pages are headed only with their numbers, in German fashion. The frontispiece of Mount Tasman and the Hochstetter glacier is remarkably fine.

W. M. Davis.

CONTEMPORARY THERMODYNAMIC EFFICIENCIES.

This is the day of remarkable things in the field of heat-engine construction. The *Inchdune*, and a sister ship on the 'Inch Line' of a well-known British steamship company, has produced the horse-power-hour on 0.96 pound of coal and, for the time, holds the world's record in steam-engine efficiency. This gives an efficiency, between the coal-pile and the point of transformation into power of the potential energy of the fuel, of almost precisely twenty per cent.

The steam-turbine is produced in such perfection of design and construction as to compete with the best of reciprocating engines of similar power and the report now appears in the German engineers' *Zeitschrift* that Jacobson, at Potschmühle, has tested a Laval Turbine which, rated at 300 horse-power, demands but 7 kilograms per horse-power-hour at its rating, a trifle more at 342 delivered horse-power, and, a most remarkable achievement, at one-tenth its rated power only increases the consumption of steam to 9.74 kgs. This is better than any record yet reported for the reciprocating engine in maintenance of efficiency with diminishing delivery. The steam-pressure was about 8.5 atmospheres. Superheating gave about ten per cent. gain. The speed of the machine was about 10,000 revolutions a minute. A condenser was employed.

The Engineer-in-Chief of the U. S. Navy, Admiral Melville, reports in his annual message to the Department a remarkable set of data from the trial of the water-tube boilers of the U. S. S. *Cincinnati.* Steam was raised from cold water to a pressure of 215 pounds in 12 minutes, 40 seconds and without injury. The old shell-boiler would have needed several hours for getting up steam and, if forced, would have been expected to develop leaky tubes in all directions. After steam was up, the series of trials reported on was made, with forced draught, fuel being burned at rates ranging between 20 pounds, as a minimum, to above 50 pounds, per square foot of grate area, and with resulting evaporation of water of from nine pounds per pound of fuel, at the minimum, to 8.6 at the maximum rate of combustion. This is the equivalent of from 12.19 to 11.43, 'from and at' 212° F., per pound of combustible portion of the fuel, an efficiency of boiler of from 85 to 90 per cent. The coal used was of the Pocahontas variety, which contains ordinarily but two or three per cent. of ash. Here the ash and refuse in unburned coal and clinker amounted to about ten per cent. This is the most remarkable performance of which we have record. The evaporation is excellent at the lowest rate of combustion and wonderfully well sustained through the higher ranges. It probably constitutes a world's record to date.

Gas and oil and petroleum-vapor engines are also coming to the fore in a remarkable way and the beginning of the twentieth century already commences to show the quality of the new era in these directions Mr. H. A. Marshall has recently presented a paper to the British Institution of Mechanical Engineers, now just published, in which he gives the outcome of investigations of the efficiencies of the gas-engines employing 'power-gas' of the Mond variety, differing from the well-known Dowson gas in the fact that it is made from bituminous 'slack,' instead of from anthracite. It requires the use of enormous quantities of steam—250 per cent. of the weight of the fuel—and makes a very lean gas; but it employs so cheap a grade of fuel as to furnish the unit of heat at an unprecedentedly low cost. It makes 150,000 cubic feet of gas per *ton* and this yields 2,000 horse-power-hours in large gas-engines of good construction. A by-product, ammonium sulphate, more than recoups the original cost of the fuel, with the English coals used. The outcome of this improvement and of the adoption of the gas-engine in large sizes for extensive work is that, whereas the cost of fuel for the ideal steam-engine of modern practice should not exceed about a half-cent, the real engine demands, as a minimum, one cent, and the average engine of the large British stations one and a half-cent, or more; while the gas-engine has come down to a considerably lower cost than the minimum just given. The figures for heat-units demanded are reported as about 25,000 B. T. U. per horse-power-hour for the best steam-engine and but 11,500 for the gas-engine, under best conditions and continuously working. The real comparison is necessarily that of costs of production of the unit of power and it is this relation which will ultimately determine the supremacy of one of the competing heat engines.

Gas-engines are now built in large powers—1,500 H. P., and larger powers can be readily supplied if called for—and are found to involve less practical difficulty on the large than on the small scale. They are now durable, regulate well and are economical in use of exceedingly cheap fuels. The results obtained at Winnington, as reported by Marshall, are, in fact, not only better, thermodynamically, than those given by any existing steam-engine, but are even better than even the ideals of the case brought into the comparison; all of which are engines in use in English power and lighting stations. The actual weight of fuel used at Winnington is one pound per h.-p.-h. This is substantially the same as the figure for the record-breaking steam-engine in marine practice already referred to; but the latter uses the most costly, the gas-engine the least expensive, fuel, and this is the vital matter. The gas-engine now has attained a mechanical efficiency of about 85 per cent. and a thermal efficiency exceeding 25 per cent.; both figures representing the practical limit in steam-engine practice also, although the former is sometimes exceeded. In both engines the efficiency, on the basis of the brake horse-power, is about twenty per cent., occasionally one or two units higher.

The Mond gas, with a thermal content of 150 *B. T. U.* per cubic foot, sells for twopence per thousand; this can be compared with our own illuminating and natural gases, storing 600 and 1,000 *B. T. U.*; of which, respectively, 16 and 9 cubic feet are used in good gas-engines, per horse-power-hour, while of the Mond gas at least 75 cubic feet are demanded.

Summing up the case: It may be said that the best work of the large gas-engine gives a thermal efficiency substantially the same as that of the very best steam-engine while it employs a fuel which is considerably cheaper than is employed where this comparison is, as here, made on the basis of fuel consumed. Its 'cost of plant,' on a large scale, is now quite as low.

The balance sheet of the best single gas-engine reported stands thus:

	Heat transformed, *B. T. U.*......	33.65
Heat received	Heat lost	
from	Cylinder-jacket.........	19.28
the fuel	Piston.....................	4.94
B. T. U.	Exhaust valve..........	3.34
100.	Total in cooling water...	27.00
	Heat waste in exhaust, etc.	38.79
		100.00

This is superior to any steam-engine performance yet reported.

During the discussion, Mr. Donkin reported in tabular form the best results of tests of gas-engines made in the United States with natural gas, the richest gas-fuel, either natural or artificial, available for large engines. The best figures in the table are those obtained in a Sibley College test of a Westinghouse gas-engine and reported by Messrs. Millar and Gladden in the *Sibley Journal* of June, 1900. The power developed was, net, 606 *H. P.*, the mechanical efficiency of the machine 90 per cent., the heating value of the gas about 1,000 *B. T. U.* per cubic foot, the consumption ranging from 10 cubic feet per *B. H. P.* to 8.8 for the indicated power. This gives a thermal efficiency of 25.5 per cent. The same figure is obtained, according to Mr. Donkin's tables, in Mr. Humphrey's test of an engine of a similar power of English make using Mond gas.

The twentieth century opens with the gas-engine for the first time in its century of evolution seriously competing with the steam-engine in important commercial work on a large scale.

R. H. THURSTON.

THE U. S. GEOLOGICAL SURVEY.

FOR the support of the U. S. Geologial Survey for the fiscal year ending June 30, 1902, Congress appropriated at the session just closed about $1,018,000, an increase of $52,000 or more over the present year's appropriation. Indeed, there was a strong disposition in Congress to make a material increase, notably for the extension of hydrographic investigations.

Of the several sums appropriated $250,000 is for the topographic surveys, including a report on the topography and geology of the territory adjacent to the 49th Parallel, west of the 110th Meridian. For the survey of the forest reserves there is $130,000, the same as the present year. For geologic surveys the amount is $150,000—no increase—and for the continuation of the investigation of the mineral resources of Alaska, $60,000. For paleontologic researches there is $10,000. For chemical and physical researches relating to the geology of the United States there is granted $20,000, being $10,000 more than the sum appropriated for the present year. The increase will enable the Director to carry on needful and long neglected physical researches in connection with the chemical work of the Survey. For want of funds the Survey has had no physical laboratory for some years.

For the collection of data and the preparation of a report on the mineral resources of the