IN TURNER VALLEY

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I

THIRTY YEARS OF PROGRESS

THE year 1912. At the foot of the ancient and rugged Rockies, low foothills stretch away to the open prairies. Coyotes howl. Large herds of cattle roam undisturbed. Cowhands ride and watch. Then, one day, a rancher of the district notices a spring bubbling eerily. Volcanic? No, the water is not warm enough. He strikes a light. Flames play on the surface of the pool as if the water were on fire. Gas! The news spreads; reaches Calgary fifty miles away. It arouses the interest of W. S. Herron, a prominent Calgary business man. "Maybe there's oil in them thar hills," he thinks. He obtains financial support, and drills a well under the direction of A. W. Dingman. In 1914 the well "comes in", to speak in the oilfield jargon. There is little crude oil, but there's a grand flow of natural gas—one and a half million cubic feet of it daily! Turner Valley has been born.

Boom conditions followed the success of this pioneer well on the edge of Sheep Creek, and just east of the present town of Turner Valley. Overnight, oil companies sprang up by the dozens. Calgary citizens bought shares, and more shares. But the company promoters mysteriously disappeared, and none of the wells were drilled. Everybody lost heavily except, of course, the stock brokers and vanished company heads. Then came the war, and four years of stagnation.

By 1920, however, there were nine wells in the north end of the field, and these were spread over an area three miles long and one mile wide. In addition, the *Calgary Petroleum Products* had built an absorption plant at a cost of $500,000. Unfortunately Dame Misfortune was not finished yet. She burned down the plant almost as soon as it was built. The following year the Royalite Oil Company rebuilt the plant and a pipeline was laid to Okotoks, a small village about twenty miles south of Calgary and seventeen miles east of Turner Valley. This line connected with the Bow Island line, from Southern

Alberta near the United States border, which was at the time supplying Calgary with gas, and city consumers burned a Turner Valley fuel in their furnaces for the first time.

The Valley's second great spurt of development came in 1924, when Royalite 4 was drilled to completion. This well produced six hundred barrels of crude naphtha daily, in addition to a large flow of natural gas. It had discovered what has since proved to be the chief producing horizon of the field—the Madison Limestone. As in 1914 a boom followed Royalite's discovery, and with almost as disastrous results. Gas wastage and overcrowding of wells also retarded progress. Despite this, however, two new pipelines were built to Calgary, one for the transportation of natural gas and one for the removal of naphtha from the field. Until then, naphtha had been shipped to the refineries by truck and rail.

From 1926 on, development was steady and unrelenting, but not at all spectacular. Wells were found mostly on a narrow strip to the east of the Valley, but pushed further and further southward to the foot of Longview Hill and the banks of the Highwood River. They struck insignificant quantities of crude oil (it was crude oil in which chiefly drillers were interested), but encountered large flows of natural gas and light naphtha.

It was in June, 1936, that Turner Valley began to experience its third and most vigorous stage of growth. In that year its first crude producer, the now famous *Turner Valley Royalties*, was completed after having been drilled through a fault, by R. A. Brown who had retired from service with the Calgary Street Railway not long before. This well produced the astounding amount of seven hundred barrels of crude oil in twenty-four hours. It was situated almost half a mile west of what was considered safe ground for drilling, on the west flank of the Valley and in the extreme south end. In rapid succession other wells drilled in the same vicinity and got equally encouraging results.

This important field now embraces a territory over fourteen miles long and over a mile wide. It has over two hundred oil and gas wells, and nearly two hundred and fifty-five miles of drilled hole. The average depth of the wells has increased from three thousand three hundred feet in 1926 to seven thousand feet at present. It has four efficient absorption plants, and at Calgary several refineries to handle the increasing volume of crude. Actual production of petroleum has increased from fifty-six thousand barrels a year in 1921 to six million a year in 1938. Between 1936 and 1938 production increased from one and a half million barrels a year to six million barrels a year, and the latest producer, Harris I, with an open flow of seven thousand barrels a day, would seem to prophesy that Turner Valley has only just begun to show the world the "metal" it is made of.

II

AN ANATOMY LESSON

The anatomy of the earth is far more complicated than that of the human body, I was informed as we gazed from Longview Hill down into the Valley studded with derricks and glistening white tanks. In general, rocks are derived from layers of sediment laid down horizontally, by the action of rivers and streams, on deltas, ocean floors and wide plains. The rivers bring down these sediments from older formations laid down earlier. The great weight of these layers piled on top of each other yearly gradually compresses the lower sediments into sedimentary rocks, as they are called.

Unfortunately (for the oilmen at least) mother earth does not leave her sedimentary rocks in such neat horizontal positions. She is very much given to eruptions and convulsions, and twists the nice neat rocks into all sorts of queer shapes. She doubles them up into domes, which the geologist calls "anticlines". She sags them into troughs, which he calls "synclines". She turns them upside down, stands them on end, forces other rocks through their weak points and performs other equally eccentric antics. The result is that it is impossible, in any given area, even though narrowly limited, to take a sample of underlying strata and say that it is characteristic of the entire area. So frequent and so numerous are the earth's convulsions that two spots less than a hundred yards apart may have entirely different geological structures underground.

Now, Turner Valley has been formed in much the same way as has been described. Sediments have been laid down, rocks have formed, eruptions have taken place. And to make matters more complicated, the earth, during one of its many adjustments, heaved up the Rockies and in doing so thrust eastward over the Valley great masses of rock which covered the younger beds already there. The heart of this great mass was once the top of a limestone ridge buried deep down in the earth. This ridge is the Madison Limestone from which the oil comes. Of course geologists do not all agree on the nature of the extremely complex internal anatomy of Turner Valley, but the analysis just given is the one generally held to be correct in view of the knowledge of the structure that is actually available at the present moment.

But how, I asked, does all this help you to find oil?

Well, was the reply, study has shown that oil and gas are usually found imprisoned in hard but porous formations such as limestone. Moreover, they will tend to collect in any anticlines there may be in the formation concerned, since they are both light and will seek the highest available level. At the top of the anticline domes will be gas, as it is lighter than oil; beneath the gas will be oil, and beneath the oil will be water. Now, provided we can find the anticlines of these hard rock formations, we stand a tolerable chance of finding oil. Hence a knowledge of the Valley's underground structure helps us to find these all important anticlines.

But how, I asked again, do you find all this out? You have no X-ray machines to probe the bowels of the earth.

At first, I was told, the only guide to the location of oil and gas pools was seepage. If oil actually appeared seeping to the surface of the earth, it was inferred that there must be resevoirs somewhere down below, and wells were drilled. That's how Turner Valley was discovered. Later, samples of strata passed through in drilling were studied and used as guides in further operations. It was not, however, until the early twenties of the present century that an invention was discovered which enabled geologists to explore undrilled territory. This was the seismograph, an instrument first used to measure the velocity and intensity of earthquake shocks, but later adapted to the oilman's needs. The mechanism of the instrument is based on the principle that sound travels at different rates in different mediums. A shot of dynamite is exploded in the area to be examined, and the seismograph records the rates at which the detonation travels through the various strata...If we know by experiment that it will travel at certain rates through certain strata, the rates recorded can then be compared with the rates previously determined as corresponding to given strata. Oil bearing rocks can also be found by releasing explosions of varying intensities. An explosion of such intensity as to be deflected back from the rocks to be discovered, rather than to travel through them, is released, and the seismograph records whether such rocks have been reached. It costs about four dollars an acre to survey land seismographically.

III

DRILLING AN OILWELL

In the old days it was a comparatively simple thing for a company with a small amount of working capital, and ability to persuade the man in the street to buy its shares, to start drilling for oil. There were no government rules and regulations as there are, for instance, in the banking business. Such laxity of supervision, however, resulted too often in grave losses both to members of the Stock Exchange and to the public at large. Wells would commence work only to be abandoned a few weeks later through lack of sufficient finances. Accordingly to-day much stricter laws govern the formation of oil well drilling companies. All companies must have, for example, a sum of money sufficient to equip and drill the wells they wish to undertake before they can even begin work. In addition, the Stock Exchange in Calgary demands a thorough inspection of the financial position of a company, and an annual financial statement, before it will allow the company's shares to be traded on the market. Once having complied with these regulations, however, the company is free to choose its location and go ahead with drilling.

Two types of equipment are used in drilling wells in Turner Valley, Cable Tool equipment and Rotary equipment. The Cable Tool rig is gradually becoming obsolete, but it is still favored by some because it is much lighter and easier to transport than the rotary rig, is cheaper to run and is handier in prospecting, as gas and oil showings are more easily discovered. It has the disadvantage of being very slow in operation, taking eight to nine months to do the work a rotary outfit could do in four or five months. The action of the rig is based upon the principle of pounding a way through the various formations. To one end of a walking beam—a stout bar of wood pivoted at its centre and moving freely up and down like a see-saw—is attached, by means of an adjustable wire cable, a bit weighing several tons. As the walking beam moves up and down, the bit at its end strikes the ground with terrific force, shattering the underlying rocks and shales. As the hole deepens, the cable is, of course, correspondingly lengthened. Motion is imparted to the beam by a bull-wheel connected with the free end of the beam. The wheel is turned by a steam engine.

The rotary type of outfit, as its name implies, depends on a rotating motion to accomplish its work. Its action is analogous to that of a brace and bit. Rotary equipment is much heavier than Cable Tool. The derrick has a base thirty feet square, and towers one hundred and thirty-six feet into the air, whereas a Cable Tool derrick is usually only eighty feet high and has a correspondingly small base. Power required to run a rotary rig runs to about five hundred horse power. A Cable Tool outfit requires only one hundred and fifty horse power. Five men per shift are needed to run a rotary rig—a driller who supervises the work being done, and four "roughnecks", as the derrick hands are called. The driller gets paid about ten dollars a day, while the roughnecks each get about five dollars a day.

It costs from $170,000 to $250,000 to put down an average well in Turner Valley. Of this, derrick and equipment alone cost more than $56,000. Derricks which were formerly made of wood are now usually made of steel. This has increased costs considerably. And the present European situation will undoubtedly increase costs still further.

The actual drilling apparatus of a rotary rig consists of a set of pulleys (the crown-block) placed in the top of the derrick. To these pulleys is attached a swivel by means of wire cables. Into this swivel are fitted the thirty-foot lengths of hollow steel pipe that make up the drill. The pipe then passes through a turn-table on the floor of the derrick, and so into the drill hole. The drill is rotated by the turn-table, which is connected with the engines. The bit itself is a fish-tail shaped piece of tungsten carbide, and it is fitted into the bottom length of drill pipe. Drill pipe required for the average Turner Valley well weighs about eighty-eight tons. How strong pulleys and cables must be, can thus be easily realised.

As soon as a well has reached the top of the producing horizon, casing is run. This is stout steel pipe, which is fitted snugly into the drill hole from top to bottom. It serves as a wall around the hole, preventing caving and leakage of water. The casing is held in place by cement poured into the hole and forced up the outside between the casing and the hole wall.

When the cement has hardened, drilling is resumed until oil is struck. Then the well is allowed to "blow" freely until it has rid itself of the collected mud and debris in the hole. The natural gas, in other words, is allowed to escape freely from the hole, carrying with it, by reason of its great pressure, the mud and silt collected while drilling. Finally, the well is "capped", that is, connected with storage tanks and pipe-lines, and it is then put on production.

IV

FROM WELL-HEAD TO MARKET

Petroleum is made up of an infinite number of crude and unrefined oil and gas products, differentiated from one another by the size and weight of their molecules. For instance, natural gas, a petroleum component, has an extremely light molecule, while tar, another petroleum product, has a very heavy and large sized molecule. The molecules of these various products of petroleum are, in turn, made up of two elements—hydrogen and carbon. Hence they are known as hydrocarbons. The two elements are combined in varying proportions, to make light or heavy molecules as the case may be.

When the petroleum rushes from the well-head, the many oil and gas products that compose it are mixed higgledy-piggledy together and have to be disentangled. How is this done?

Directly the petroleum leaves the well, it enters a separator. Here a purely physical separation takes place. The lightest member of the petroleum family—natural gas—skips out the top of the separator, while the heavier and more sluggish members sink to the bottom. The natural gas is then rushed through pipes to an absorption plant, while the naphtha and heavier lubricating oils are shipped to a refinery or sold at the derrick site as tractor fuel.

At the absorption plant the gas is passed through the bottom of a set of "absorbers"—tall towers down which drips an oil having great affinity for any oil that may have been left in suspension in the gas after it had passed through the separator at the well. As the gas passes up the absorber towers, the oil thus left in suspension is absorbed by the down dripping oil. The gas is then burned as waste or piped to the city, to be used in the ordinary furnace.

The next task is to separate the absorbed oil products from the absorbing oil. This is done in a distiller. The oil is heated until the absorbed constituents, whose molecules, by the way, are lighter than those of the absorbent, pass off as a vapor, while the heavier absorbent settles to the bottom of the distilling tank. It is then removed to the absorbers, again to repeat its job. Meanwhile the gaseous naphthas and lubricating oils are passed through a coiled cooler and condensed to a liquid. They are then shipped off to join their fellows at the refinery. Large quantities of oil, that would otherwise be wasted, are saved by the absorption process.

At the refinery the petroleum gathered at the well and at the absorption plant goes through a further process of distillation. This distillation process is based on the fact that the various components of petroleum can be driven off separately as vapors, because they have different boiling points. The petroleum is first heated to about 300 degrees Fahrenheit, at which temperature the gasolene ethers—naphtha and benzine—come off as a vapor, the rest of the petroleum remaining in liquid form. This vapor is collected in a separate tank and cooled. The remaining petroleum is then heated to about 600 degrees Fahrenheit, at which point kerosene and the lubricating oils come off as a vapor. It, too, is separated and cooled. Finally, what is left of the petroleum is raised to 900 degrees Fahrenheit, at which point the heavy greases and waxes are driven off and cooled in the same manner. After a further cleansing process, to remove whatever impurities may still be left, the various petroleum products, now thoroughly separated, are ready to be distributed and sold at service stations and elsewhere.

But the refinery may decide that it would like, for instance, to sell more gasolene and less lubricating oil, or *vice versa*. If so, it can, in the first case by a process known as "cracking" and in the second by a process known as "polymerization", rearrange the hydrogen atoms so that lubricating oil becomes gasolene or gasolene lubricating oil. A lubricating oil molecule is "cracked" by heating it under pressure until it loses a couple of its hydrogen atoms, thereby becoming a light gasolene molecule. A gasolene molecule is "polymerized" by stripping a hydrogen atom from each of two gasolene molecules under heat and pressure. The two molecules thus treated are attracted to each other, and join together to form a heavier lubricating oil molecule. Of course these processes are not confined just to these two substances. Certain parts of natural gas may be turned, by such methods, into gasolene, and so on. And in the laboratories of the big oil companies experimenting in the turning of one petroleum product into another still goes on continually.

V

MARKETING PROBLEMS

The total yearly world production of oil amounts to over 1,800,000,000 barrels. Of this total the United States produces 62 per cent. Russia contributes 12 per cent. Venezuela accounts for 9 per cent. and Roumania for 3 per cent. These four countries, that is, produce 86 per cent. of the world's oil supply. The remaining 14 per cent. comes chiefly from the Dutch East Indies, Mexico, Iraq and Trinidad. How does Turner Valley fit into this world picture of the oil situation?

Turner Valley's production is steadily growing, but even its latest figure of some 6,000,000 barrels a year seems very insignificant when compared with the world as a whole. It is only 0.3 per cent. of the total world supply. Its real significance, however, lies not in its relation to the entire world, but in its relation to the British Empire. The British Empire has within its own territory several oilfields—Trinidad producing 0.7 per cent. of the world's supply, British India producing 0.5 per cent and Bahrein Island producing 0.2 per cent. Compared with these, Turner Valley assumes considerable importance. To the British Empire it means another valuable source of oil supplies for the prosecution of the present war.

But while the British Admiralty may seem to be the proper market for Canadian oil, there are some serious difficulties to be surmounted. There is, first of all, the transportation problem. To ship the oil to Vancouver or to the East by rail is, under existing freight rates, far too costly an undertaking, and not justifiable for the amount of oil that is being produced. Nor are the freight rates likely to be lowered. Empty oil cars can not be loaded with goods for the return trip. Another suggestion has been the building of a pipeline to the Coast or down East. But such an enterprise would cost $20,000,000 or more, and would require a flow from Turner Valley of 36,500,000 barrels of oil a year to justify its existence. Thus while Britain is a potential market for the field, a much larger yield will have to be forthcoming before a great deal can be done in this direction.

Turning to Canada itself as a possible market, we find that Canada consumes about 30,000,000 barrels of oil a year. Most of this comes, at present, from the States. Could Turner Valley capture this market from its neighbor? In the first place, Turner Valley does not produce enough to supply the whole of Canada. In the second place, it cannot compete with the oil shipped by water from California to British Columbia. Nor can it compete with the oil in the East piped in from the United States. This leaves the prairie market, which it has succeeded in catching. But it produces more oil than the prairies need. Thus we get a dilemma, where there is too little oil for one possible market, Britain, and too much oil for one actual market, the prairie provinces. Conservation has resulted. But conservation will not encourage development to the point where the required 36,000,000 barrels of oil a year for overseas consumption can be produced. Yet if development is allowed to proceed freely, there will be a large surplus until the required 36,000,000 barrels a year is reached. What is to be done with the extra oil, in the meanwhile?

Some have suggested a high tariff against imported oil, but Canadian consumers pay a high enough price as it is for their gasolene and fuel oil. It has also been suggested that the government subsidise Alberta's oil industry, but this too would not be acceptable to the consumer, as the subsidy would come out of his pocket in the form of taxes. The McGillivray Commission, a Royal Commission recently appointed to investigate all phases of the Alberta oil industry, may help matters a lot. Already the Commission has decided that Imperial Oil Company, which controls almost half the field and which owns the only pipeline system for transporting oil to the refineries in Calgary, has been charging too high a transportation rate to other companies. The rate has accordingly been cut from fifteen cents a barrel to nine and a half cents a barrel. In addition, the pipeline system is to be placed under the supervision of the Provincial Public Utilities Commission. Further investigations of the McGillivray Commission may reveal points where other excessive costs may legitimately be reduced. If so, the chances for Turner Valley products to compete with foreign imports in the East and on the west coast will be considerably enhanced. Moreover, the war situation will in all probability make British consumers more determined to get the oil from the Valley, even at higher prices, rather than depend on a foreign source of supply which might at any time be suddenly cut off. The Canadian people, too, will be more willing to make sacrifices in the form of taxes or subsidies if they feel that by so doing they will aid Britain in her hour of need.