He is known as a man who can 'really put away the boose'. Although his family never brags about it, he does, and so does some of his friends at work.

After a hard working day he often skips lunch in favor of three or four Bloody Marya. His favorite line is 'Look at all the Vitamin C I'm getting outa the tomato juice!' Lunch runs two hours or so, but there have been no major gripes about his work, so far. Lately, though, he spends many afternoons behind closed doors. His loyal secretary explains that he's 'on the phone' or 'in conference'.

By five he's ready to unwind with a few scotchies. About seven he phones home that he'll be late for dinner, and returns to the bar grumbling, 'Dinner what the hell she's mad about? I'm the one that's had the louisi day!'

Lately he has been getting more and more surly in these after-work drinking bouts but his friends shrug it off. Maybe he has problems, they say.

He certainly has one problem: he is sick.

His sickness is alcoholism. He is perhaps not yet a full-fledged alcoholic, from his symptoms, but he's on the way.

Every company has a few like him. There are something less than 400,000 alcoholics in Canada, and nearly twice as many other people on the verge of a serious drinking problem. Only a fraction of them are the stereotype staggering skid row drunk, Most of them are upstanding citizens. More than half of them are fully employed, and their problem costs industry an estimated $1 million a day.

Each problem drinker costs his company about 25 per cent of his annual earnings--maybe $1,500 to $4,000 a year, depending on his job and experience. In the case of a senior executive, it naturally costs more; indeed, five fuddled minutes over a vital contract could cost a company millions.

Surveys show that the alcoholic employee is only 50 per cent efficient on the job; has an above-average absentee record for other illnesses; has more than twice the number of occupational accidents; has up to 10 times the average number of non-occupational accidents (alcoholics try to be extra careful on the job, but after work all their caution breaks down); and lives 12 years less than the non-alcoholic. Nobody can estimate the loss in homes broken, marriages destroyed and children's lives warped.

Many companies in Canada—including Imperial Oil, Eaton's, Simpsons, General Motors, Bell, Kodak, Ontario Hydro and the Royal Bank—have specific programs to help the business drinker. About 60 per cent are successfully rehabilitated.

But in industry generally there is much yet to be done. The Harvard Business Review estimates that out of some 100,000 North American companies large enough to have effective alcoholism programs, only about two dozen did, in 1972. Companies are looking for guidance, though. Recently, a magazine reported on Mrs. Ann St. Louis, personnel counsel for Canada's Department of National Revenue, whose program is maintaining a phenomenal 90 per cent recovery rate among alcoholic government employees. As a result, the received more than one thousand enquiries from companies, hospitals, universities, police forces and governments across Canada.

'This kind of response is encouraging, because an employer—far better than wife, brother, minister or social agency—can lead an alcoholic to treatment by constructive coercion. It means: give an employee every chance to take treatment, but make it clear that he must co-operate, or lose his job. This has been proven more effective than loss of friends or family.'
In the old days, a business alcoholic was generally considered a drunken sinner, and fired on the spot. Now, among enlightened companies, his problem is recognized as a sickness, outranked in seriousness only by cancer and heart disease. If caught soon enough, it can be arrested (doctors don’t talk about ‘cures’ for alcoholism any more than for cancer). It generally takes 10-15 years of drinking to produce an alcoholic. Hence most of them are 35-55 years old, married, with children, and have an average of 10 years on the job. Usually, then, they are valuable employees. The alcoholic can be man or woman, company president or assembly line worker. No occupational style or level is immune. The sickness can be spurred by stress or frustration on the job or at home—or by loneliness in either place. A job loss, a death in the family, years without a promotion, or the prospect of retirement can tip some people into the bottle.

No one knows for sure why some drinkers become alcoholics and others don’t. Those from either a ‘dry’ family or an alcoholic family seem to be more prone to alcoholism than those from a background of moderate drinkers. Some nutritionists believe that an undersupply of B vitamins, particularly niacinamide, is a contributory factor. Certainly, proper diet, under a doctor’s supervision, is essential during a rehabilitation period. ‘Alcoholics tend to deprive themselves of proper food,’ explains Empire’s medical director, Dr. Jack Fowler. ‘Whether malnutrition is a cause—well, it’s like the old canard: which came first, chicken or egg?’

But a sickness it is, and a major difference between this and most other illnesses is that the sufferer can’t or won’t admit he’s sick—even when the facts are laid before him. A few years ago, a study of some 8,000 U.S. business executives found that 73 per cent took no more than two drinks a day (no problem); seven per cent quaffed five or more (big problem); and the middle group, three to four drinks a day—about six ounces. The last group was deemed to have reached or passed the danger point. Of course the average four-drink-a-day businessman would argue stoutly that he ‘can hold’ his liquor. Yet, alcoholism is an insidious disease. One U.S. business executive refused to admit liquor was getting the best of him until he woke up in jail, after slumming, nude, up the neighbors’ front-lawn flagpole and peeking in their bedroom window.

Almost invariably, the alcoholic is identified by someone else before he ever reaches a doctor’s office. The someone may be his long-suffering wife, or a fellow employee. His friends on the job are often reluctant to turn him in. Many a department covers up for the good old boy who spends each Friday afternoon ‘out on a call’ or each Monday morning ‘sick’. Union shop stewards find it particularly awkward, since their traditional function is to protect the employee from getting fired. But most companies and unions now realize that overprotection is no kindness to the problem drinker.

‘Alcoholism is a progressive illness,’ says Earl M. Pattow, of Ontario’s Alcoholism and Drug Addiction Research Foundation. ‘If there is no meaningful and effective intervention and treatment, they’ll suffer.’

The alcoholic, however, is a matter of deception. ‘Almost unconsciously, he lies about his drinking,’ says Dr. Clifford Preece, of Empire’s medical department. ‘If he says he drinks a half-dozen beers on a weekend, you can be fairly sure it’s a case. If he says two or three shots of rye, it’s more likely a bottle. Even if you find liquor in his desk, and confront him with it, he’ll come up with an alibi.’

But no matter how cunningly problem drinkers cover their tracks, they’re eventually spotted, especially in companies where supervisors are trained to watch for the symptoms. ‘The success of any industry program depends on how well oriented the supervisors are,’ says Earl Pattow. The worker who makes too-frequent trips to a warehouse or storeroom is suspect. So is the executive drinker, esconced every day behind closed doors. For years an advertising man tipped daily from a perpetual glass of gin, tucked behind the drapes on his window sill. To his dying day, he never knew that his partner was on to him all the time.

‘You learn the tell-tale signs, especially if you know the individual,’ says Dr. Preece. ‘We once had a professional person whose neat appearance was essential to his job. He began showing up scruffy and unpressed. Then he began sneaking out earlier every afternoon. That didn’t jar the alcoholism, but it turned out to be the case. In fact, his family called to enlist our help.’

Supervisors are also advised to watch for persistent absenteeism (especially on Monday mornings or after payday), long lunch hours, hand tremors, irritability, hangovers on the job, and the frequent use of breath清新ers to disguise a liquid lunch or the after-breakfast pick-me-up. A decline in work performance is reason enough for a supervisor to talk to the employee. Nowadays, in most firms, mention of alcohol doesn’t immediately enter into such discussions, unless the supervisor has strong evidence. Our
is referred to us, it’s up to us to dig and dig until he admits he has the problem,’ says Dr. Preece. Only then will treatment be effective.

At Imperial and most other major organizations, the alcoholic gets the same sick benefits and time-off allowance as any other ailing employee. The doctors may refer to one, or a reimbursement of family physician, clergyman, local alcoholism organization (every province has one; the provincial department of health can advise on its whereabouts), Alcoholics Anonymous or a hospital.

‘We describe all the available facilities and help the employee find the one best suited to him,’ says Dr. Fowler.

‘I don’t care where the patient goes, but he must stop drinking,’ adds Dr. Preece.

Both doctors recognize that the alcoholic may suffer a relapse or two, even after taking ‘the cure.’ One employee, merely on the mend after treatment, allowed himself one drink on a holiday—which set off a binge that ruined the family vacation. He climbed back on the wagon and stayed there. But in ‘constructive coercion’ the employee is warned that a minimum of relapses are permitted.

Supportive help, through Alcoholics Anonymous, is available in all provinces. Imperial’s doctors call it ‘a fantastic organization, the single most successful group. AA does no psychiatry, no delving, merely offers the shared meeting, group support and the latent ability to help.’

Some prefer more of the medical element in their treatment. Ontario, which accounts for 60,000-70,000 business alcoholics, offers at least two such options. One is the Donwood Foundation in Toronto, a handsomely equipped public hospital for alcoholics and other addicts. Operated by Dr. Gordon Bell, whose work began 27 years ago when he took an alcoholic into his home, Donwood provides effective aid for some 75 per cent of its patients. They are treated in three phases: the initial agony of sobering up; three weeks of education, analysis, group therapy and physical training; then an out-patient program of at least a year.

Toronto also has the May Street Clinic, operated by the provincial government’s Addiction Research Foundation, and unique in that it caters strictly to the business drinker. Once the company doctor agrees on the nature of the problem, the employee is steered to the clinic as a prerequisite for keeping his job. Many companies, including Imperial, participate. In four years the May Street Clinic has handled some 500 patients and its success rate—gauged by the employee’s improved performance on the job—is about 80 per cent.

The May Street Clinic, in a handsome old house with space for 10 patients, has no uniforms or locked doors. After the first week, patients are free to go home for an evening or over weekends. The staff includes two physicians, a psychologist, two social workers, two public health nurses, a physiotherapist, three registered nurses, a research assistant and a program consultant.

Treatment relies heavily on group therapy, with closed-circuit TV used for later playback and study. Structured recreation periods show a patient how to relax without alcohol. Weekly outings show the recreational alternatives to drinking. The average stay is three weeks, following by a long out-patient treatment. When the long-term success rate is established more clinics like this may be set up in other cities around the province.

A fringe benefit of this, or any other successful program, is that it gives each company a core of valuable allies—employers who’ve had the problem, taken the treatment, and can advise and counsel others like themselves. As well, the May Street Clinic holds weekly training seminars for management people; so far 3,000 people from 40 to 50 companies have attended.

‘The strength of our clinic is in education and training,’ Patton stresses. ‘Our small facilities can’t handle many alcoholics. But if we can demonstrate that the disease can be arrested, if we can get it early enough, and if we can erase the old stigma from the business alcoholic, then our program is a success.’

The companies participating in this and other programs, knows it is worth the effort and expense. In human terms, a case of arrested alcoholism means one life literally saved, and several surrounding lives made easier. In cash values, U.S. insurance company estimates that an employer saves $10 in potential losses for every dollar invested in an alcoholism program.

Either way, it’s a gilt-edged investment.
Saxifraga oppositifolia/ purple saxifrage

The purple saxifrage is sometimes called the 'rock breaker'. It will survive on exposed ridges where no other flowering plant exists, taking root in tiny cracks in the rock. An extremely adaptable plant that can make the best possible use of its habitat, it is the most common flower of the northern region and is widely accepted as the hardest of the seed-producing plants of the Arctic. All it needs is a place to root, a few weeks free of snow, and an air temperature above freezing - or enough sunshine to warm its dark foliage. While most other flowers are still thinking about it, the purple saxifrage is up and growing. While it's blooming, early in June, it must be counted as one of the world's most beautiful flowers, shining against its bleak surroundings. When the flowers fade it becomes untidy, forming brownish mats or tussocks. Few visitors to the Arctic ever see the plant at its best for it has bloomed and gone so quickly that they are usually too late. It grows almost everywhere on ice-free ground but is seldom able to stand competition. A loner in the plant world, the purple saxifrage is one of the four plants recorded by the northemmost botanical station on earth, on Lockwood Island off the north coast of Greenland. Purple saxifrage is one of the plants that forms little forests of warmth. Its spread is not uniform but very rampant and no part of the plant rises to a height of more than a few inches. Its leaves, which stay green year round, form the principle winter food of the ptarmigan, a northern grouse. The flowering stems of the purple saxifrage, which often grow to one foot in length, are topped with solitary, five-lobed flowers that may be violet, purple or dark pink.

Wildflowers of the Arctic

by Steve Lynett / paintings by Jerry Kozoriz and Eric Aldwinkle

The harsh extremes of the Arctic climate make special demands on the region’s living things. Polar bears have buoyant fur to keep them afloat and bristly feet to help them clamber over ice; seals have insulating layers of fat and remarkable circulation systems to conserve their body heat in the chill water. The flowering plants of the Arctic have also developed ways to live in this region where winter is one long frozen night and summer is a two-month, non-stop day.

About 500 species of flowering plants complete their growth cycles over the short Arctic summer. To survive they are faced with nearly insurmountable difficulties. The region is virtually a desert: it often gets less than seven inches of precipitation annually – the driest parts of the Sahara desert get five inches of rainfall a year. Only the perpetually frozen ground prevents the surface water from sinking below the reach of the plant roots. To conserve moisture the plants have developed small, often leathery or hairy leaves; stems that are thick and covered with densely matted hairs; and large root systems. To carry on photosynthesis the plants must have heat, often scarce in the Arctic. But with
special adaptations plants hoard what little heat can be found. Growing close to the ground they escape the drying, often abrasive winds. Large, colorful blooms trap the solar heat. Growing closely together they form small, warm forests of vegetation. A researcher found that the temperature near the base of a saxifrage plant was 38 degrees Fahrenheit while the surrounding air temperature was only 10 degrees. Within a cushion of dark-colored mosses nearby the temperature was 50 degrees.

Arctic plants also differ in a number of other ways from those of warmer climates. They grow and develop more quickly. Some of them start growing while still under four feet of snow, safe from the chill winds during the critical early stages of development. At other stages, freezing doesn’t seem to matter. Some flowers can be as stiff as boards only to thaw and continue their growth. Seeds have germinated after being frozen for 10,000 years.

And how do Arctic plants survive and multiply? Since the short summers seldom permit a full growth cycle, almost all truly Arctic plants are perennial. In this way a species can survive even if one season’s seed crop fails. But not all Arctic plants rely on seeds for propagation. Some multiply through widely spreading rootstocks; some send out runners or modified stems; and some produce plantlets that grow on or near the leaf, drop off and take root. Pollination in the plants of the Arctic, though little is known about it, takes place in two ways. Some plants are self-pollinated — there is little time to waste in such a short growing season. And some are pollinated by various species of bees, flies, moths and butterflies that also live in the Arctic.

There are no poisonous plants in the Arctic and none protected by thorns or spines. All of them are edible, containing varying amounts of protein, sugar and starch. The leaves of the Labrador tea, a shrub-like plant common to muskeg, can be steeped to produce a tasty drink; the rootstock of the licorice-root — a short, leafy, trailing plant on the Canadian tundra — makes substantial food either raw or boiled; and the young, flowering stems of the woolly loosewort, a common Arctic perennial, produce a nutritious dish either raw or cooked.
Pedicularis hirsuta/
hairy lousewort

The hairy lousewort, one of about 500 species in the genus, gets its name through superstition; it was widely believed that livestock would get lice if they ate it. Though innocuous itself, there is one member of the family, the foxglove, that has medicinal qualities; it secretes a sedative when boiled in water or alcohol. The hairy lousewort can be found in most regions of the Arctic on ice-free land, except in the mainland regions of the extreme southern Arctic. It grows chiefly in grass-covered places and open waste-land areas. It can also be found on gravelly and sandy ground and sometimes pushes its way through patches of slowly melting snow. In fact, the plant has such a tolerance to nature’s variety that it can be found flourishing in almost any plant community or land habitat, marshes included. The hairy lousewort can sometimes be found in bloom long after all the surrounding plants have dropped their leaves. But this is the exception rather than the rule. Generally the plant bears both its flowers and fruit like most other Arctic plants: early and quickly. The hairy lousewort has a pale, spindly taproot from which project slender stems, two to eight inches high, topped with elongated spikes of pale pink flowers. Its luxuriance is heavily determined by the local climate and habitat. Its “hair” is a delicate, foamy-like fuzz that wraps around the stem.

Dryas integrifolia/Arctic rose

The Arctic rose traps and conserves heat by growing in clumps. The plant endures the harsh winter in exposed places, free of snow cover, so that it can start its growth cycle quickly. Its clustering nature and oak-like leaves inspired its scientific name, Dryas integrifolia. In classical mythology dryads lived chiefly among oak trees and were generally associated with fertile or growing things. Special recognition was given to the plant in 1957 when it was adopted as the floral emblem of the Northwest Territories. The rose is a deposed dwarf shrub with short horizontal rooting branches and has been recorded by botanists throughout the Canadian Arctic and Greenland. Its small, leathery leaves help it to conserve moisture by resisting the drying effects of the Arctic winds. Black, hairy stems from two to six inches high support solitary, creamy-white flowers. The Arctic rose is among the most common and widespread of the Arctic plants that reproduce by flowers and seeds. It can also be found on limestone and gravel or rocky barrens into northern Quebec and western Newfoundland as well as the Arctic. It is one of the few Arctic plants that can be grown in warmer southern areas. It can survive in a rock garden or among pebbles where drainage is good but only where moisture keeps the soil from becoming too dry. It should be exposed to as much sunlight as possible except in early afternoon when the sun is hottest. Southern gardeners must be patient with it since plants raised from seeds take several years to flower.

Rhododendron lapponicum/
lapland rosebay

The lapland rosebay is one of the most beautiful flowers of the Arctic. A dwarf shrub, it blooms in early summer with an abundance of delicate purple flowers. Its charm is further enhanced by a pleasing aroma produced while in bloom. Though it rarely grows higher than four inches, the lapland rosebay develops as a spreading bushlet. Near the base it becomes trunklike, often more than ½ of an inch thick, growing into a gnarled, many-branched structure. Unlike some of the plants of the Arctic, the lapland rosebay does not vary noticeably from one location to another. It is common in the southern Arctic region but has rarely been seen north of the Arctic circle. Its favorite habitat is dry and gravelly soils and it can usually be found growing among heath and lichens. The rosebay, sometimes found in marshes, has also been known to grow in exposed places, free of winter snow where moisture is almost non-existent. It has been found trailing down the ledges of cliffs along the Wisconsin River at Wisconsin Dells and on Mt. Washington in New Hampshire, but cases like these are rare and except for them the lapland rosebay has not been found south of Hudson Bay. The plant belongs to a large and well-known genus that has often been split into the rhododendrons that retain green leaves in winter, and the azaleas that don’t.

See paintings next page.
The Technology of Energy

The sources of power available to man are virtually unlimited. But the costs of some are high, and the techniques of using others have yet to be perfected.

The world runs on energy, and always has. For countless ages the world has obtained its energy from the sun, using it directly, storing it in living plants and animals and in their fossilized remains, and in the power of falling water. Man has put this energy to his own use, extracting it from the leaves of plants and the flesh of animals as food, from the branches of trees as fuel, from coal, oil and gas, from falling water, from the wind itself. Recently he has begun to find power in a different source. In the energy locking together the atoms of matter.

Some of these sources are easy to tap for the power within them; some still defy the most persistent effort. Together they constitute the world’s energy resource and until recently they have virtually been taken for granted. But rising costs of oil and gas and uncertainties about supply have increased interest in all sources of energy. How great are these resources, and how much is available for mankind?

Oil and gas are today’s favorite fuels, but there are other sources of energy - coal and uranium deposits, solar power, tidal power, the earth’s natural internal heat. Taken together they are a resource so vast that the planet is in no danger of running out of energy in the foreseeable future. While oil companies continue the perennial search for new reserves, scientists and engineers are exploring such alternative sources as the conversion of coal into pipeline-quality gas or synthetic crude oil, or solving the problems of the fast-breeder nuclear reactor (which creates new fuel, plutonium, as it burns up uranium). These two new energy forms have the greatest potential for adding to present resources, for in both cases the technology is fairly well known.

In the search for new oil and gas supplies, geologists, geophysicists and other earth scientists keep trying to improve their chances of discovery by using every known resource of technology. What they are looking for are areas of porous rock topped by a cap of dense rock which has trapped oil or gas and allowed it to accumulate in the pores of the rock. Sometimes the reservoir is empty of hydrocarbons - the cap may have formed too late to prevent the escape of oil or gas, or there may have been no oil-generating formations nearby - a fact that is only discovered when the well turns out to be another dry hole.

Since there is still no direct method of peering underground to see where the traps are (just as there is no way to detect directly the presence of oil or gas) the underground structure must be deduced from geophysical observations, and the likelihood of petroleum-bearing rocks must be inferred from the observations of geologists. Of the geophysical techniques used, the most important is seismography, which still...
comprises about 95 per cent of geo-
physical activity, with the remaining five per cent coming from gravity and air-borne magnetic surveys. In a seismic survey a surface ex-
plosion is set off, and sound waves refracted by or reflected from the various underlying rock layers are picked up by geophones and recorded. In former years just about the only information obtained was the record of the reflection times from the various layers, from which structures capable
of trapping hydrocarbons could be inferred. This is still the main purpose of seismic surveys, but recently complex techniques have been developed to get more information from the seis-
mic recordings, and to do it faster and more accurately. These techniques have been made possible by high-
speed digital computers, which Im-
prial has been using for processing seismic recordings since 1965.

More research on seismic explora-
tion is under way. A project at the
Massachusetts Institute of Technology is aimed at a more precise understand-
ing of how the rock structure affects the transmission of seismic vibrations. If it is successful geophysicists may be able to calculate and to understand how seismic energy is changed by passage through a hydrocarbon-
saturated sand, as compared with one that is water-saturated, and thus use the seismic method to find hydrocar-
bon pools directly instead of just finding likely places to look for hydrocar-
bons by drilling.

Recently, the oil seekers have left dry land and the shallow waters near shore to explore the geology under some of the world's most forbidding seas—the storm-tossed North Sea, the fog-bound Atlantic off Labrador and Newfound-land, the ice-choked Arctic Ocean. (Seismic exploration at sea cannot use dynamite as an energy source, as is done on land, without harming marine life, and other devices have been developed. One, a gas ex-
plosion contained in an expanding rubber sleeve, transmits the necessary energy to the rock formations without harming marine life. The gas exploder was developed by Esso Production Research Co., an Imperial affiliate, and licensed to industry in 1968.)

One result of this foray into the continental shelves has been a recent addition to the map of Canada—an artificial island in the shallow Beaufort Sea. The 300-foot-long island is big enough to accommodate a conven-
tional drilling rig. A bed of gravel was found about 3,500 feet northwest of the site, and late last summer, after the whaling season, Imperial began to build the island, using a derrick to pipe the gravel to the chosen spot. Imperial plans to complete the island this summer, seek a permit, and begin drilling as soon as possible.

The island is an innovative approach to the special Arctic problems posed by winds and ice pressure too great for conventional offshore rigs to with-
stand. In waters such as the Gulf of Mexico and Venezuela's Lake Mar-
cabo the 'jack-up' rig is common—a drilling platform that can be pushed ex-
tensible legs to plant itself firmly on the bottom.

For wildcatting in deeper waters, such as over the continental shelf that curves around Newfoundland, drillers have two types of rigs available: the semi-submersible and the drilling ship. A typical semi-submersible is the 915,000-ton Sedco 1 ('leased to Imperial and its associates and still exploring off the Grand Banks), which floats on three huge buoyant legs. Fixed on the spot by nine 30,000-pound anchors and made stable by filling parts of the legs with water, the rig can drill as deep as 25,000 feet in 600 feet of water.

Exploratory holes can be put down in even deeper water by some semi-
submersibles or by a drilling ship—a large, specially designed vessel with a built-in drilling rig. The drilling ship may be anchored or held in one spot by the action of its main screws and several side-ways-acting propellers, all computer-controlled to counteract the forces of winds and waves. Such deep water "dynamic positioning" was used for the first time recently when the drilling ship Sedco 445, operating in more than 1,300 feet of water off the coast of North Borneo, bored to 5,893 feet under the sea bed. Re-entry of the drill pipe (the whole length of drilling pipe has to be pulled out periodically to replace a worn drill bit or to remove a core of rock for analysis—and then run back into the hole) was effected by a sonar device. An under-
water television camera helped the shipboard drillers to keep track of what was happening down on the sea floor.

While exploring crews are hunting for new reserves on dry land or under the sea floor, production engineers are seeking answers to a long-standing question: "How can we get maximum recovery from existing oil fields?" The amount of oil recoverable from a reservoir depends on three things: the viscosity of the oil, the permeability of the rock, and the pressure in the reservoir. This pressure is sometimes enough to force the oil out of the pores in the reservoir rock, into the wall bore and up the tubing to the surface. As the oil is withdrawn the pressure usually falls until eventually the oil must be pumped out. The pressure can come from gas above the oil or dissolved in it, or from water below—or from all three. At the big Redwater field, 40 miles northeast of Edmonton, the energy for the reservoir comes from a layer of water under pressure that lies beneath the oil. The force of the water is expected to be sufficient to per-
mit recovery of 65 per cent of the oil in place. Not all fields have such good recovery—the average in Western Canada is about 32 per cent, and many are as low as 10 per cent.

To increase the amount of oil where recovery is low, the producer may introduce secondary methods. He may re-inject the gas produced in solution with the oil to augment the reservoir pressure, a process known as gas flooding. More likely he will pump water into the pool to force more oil out of the producing wells, a fairly common procedure known as water flooding. Water flooding more than doubled recovery at the Judy Creek field in Alberta—from 20 per cent to 50 per cent. Or, as at Golden Spike, 15 miles west of Edmonton, he may inject a propane-butane solvent bank above the oil which scrubs as much as 90 per cent of the crude out of the porous rock as it advances through the Reser-
voir while the oil is withdrawn.

Such a high recovery is very unusual, though, and means to squeeze more
oil out of reservoirs is the aim of tertiary recovery, currently the subject of much research. Neither water nor gas alone can push the smaller oil particles out of the rock pores. A possible way to pry the oil loose is to use detergents plus polymer thickeners followed by water flooding. The detergent reduces the surface tension of the oil, loosening its grip on the rock, while the polymer thickener permits a more uniform flushing of the reservoir.

Interest in tertiary recovery methods has recently quickened owing to the higher prices for crude which are in prospect, and which will help to cover the higher costs involved. Higher prices are also quickening interest in oil deposits that cannot be produced by conventional methods.

To recover the heavy oil at Cold Lake, Alta., where Imperial has been operating a pilot plant on a limited scale for some 10 years, steam injection is used, in a cycle known in the trade as “huff and puff.” For several days high-pressure, high-temperature steam is pumped into the oil-soaked sand. In the next or “puff” portion of the cycle, the oil, thickened by the heat, is pumped to the surface. Main aim of the pilot plant operation is to establish the optimum parameters of the cycle— how long to heat, how long to pump, and so on.

Based on results so far, it seems possible that this type of cyclic steam stimulation could be made more economic by following the “huff and puff” phase with a type of secondary recovery—the use of a water bank to drive the heated oil to nearby producing wells, and so increase the amount of oil recovered.

While Cold Lake has an estimated 100 billion barrels of oil in place—five times the energy equivalent of Canada’s present oil and gas resources—the area around Fort McMurray, north of Edmonton, is believed to contain some 600 billion barrels of oil in place, locked in the famous Athabasca tar sands. Depth of burial varies from zero to 1,500 feet, with the greater portion of the oil under deep cover so that in-situ methods (as at Cold Lake) would have to be used. Some 86 billion barrels, however, are recoverable as synthetic crude by using conventional open-pit mining methods: huge draglines can remove the overburden and dig the oil-bearing sand for transportation by unit trains to the extraction plant.

The oil can be separated from the sand by a combination of hot water and steam. This yields an oil froth that can be upgraded into a low-sulfur synthetic crude. This is the type of operation envisioned by Syncrude Canada Ltd., a consortium that includes Imperial, which has received permission from the Alberta government to build a 125,000-barrel-a-day plant. Great Canadian Oil Sands Limited has been operating a plant for several years, running as much as 60,000 barrels a day. A major difficulty with tar sands is that even the rich sections contain only about 10 per cent bitumen so that the remaining 90 per cent of sand must be moved with the bitumen to the processing plant, then moved back again. The material handling job is prodigious. As Imperial’s research manager, C. H. Caesar, remarked recently: “It is estimated that by 1990 this movement of dirt will be equivalent to building a St. Lawrence Seaway or a Panama Canal every seven to nine months.”

Hydrocarbons from the tar sands exist elsewhere in the world—there are hundreds of billions of barrels of oil in the “tar belts” of eastern Venezuela, the Miocene tar accumulations in Sicily, the tar belt in southern Mendoza, Argentina, the pitch deposits of Trinidad, the oil shales of Colorado. With the exception of the Trinidad pitch lake and the Venezuelan tar belt, none of these deposits is being worked commercially, although considerable research has been done on the U.S. oil shales. At Parachute Creek, Colorado, a 1,000-ton-a-day pilot plant has been operating intermittently for some years, gathering data for a 60,000-ton-a-day plant that would produce some 53,000 barrels of oil a day from the waxy kerogen in the shale. As before, vast amounts of rock must be processed. This has led another U.S. company to try steam injection (as at Cold Lake) with moderate success. This company has also patented a process in which heated natural gas is pumped into the ground to permeate the shale, vaporize the kerogen and pick it up for recovery above ground by way of conventional drilled holes.

There’s a possible short-cut to recovering oil from shale rock, which is favored by some—“nuclear stimulation.” In plain language, set off a modest-sized nuclear explosion underground. It is suggested that the intense heat...
generated would thin the oil and let it accumulate in an underground reservoir formed by the explosion.

Nuclear stimulation to free natural gas from tight rock formations was tested by underground blasts set off in 1967 and 1969 in New Mexico and Colorado as part of the U.S. Atomic Energy Commission's Pivshevar Program. The blasts worked as advertised. Such is the appalling power of even a 40-kiloton atomic explosion that chimney-shaped underground caverns were formed by vaporizing the rock. Gas accumulated as planned but it has not yet been sold to customers, and the amount of radioactivity it contains is in dispute.

Research is currently being done in the United States on better ways to use that old-fashioned energy source: coal. If U.S. coal reserves could be turned into synthetic gas of pipeline quality (about 1,000 btu per cubic foot) they would take care of U.S. gas needs for about 250 years at estimated 1990 rates of use. Canadian coal reserves, the energy equivalent of about 450 billion barrels of oil, contain 25 times as much energy as Canada's reserves of conventional oil and gas. They are sufficient to meet Canada's oil and gas needs combined for 265 years at projected 1990 rates of demand.

Attempts are being made to turn coal into a gas or a liquid fuel. This will make a fuel that is more easily transported and cleaner. One of the results of burning high-sulfur raw coal is the release of sulfur dioxide as well as arsenic, lead and beryllium. Various schemes for removing sulfur dioxide from boiler stack gases are being tried, but a more effective approach may be to desulfurize the fuel before it is burned. This can be done at the refinery or at the generating plant, an approach being developed by Esso Research and Engineering Company at Abingdon in England. The method passes the sulfur-bearing fuel -- either residual fuel oil or high-sulfur coal -- through a bed of lime granules at 850 degrees centigrade. The sulfur reacts with the lime, leaving the fuel that passes on to the burner completely sulfur free. The lime is then stripped of the sulfur and used over again.

Various schemes have been advanced for converting coal into a liquid fuel and removing the sulfur at that stage, but turning it into gas shows more promise, since the technology is better known. Coal can be easily gasified -- water plus coal reacts at high temperatures to form gases that can ultimately be converted to methane, the chief component of natural gas. Coal gas was once widely used to light towns and cook food. But because it contains only 50 per cent methane, coal gas has a heat content only about half that of natural gas.

Coal gas can be upgraded into pipeline-quality, synthetic natural gas (SNG) by taking some of the carbon monoxide produced in the initial reaction, adding hydrogen and converting it into methane by a catalytic process. Currently the U.S. federal government and the gas industry are spending about $100 million a year to perfect this process. Ultimately, according to a recent report by the U.S. Office of Energy Preparedness, up to 420 billion may have to be spent on coal gasification plants, while further billions will be needed to increase coal production to supply the raw material.

Among other proposals being developed, one that is considered to have considerable promise is the combination of a low-btu gas-from-coal fuel with a gas turbine/steam turbine complex. Since gas turbines do not necessarily require a rich fuel, the idea is to produce a low (about 130 btu per cubic foot) heat content fuel from coal, 'scrub' it to remove the sulfur, and feed this to the gas turbines. Exhaust from the turbines may be as hot as 400 degrees Fahrenheit, ample for raising steam to feed conventional steam turbines. The net result is higher efficiency (perhaps 50 per cent versus the typical 35 to 40 per cent) from somewhat less expensive fuel.

Just what will emerge from this welter of research is not clear but there is very strong pressure to increase the U.S. capacity for generating electric power -- the area in which the so-called energy 'crunch' is presently most serious. For years Americans have been on an electric energy kick. Canadians are not far behind, of course, but there are not so many of us. Of the 4.9 trillion kilowatt-hours of electricity produced by the planet's generators in 1970, U.S. customers consumed 1.6 trillion, or just about a third. Canadians used 202 billion kw/hr and more than three-quarters of that came from hydroelectric sources.

With electricity generated by atomic means now becoming competitive with that from fossil-fueled power plants, the list of U.S. nuclear plants is growing. To the end of 1972, some 122 new units were either on order or being planned at 70 plant sites. At present the United States is the leader in atomic electricity, with 34 billion kw/hr generated in 1971, ahead of the United Kingdom at 20 billion. Canadian production was around four billion kw/hr. It has been predicted that by 1990 some 45 per cent of U.S. power will be uranium-fueled -- in Canada 30 per cent is expected to be uranium-fueled by the year 1990, although in some places the percentage will be higher. In Ontario, for example, more than 60 per cent of the electric energy generated in 1990 is expected to come from nuclear plants. Present nuclear plants are of the fission type, in which neutrons slowed by a moderator split uranium atoms, thus releasing more neutrons and creating high heat that can be tapped to generate steam to run turbines hooked to electric generators. A variation, for which many have high hopes, is the breeder reactor, which creates more fuel than it consumes by transforming the relatively abundant uranium 238 into fissionable plutonium 239, or thorium 232 into fissionable uranium 233. The breeder is thus very attractive from the fuel standpoint. Meanwhile, the United States has budgeted $500 million for a large-scale

Ontario Hydro's nuclear plant at Pickering generates 2,000 megawatts of power, about the same as Niagara Falls.
breeder, the United Kingdom’s is expected to go on line soon, and Russia has one in operation—partly experimental but Dr. W. Bennett Lewis of Atomic Energy of Cana言论 Limited has said: ‘Breeder or near-breeder (CANDU) reactors can derive so much energy from such a minute fraction of the world’s uranium and thorium that there need be no fear of shortage for at least hundreds of centuries and possibly millions of years.’

Quite different from such plants is the hydrogen fusion power generator—a source of virtually unlimited energy. Visualize a large hollow metal doughnut, some 30 feet across, wrapped with innumerable turns of wire to generate a strong magnetic field. Inject some particles of heavy hydrogen—deuterium—in such a way that the particles are blasted against each other, thus overcoming their mutual repulsion. If all goes well, these hydrogen nuclei will fuse into another element—helium—and release vast quantities of heat energy. The magnetic field acts to keep the hot particles—up to 60 million degrees—in the centre of the doughnut, away from the walls which would dissipate their heat. As before, the heat is extracted to run turbo-generators, although there’s a possibility that electricity could be generated directly, eliminating the need for the energy-losing turbines.

The idea is great, but so far researchers in half a dozen countries have been unable to make it work. Since this is probably the way the sun generates heat, physicists don’t know of any reason it won’t work, but so far in practice they’ve been plagued with various frustrating technical difficulties. They’re still puzzling over plasmas, for instance, those chunks of hot, highly ionized gas. A common lightly ionized gas is the gas in a fluorescent tube. Because it is ionized, it conducts electricity, and glows in the process. A highly ionized plasma not only glows, it can be raised to extremely high temperatures—high enough to cause a fusion reaction. The problem is to keep it away from the walls of the vessel containing it so that it doesn’t lose its heat. Generally speaking, learning about plasmas is taking longer than anybody thought.

Meanwhile, coming in from the wings is that solution looking for a problem—the laser, which is capable of creating a very high temperature in a tiny area. Why not take a pellet of frozen heavy hydrogen (deuterium) and blast it with a laser pulse of the right ‘shape’ and intensity to start a fusion reaction? This approach is being pursued in several laboratories. Present lasers are not quite powerful enough but their output is being raised constantly. Hydrogen fusion might be achieved in the laboratory in a year or so, or it may take 20 years. Nobody really knows when the breakthrough will come. Talk about nuclear power makes many people slightly uneasy. One reason why atomic electrical power has been slow to grow in the United States is that everybody says: ‘You can’t build that thing in my neighborhood.’ People fear that nuclear generating stations could blow up like an atom bomb, a danger all experts agree is all but impossible. They fear that the continual discharge of radioactive gases and liquids, even in small amounts, will affect their health; that there could be a disastrous accident that might spew radioactive materials into the air; that the disposal of spent fuel—all enormously radioactive—poses a hazard; and that the amount of water needed to cool the plants will create thermal pollution when it is returned to its source in lakes and rivers. For many people, these questions are still not resolved, and their opposition has reduced the pace of nuclear power plant construction, especially in the United States.

There is one source of energy that is completely safe, pollution-free and inexhaustible: the sun. Solar power is not new—several solar-heated houses have been built, while solar cookers (consisting mainly of a parabolic dish to focus the sun’s rays) have been in use for centuries in Middle Eastern countries. The United States has spent over two billion dollars on solar power research and development in recent years: the next step is for the government to encourage the use of existing technology.
As world energy demand increases and prices rise, the high cost of exploring for remote reserves with expensive equipment like this jack-up rig becomes justifiable. This rig was built to drill in the Bay of Biscay, in waters as deep as 350 feet.