Dr. D.K. Taknet is a well-known business historian and writer. He has undertaken many analytical research studies and been awarded scholarships and fellowships by premier institutions like the University Grants Commission, Indian Council of Social Sciences Research, Ministry of Human Resource Development, Government of India, and others. He is the author of a number of books which have been well received and widely reviewed and excerpts reproduced and serialised in the leading national daily newspapers. With over 30 years of research and teaching behind him, his documentation of Indian industrialists and business houses in a series of books are based on over a thousand interviews with eminent corporate executives and organisations. He also writes extensively for the national and international press.

An avid traveller, he has participated in international seminars and conferences and is associated with several distinguished professional and social organisations throughout the world. He is the recipient of the President's Award. He can be reached at : dktaknet01@gmail.com.

I am very much delighted to go through this fascinating account of the history of oil production and its uses in the world from much ancient times to the present. The much researched work of Dr D.K. Taknet outlines the development of civilisation based on oil as a fuel which has been a well recognised energy. The oil has certainly brightened up our lives as the title of the book itself suggests. This illustrative and chronological account of oil tracing its crude foot-steps from ancient to the present higher level of sophistication is a commendable job skillfully demonstrated by Dr Taknet. This is an academic treat to the discerning reading world in general and to the students of business history in particular.

Prof Y. Sudershan Rao,
ChairmanIndian Council of Historical Research
Ministry of Human Resource Development,
Government of India

Remarkable, highly informative, well documented and meticulously researched and elegantly written coffee table book on the global oil industry. It is an interesting and insightful pictorial book which is worth reading. A masterly narrative and thoroughly researched and vividly illustrated book, provides a lively history of oil since beginning and fills in many blanks in earlier studies ... The story is brilliantly told with its remarkable cast of characters. It provides valuable information on various interesting facets which are lesser known about the industry.

Inder Sawhney, Chief of Bureau
Gujarat Samachar, New Delhi

Back cover: Flowing of oil which had various uses from ancient to modern time. Leonardo Maugeri rightly said that oil has played a unique role in the economy and history of modern times. No other raw material has been so critical in shaping the destiny of nations. Today, about six thousand products are made entirely of petrochemicals, of petrochemicals blended with other materials. A flood of these useful products have become so common that we regard them as necessities.

SOME OPINIONS

Dr D.K. Taknet's book is well researched and insightful ... packed with information, and those who made their fortunes from, the oil industry. The wide range of illustrations in the book are a delight to the eye and supplement the text effectively. I have no doubt that the way in which the book has been conceptualised and written will prove to be absorbing, exciting and educational for the reader.

Dharmendra Pradhan, Minister of State (I/C),
Petroleum & Natural Gas, Government of India.

Dr D.K. Taknet and his Institute have been rendering a signal service to the cause of Business History by bringing out coffee table books on significant themes ... The present work, focusing on the antecedents and development of petroleum industry, too, bears witness to painstaking research and analysis. Richly illustrated with appropriate captions which is a delightful and educative read on a subject of vast significance.

Dwijendra Tripathi, Professor of Business History,
Indian Institute of Management, Ahmedabad.

Painstakingly researched, well written and beautifully embellished with paintings, illustrations, etchings and photographs, this book is both a visual and intellectual feast. Dr Taknet has written with great comprehensiveness and lucidity on a subject that plays a very important role in our daily lives and is of immense geo-strategic importance. The captivating style and fascinating subject make it very difficult to set this book aside. A must not just for oilmen, but also for sociologists and historians.

Vikas Singh, Deputy Executive Editor, The Times of India.

The fascinating story of oil from time immemorial to present day, events which shaped its discovery and use, and people and institutions who played the key roles, is told in this well researched and elegantly produced book by Dr Taknet. He has a produced a work of lasting importance and should be congratulated for producing a work of immense scholarship, and presenting it in an attractive and lucid manner.

Padam Bhushan Prof V.S. Vyas
Former Member Economic Advisory Council to Prime Minister

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OIL
LIGHTING UP OUR LIVES
D.K. TAKNET

OIL
LIGHTING UP OUR LIVES

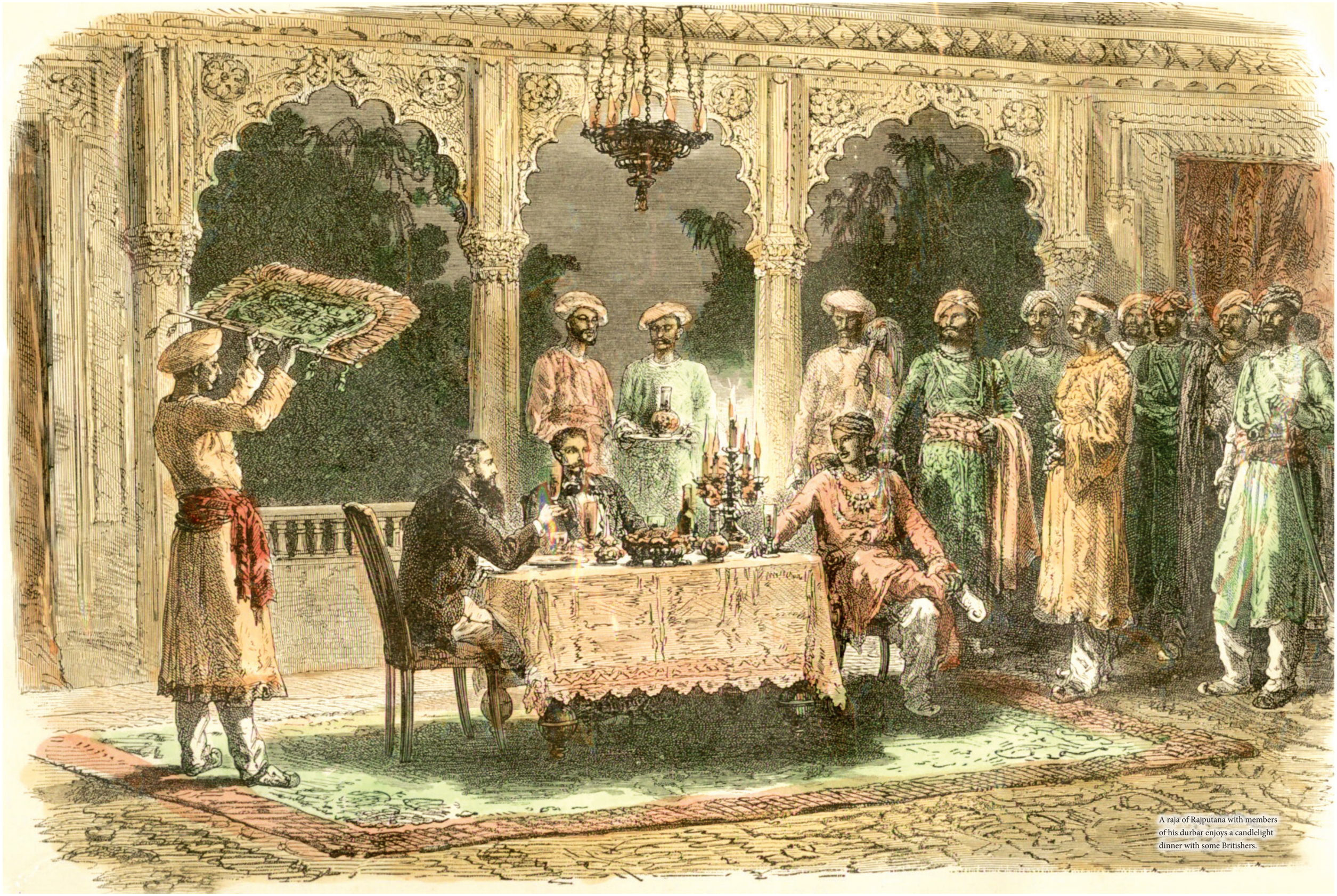
D.K. TAKNET

IIME

Oil, known to man even prior to the contemporary era, has found a permanent niche in the lives of people throughout the world, serving a range of needs from morning to the moment we go to sleep. Our civilisation depends more heavily on oil than on any other single commodity. Our world is ruled by oil. Its widespread availability and use rose in prominence during the First World War, and since then the world has continued to depend more and more heavily on it for a multitudinous range of products and services, among which transportation is the most important.

The history of oil dates back to the dawn of civilisation. For instance, one of the earliest civilisations that developed in the great river valleys of Mesopotamia used asphalt obtained from hand-dug pits for caulking boats, medicinal and ornamental purposes. *Oil: Lighting up Our Lives* unfolds a worldwide view of the history of the discovery, development and uses of oil, the global oil industry, how the geopolitics of oil and its availability has transformed the fate of nations, and the multifaceted role that it plays in our everyday lives. The reader is caught up in the excitement of early oil discoveries worldwide and in India, and their cataclysmic effects on men and nations, while at the same time absorbing its damaging effects on the environment.

For all those with even a passing interest in history, politics, international affairs, global economies, sociology and the environment, and the significant role that oil plays in them, this well-researched book presents an engrossing and all-embracing picture of the role of oil through the ages and, more particularly in our time, and the development and power of the global oil industry. The author's compelling narrative, supplemented by 600 rare photographs, illustrations, lithographs and paintings are calculated to capture the imagination of the discerning reader.



A raja of Rajputana with members of his durbar enjoys a candlelight dinner with some Britishers.

OIL

LIGHTING UP OUR LIVES

D.K. TAKNET

IIME
JAIPUR

International Institute of Management and Entrepreneurship
Manglam-401, C-79, Yash Path, Tilak Nagar, Jaipur 302 004
Tel: +91 141 2620111
Mobile: +91 9799398505
E-mail: iime.jaipur@gmail.com/info@iimejaipur.org
Website: www.iimejaipur.org

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Author and Project Director
Dr D.K. Taknet

Consulting Editor
Veena Baswani

Senior Research Associates
Brig K.N. Pandit, VSM
Dr N.M. Sharma
Neeraj Mehrotra
Anand Soni
Nirati Agarwal
S. Mukherjee
Devashish Taknet
Govind Singh Negi
Surendra Singh Chauhan

Archives and Photo Research
Sujata Taknet

Visuals
Bridgeman Images
Dinodia Photo
Alamy Photo Stock Pvt Ltd
Raj Chauhan
Trilok Chand

Artists
Suresh Sharma
Gopal Khetanchi
Devang Taknet

Designer
Pankaj Bhatnagar
(pankejbhatnagar@gmail.com)

Coordination
Rajesh Kudiwal
Shiv Hari
Mithlesh Chaturvedi
Chhotelal Mahawar

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Dedicated to

the gallant oilmen and professionals

whose toil, grit, and determination over the centuries

have kept oil flowing throughout the world

for the greater benefit of mankind.

CONTENTS

सत्यमेव जयते

FOREWORD

The energy industry is a vast and widely diversified global enterprise with aggregated revenues of over several trillion dollars a year. The oil and gas industry, the crown jewel of this industry, will continue playing a central role in the worldwide geopolitical arena until economically feasible alternatives are discovered ... Today, oil and gas companies have perforce become far more conscious of being ethically invested in the environment, the health and safety of their employees, the welfare of the communities with which they interact, and the socio-economic development of the regions within which they work. Corporate social responsibility has become the buzzword and bitter lessons from the past have fortunately been learnt and acted upon.

Dr D.K. Taknet's book is well researched and insightful. It provides the reader with a holistic perspective of the industry, transforming what would appear to be a dry and matter-of-fact subject into an exciting saga of adventure packed with information and delightful cameos of individuals who worked in, and those who made their fortunes from, the oil industry. The wide range of illustrations in the book are a delight to the eye and supplement the text effectively. I have no doubt that the way in which the book has been conceptualis0ed and written will prove to be absorbing, exciting and educational for the reader.

I warmly congratulate Dr Taknet for this absorbing book on the phenomenal growth and spread of the oil and gas industry which will make lay readers aware of the exciting background of commodities they so acutely depend upon and know so little about.

21 November 2016

Dharmendra Pradhan
Minister of State (I/C)
Petroleum & Natural Gas
Government of India
New Delhi

INTRODUCTION

The history of oil makes for spectacular reading. Oil began its steady ascendance as a minor actor used for caulking boats and valued for its medicinal properties. The twentieth century witnessed its dramatic rise. The Allies defeated Hitler and won the Second World War riding on the back of oil. International trade expansion enabled the growth of multinational corporations. It would not be incorrect to say that oil was the single most important factor that transformed the world into a global village. Most parts of the world became accessible. Research and development advanced rapidly, and with the arrival of the twenty-first century, the age of technology began. Oil was everywhere, and its multifaceted uses were sufficiently significant for it to become the focus of a book!

The scramble for oil wealth has been a journey of highs and lows: price wars, climate change resulting from a destruction of natural biodiversity and damage to the ozone layer by the noxious emissions from oil, and socio-economic exploitation resulting in major geopolitical ramifications. The picture today, although not altogether gloomy, is certainly one where inspired international leadership is imperative to govern this juggernaut. Alternative sources of energy, still in their infancy, must be explored with the greatest urgency and intensity, if we are to rescue our planet from depletion of this precious resource and the equally alarming fatal side-effects of our addiction to burning of fossil fuels.

Oil: Lighting Up Our Lives by Dr D.K. Taknet, richly illustrated with photographs of the oil industry that has transformed the world and so greatly enriched our lives, provides the reader with a wonderfully graphic picture of the multifaceted uses of oil and the adventure and technology that enabled it.

PREFACE

The heritage of oil goes back several millennia when the Sumerians and the Babylonians used oil seepages in many ways. At the dawn of history, in parts of Persia and what is now Iraq, bitumen was extensively used in the construction of irrigation canals and as mortar for bricks. The eternal fire in the temples of the ancient Persian religion (Zoroastrian) was probably fuelled by the oil and, gas seepages. The first oil well is said to have been dug in Shush, Southern Iran, in about 500 BCE, while the Chinese are believed to have drilled for oil with bamboo tubes and bronze drill bits as early as 200 BCE. Originally oil was collected from natural surface seepages and shallow pits, and for hundreds of years was used mainly for medicinal purposes, waterproofing, occasionally as a basic lubricant, and later, for lighting.

The Arabs and the Iranians developed a process of distillation of crude oil and extracted an illuminating material from it. This technology travelled to Europe. Before the Industrial Revolution, which began in Western Europe towards the close of the eighteenth century, whale oil was used to provide the illumination in houses and on roads. Later, whale oil was replaced by kerosene and gas obtained from distillation of coal.

The first modern commercial drilling and production of oil is believed to have begun in 1859 in the US, when Col Edwin L. Drake sank a well in Pennsylvania near some natural oil seepages. He was working for the Pennsylvanian Rock Oil Co. which was interested in using oil for lighting and establishing a rudimentary oil industry. However, some authorities claim that the first modern oil well was sunk in 1806 near Charleston in West Virginia.

During the late nineteenth and early twentieth centuries, the oil industry concentrated on making kerosene from crude oil to light lamps and stoves. Its uses as a lubricant also began to be developed at this time. However, more important was the development of crude oil as a boiler fuel, which soon became competitive with other established forms of energy, especially coal used in locomotives and ships. By the time the First World War broke out, advances in refining had extended the use of oil from being a source of lighting to a fuel for car and airplane engines.

As the oil industry developed over the years and greater knowledge was gleaned about the nature of oil and its reservoirs, the technology and science to determine where likely oil traps might lie under the earth's surface developed. The oil industry itself is bigger than any other. Its operations span the globe, and oil companies negotiate with governments on highly competitive terms, aware that the product they supply is indispensable to the former, especially to developing nations. In fact, the enormity of the finances that flow through their hands can dwarf the national budgets of many countries.

Today, oil is virtually an indispensable commodity which provides a blueprint for modern life. It is often viewed as a barometer of economic progress. Petroleum is the basic raw material for lubricating the machinery and equipment in industry, transport and agriculture. One of the most important raw materials for the chemical industry, petroleum yields more than a thousand products which make or help in the manufacture of 5,000 different goods used in every sphere of life.

Exploration for oil begins with geologists selecting likely areas where oil may be found, and then pinpointing the most suitable sites for drilling explorationary wells. Potential oil-bearing areas are found all over the world wherever sedimentary basins exist. Using highly sophisticated technology and equipment, ranging from aerial photography, satellite photographs and computers, as well as specialised tools to measure variations in the earth's magnetic field and gravity with a magnetometer and a gravimeter, geologists are able to hone in fairly closely to areas with the best prospectus. However, their principal tools to map the rock formations below the ground and to choose the most propitious sites for prospective drilling are seismic surveys. The expense of drilling a well and the high risk of failure in finding oil, make oil exploration, including surveying, one of the costliest stages of the oil cycle. Before a well can be sunk a site has to be cleared and access to roads and tracks have to be laid.

The oil industry has for many years made continuous and conscious efforts to play a constructive social role commensurate with its position as a major player in the global economy. This book highlights the history of the global oil industry, its major role in the economy.

The subject of oil is quite vast and complex as the oil industry is widely spread over a large geographical area. Given the range and scope of the welfare programmes undertaken by the industry, it has not been possible to cover all that the industry has achieved for the people and communities of their respective countries. Through grants, donations, volunteer groups, humanitarian aid and allocation of resources, these companies are demonstrating their commitment to help in solving pressing needs in society. Corporate social responsibility has become an integral part of the oil industry across the world. Additionally, oil companies are attaching more and more importance to the environmental

impact that related industrial pollutants have and are making a determined effort to reduce the carbon footprint. They interact more with local communities to become aware of their specific problems and needs.

The goal of writing this pictorial book is to present a condensed and succinct history of oil right from its discovery to present times, how it has changed the lives of billions of peoples around the world and what lies ahead in the future. The book outlines the development of oilfields of the world and actually visualise the difficulties and hardships that pioneers in the oil industry faced and their joy when an oilfield struck oil.

The world of oil is completely new and fascinating for me. Its multifaceted history and the wonderful people who have left their footprints in its variegated activities have been an engrossing study for me as well. Meticulously researched over 7 years research teams traverlled over 4,00,000 kilometres, a distance equal to travelling five times around the world. I spent 2,000 days on the road to interview over 2,500 people directly or indirectly associated with oil, ranging from chairmen to common oilmen. I visited places where oil started its journey and moved on to global oilfields. Approximately 2,50,000 sheets of data, including company reports, news cuttings, journals, official records, periodicals and publications lay in stacks in my office over months, as I pored through them in turn.

Oil: Lighting Up Our Lives is the culmination of the cooperation and efforts of many individuals, organisations and corporations. I would like to convey my special gratitude for the research support extended by the Research Advisory Committee and research associates of IIME, Jaipur. The Business History Museum (BHM)-IIME continues to be a treasure trove of knowledge and literary resources with its outstanding collection of rare, old and new books and journals. I take this opportunity to acknowledge the courteous and efficient services rendered by various private and public libraries and museums. Eclectic insights were gained through interviews with art collectors and art galleries in India and abroad. It has truly been a mammoth task to distil the essence from my research to fit into the limited space available. Perhaps, there is still enough material to continue my probe and study to put together another book on the subject! It has indeed been a memorable tour de force.

The old guard to today's young and professional oilmen-all had fascinating oil stories with dramatic insights into the oil industry. To say that I benefitted from their first-hand accounts would be a gross understatement. I experienced their highs and lows as they shared any number of incidents and stories that brought tears to my eyes at times and at others, made me smile. Mere research from written material could never have taken me right to the centre of things without these brave hearts who stood through testing times with one goal in mind – to put India on the oil map of the world. I salute them.

A lot of people have helped me in the process of writing this pictorial book. I would like to thank Veena Baswani for her judicious editing and many constructive suggestions. I am indebted to Adil Tyabji and Neeraj Mehrotra who offered valuable advice and close reading and editing from the first to the final draft, as well as their insightful and always thought-provoking commentary and analysis. I warmly acknowledge the assistance of Brig K.N. Pandit, S. Mukherjee, Arti Walia and Nirati Agrawal with the manuscript. I am grateful to Govind Singh Negi who slaved cheerfully over my PC for the last 5 years at all hours with full dedication and perseverance. My special thanks to Pankaj Bhatnagar, Ram Parshad and Akash Aundwar who coordinated the design of this book meticulously with a talented team of artists.

I am especially indebted to the team of Lustra Print Process Pvt Ltd and its executives and colleagues for their invaluable personal and sustained efforts to achieve the highest quality printing standards. My heartfelt gratitude to Dharampal, Suresh Sharma and Amit Dangi who made paintings especially for this book. While collecting the visuals for this pictorial book, I had the pleasure of visiting many repositories and working with unfailingly helpful curators. I warmly acknowledge the photography skills of Dinodia Photo Library, Bridgeman Art Library, Alamy Images Pvt Ltd, Can Stock Photo, Dreamstime Photo, and Fine Art America for painstakingly providing rare and valuable visuals.

Persons whose names do not appear have given me no less encouragement, and I am deeply grateful to them too. Finally, I owe a deep debt of gratitude, appreciation and love to my beloved wife Sujata and my sons Devashish and Devang who have been a constant source of strength, vitality, youthfulness and encouragement, who patiently and stoically were willing to sacrifice wholeheartedly our family time of fun and frolic of togetherness while writing this book.

I sincerely believe that this book will generate a new broad-based understanding and appreciation of the global oil industry's proactive developmental role, along with its triumphs and perils. At the same time, it will undoubtedly interest all those associated with the oil industry and who have the well-being of the industry at heart.

New Delhi — D.K. Taknet

June, 2017

CHAPTER 1

DISCOVERY OF BLACK GOLD

A century ago, petroleum – what we call oil – was just an obscure commodity; today it is almost as vital to human existence as water.

James Buchan

Among nature's many bounties, oil is, perhaps the sole resource for which man's appetite has unquenchably increased over the years. It probably dates back to the dawn of civilisation itself and touches every aspect of our lives. 'Oil' is a generic term for liquids used in the food we eat; the cars, buses, trains, and airplanes in which we travel, plastics employed for multitudinous purposes, the heat that warms our homes, electricity, lubricants, paints, medicines, perfume . . . Oil has undoubtedly, for the major part of the last century and to this day, been a great enabler, providing a vast range of products from one basic resource. Indeed, the oil industry was the first modern business to operate on a global scale. Even in this 'Age of Plenty', when man has extracted around 1.3 trillion barrels of oil from the earth over the past 150 years, the pre-eminence of oil is such that it has played an important role in regulating the political and economic order of our planet. Almost half of the world's energy requirements are met by oil.

Formation of Oil

As is the nature of things, whenever a new discovery is made, its origin is attributed to varying causes, and this too was the case with oil. Some scientists claimed that oil was obtained from inorganic matter through a chemical process. Though laboratory experiments did prove that some oil could be made in this way, they failed to explain the existence of oilfields beneath the earth's surface. The debate continued until eventually a unanimous viewpoint emerged.

How then is oil formed? Without attempting a highly detailed or academic explanation which is beyond the scope of this book, it is important to understand how this extraordinary 'gift' came within man's reach. Nature has repeatedly demonstrated that it is not a static force. Its many faces include rain, snow, frost, wind and vegetation that impact it in various ways. When the wind blows, it carries sand, eroding parts of the earth's surface. Frost cracks the rocks around it. Seeping water, combined with decomposed vegetable and plant matter decays, and solid rocks disintegrate into clay and sand. Rain washes away this soil, aided by the wind, to creeks, which, in turn, carry it down to rivers. The rivers play their part by transferring this soil to the sea. The sediment carried to the sea includes leaves, twigs, tree trunks and fish. Erosion and deposition of these materials is not an overnight and takes place continually and gradually over millions of years.

A Long Gestation Period

The carcasses of marine animals such as squids and whales are added to this sediment. Innumerable tiny vegetable forms known as algae that thrive in water and are almost invisible to the human eye add countless tons to the sediment that settles at the bottom of the sea. The sea also contains many other tiny animals and plants known as plankton which derive energy from sunlight to survive and multiply. When they die, they too sink to the bottom of the sea and lie alongside the dead plankton for millennia, and from there are spread by the waves and tides across the ocean floor. Gradually, covered by mud, these deposits decompose and are acted upon by anaerobic bacteria. Pressure and heat transform the sediment into rocks and then convert the organic matter through various stages into oil and gas.

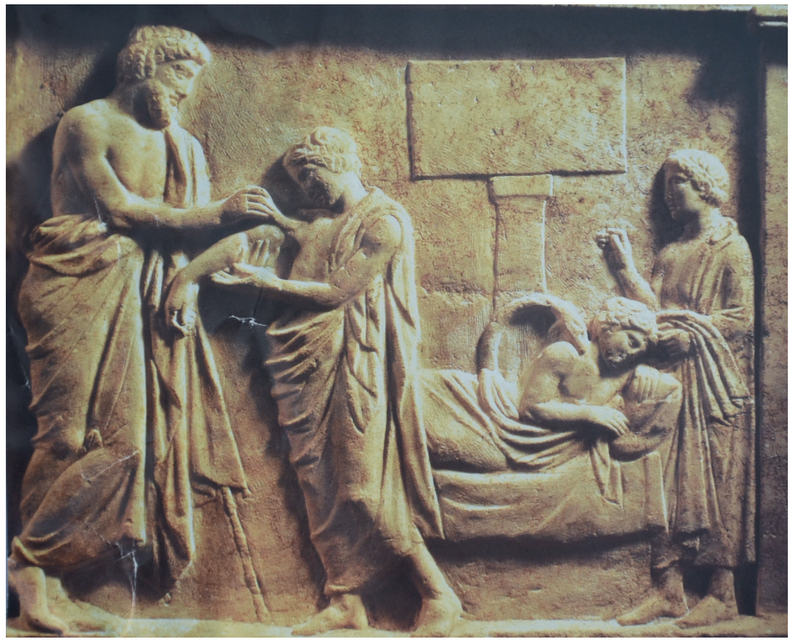
Scientists describe the formation of both coal and oil deep within the earth as a black, organic, slimy substance called kerogen. Loosely defined, kerogen is an abundant wax-like substance that is an intermediate between the original organic material and oil. Variations in the quality of crude oil depend upon the origin of the kerogen. The gradual process of distillation by bacteria of dead organisms in the *source* rocks is responsible for the creation of oil. The pressure of the water and temperature at that depth causes the mud to be converted into shale or Kerogen I.

In Kerogen II, the spores and outer skins of plants from land settle at the bottom of the sea along with plankton and are gradually transformed into hydrocarbons. Kerogen III is produced from terrestrial plants deposited in lakes and rivers. All 3 kerogens can produce oil or coal, depending upon the pressure, temperature and bacterial action they undergo. Some desulphurisation takes place in the formation of crude oil due to the action of the bacteria.

Traps and Reservoir Rocks

Fossil fuel and natural gas are often found together in dome-shaped geological *traps* deep beneath the earth's surface. Crude oil and natural gas reach the surface of the earth by seeping through fissures in the rocks. Often, however, they are prevented from reaching the earth's surface by impervious rocks that block their path. The porous rocks within which they remain trapped are known as *reservoir* rocks,

Sponges being used to collect naphtha from the surface of waves. Also known as asphalt, bitumen, slime, or pitch, naphtha is liquid petroleum. It may be found in natural deposits or may be a refined product. According to Herodotus and Diodorus Siculus, over 4,000 years ago, asphalt was used as mortar in the construction of the walls and towers of Babylon. There were oil pits near Ardericca (near Babylon) and a pitch spring on the Zacynthus. Great quantities of it were found on the banks of the river Issus, one of the tributaries of the Euphrates. Excavations at Kish, Ur and Nineveh reveal that it was used as a water-proofing agent for baths and boats, cement for pottery and as paint.
Facing page: Sir Walter Raleigh in Trinidad examining naphtha. A flammable oil containing various hydrocarbons, naphtha can occur naturally or be obtained by the dry distillation of organic substances such as coal, shale or petroleum. Ancient Egyptians applied naphtha on dead bodies prior to burial. It appears that parts of the Dead Sea occasionally gave the impression of boiling and threw up large quantities of naphtha.
Chapter opening page: Crude oil is a naturally occurring, unrefined substance composed of hydrocarbon deposits and other organic materials. Abundant evidence indicates that oil was used in ancient times for medicinal purposes, caulking boats and subsequently, for lighting. Oil is usually drilled from the depths of the earth or the sea. It is then refined and separated, most easily through distillation, to produce usable products such as petroleum and/or gasoline, diesel, kerosene and asphalt. Exposed to chemical reagents, it is used in the manufacture of plastics, pharmaceuticals and various forms of petrochemicals. It is virtually impossible to imagine a world today without oil.



Top and above, left: Ancient Persian tablets and manuscripts indicate the use of petroleum for medical and lighting purposes by the upper echelons of society. Crude oil was used as traditional medicine. Some medicines were manufactured from chemicals and many of these came from these petroleum products. By 347 CE, oil was produced in China from wells drilled by bamboo staves. Early British explorers in Myanmar in the eighteenth century documented a flourishing oil extraction industry based in Yenangyaung. Hundreds of hand-dug wells were under production. *Top right:* Relief from the sanctuary of Oropos, dedicated to the physician Amphiarios, showing Hippocrates treating a patient.
Facing page and following spread: Drop of Hope: Crude oil, which became the world's first trillion-dollar industry, is a natural mix of hundreds of different hydrocarbon compounds trapped in underground rock. Oil and natural gas, together makeup petroleum which is also known as 'rock oil' or 'fossil fuel'. Petroleum taken straight from the ground is called 'crude oil'. The hydrocarbons were formed millions of years ago when tiny aquatic plants and animals died and settled on the floors of ancient waterways, creating a thick layer of organic material. Sediment later covered this material, applying heat and pressure and transforming it into the petroleum that comes out of the ground today.

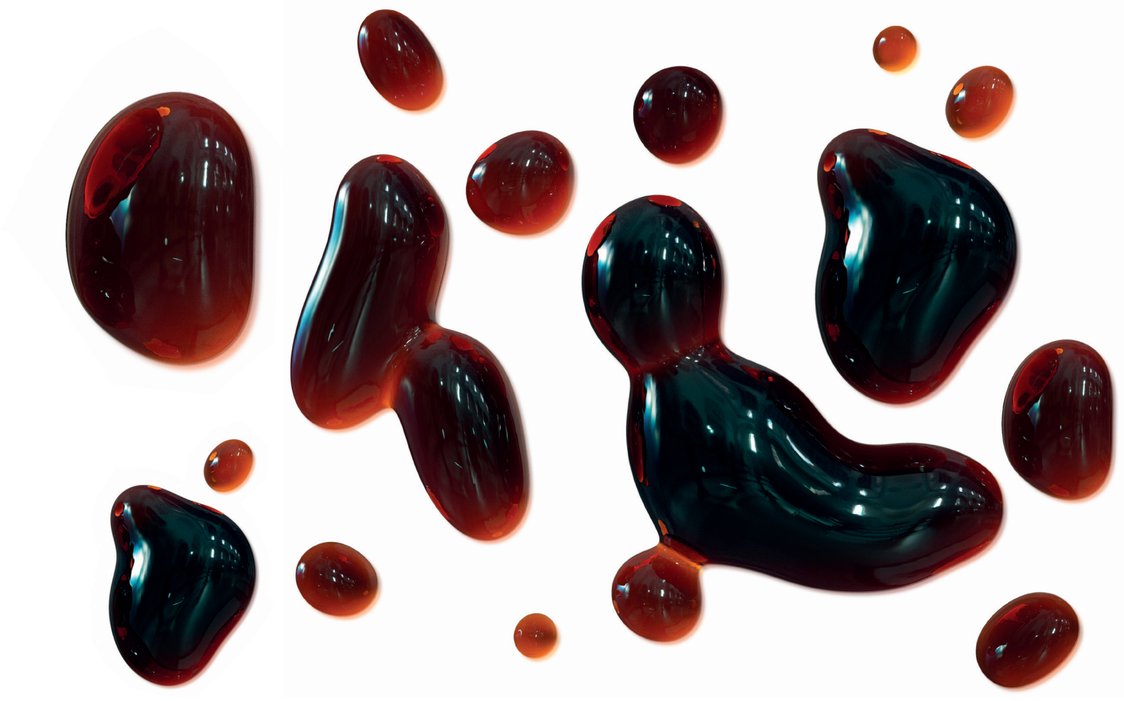
the most common of which are sandstone and limestone. Porous rocks also need to be permeable that is oil should be able to flow through their pores. That is the only way in which the oil will reach the surface of the earth. Over and beneath the porous rocks lie non-porous rocks such as shale.

Oil is usually found in an anticline which, explained simply, is an arched sequence of rocks that acquires this shape due to folds in the earth. At least 80 per cent of the oil and gas discovered in the world so far has been from anticlines which were probably formed about 200 million years ago. The processes that break down the organic matter, and lead to the formation of oil, mostly occur at temperatures between 75° C and 150° C, around 2–3.5 kilometres below the surface of the earth.

Oil, which is lighter than water, floats on water; natural gas floats above it. Once the oil reaches the earth's surface, it is exposed to oxygen from the atmosphere, and much of it ignites. Records of early history tell us that man used to worship what he saw as enormous fires emerging from the earth. In some countries such as India, these flares, such as that at *Jwalamukhi* in the Himalayan foothills, acquired religious significance. The heat from the sun hardens the oil and this harder, more viscous form, is called bitumen.

Petroleum: A Liquid Hydrocarbon

Gas either separates from the oil beneath the earth's surface or when it rises to the surface. Natural gas fields are, therefore, found near oilfields.



The oil and gas rarely completely displace the water component in the reservoir bed. Indeed, the reduction of pressure as the oilfield is produced may allow water from above, below or around the oil to permeate through. Therefore, oil and gas almost invariably carry some moisture to the surface. If the oilfield is relatively new, the water may go undetected but in old fields or if the fields are nearing depletion, the quantities of water are much larger. Oilfield water is known as brine because it contains sodium chloride.

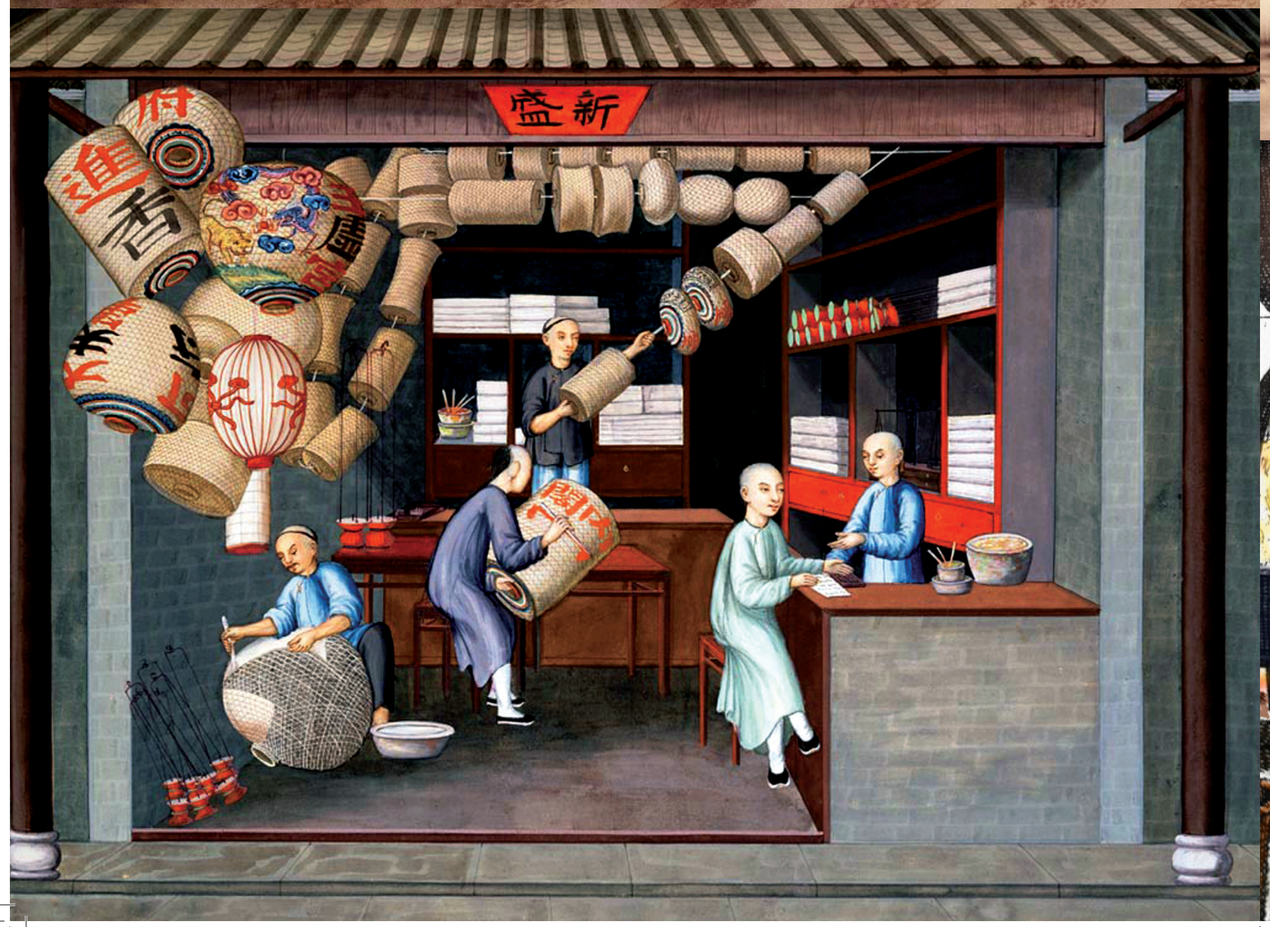
Around the fourteenth century, oil came to be known as 'rock oil' or petroleum, originating from the Latin word 'petra' meaning rock, and 'oleum' meaning oil. When petroleum reaches the surface and evaporates, the solid parts left behind are asphalt deposits. A large number of areas with oil shale have been discovered too but have so far proven to be an expensive process to exploit. However, given the high price of oil, in recent years their exploitation, particularly in the US, has proved a bonanza, resulting in the US becoming less dependent on oil imports. The common factor in all petroleum substances is that they are composed entirely of carbon and hydrogen combined into chemical compounds known as hydrocarbons. Crude petroleum, however, does not comprise hydrocarbons alone.

Oil is a liquid hydrocarbon. Therefore, unlike gas or coal, it can be transported over long distances with relatively modest energy and labour inputs. Arguably, the world's most precious resource, at least in this century, nations have to guard against exhausting this indispensable treasure too rapidly before a reliable substitute is found. It is imperative to conserve more than is used so that future oil supplies will be available to the world. The thumb rule in the oil trade is that only about one-twentieth of the oil in a reservoir should be extracted each year.

Early Discoveries

Man has known about oil since time immemorial. The earliest historical record of the use of oil

Top: Christian defenders of Constantinople (now Istanbul), capital of Turkey, invented a terrifying weapon known as 'Greek fire' from oil, sulphur and some other secret ingredients, as a lethal tool of battle in the twelfth century. They armed their warships with brass pumping devices, which served as flamethrowers.
Bottom: Oil served both the living and the dead. The ancients used it as an ointment to treat bruises, sores and minor cuts. The word 'mummy' is derived from *mummiyaah*, the Arabic word for 'asphalt'. Asphalt was a key ingredient in embalming a corpse and preserving it as a mummy.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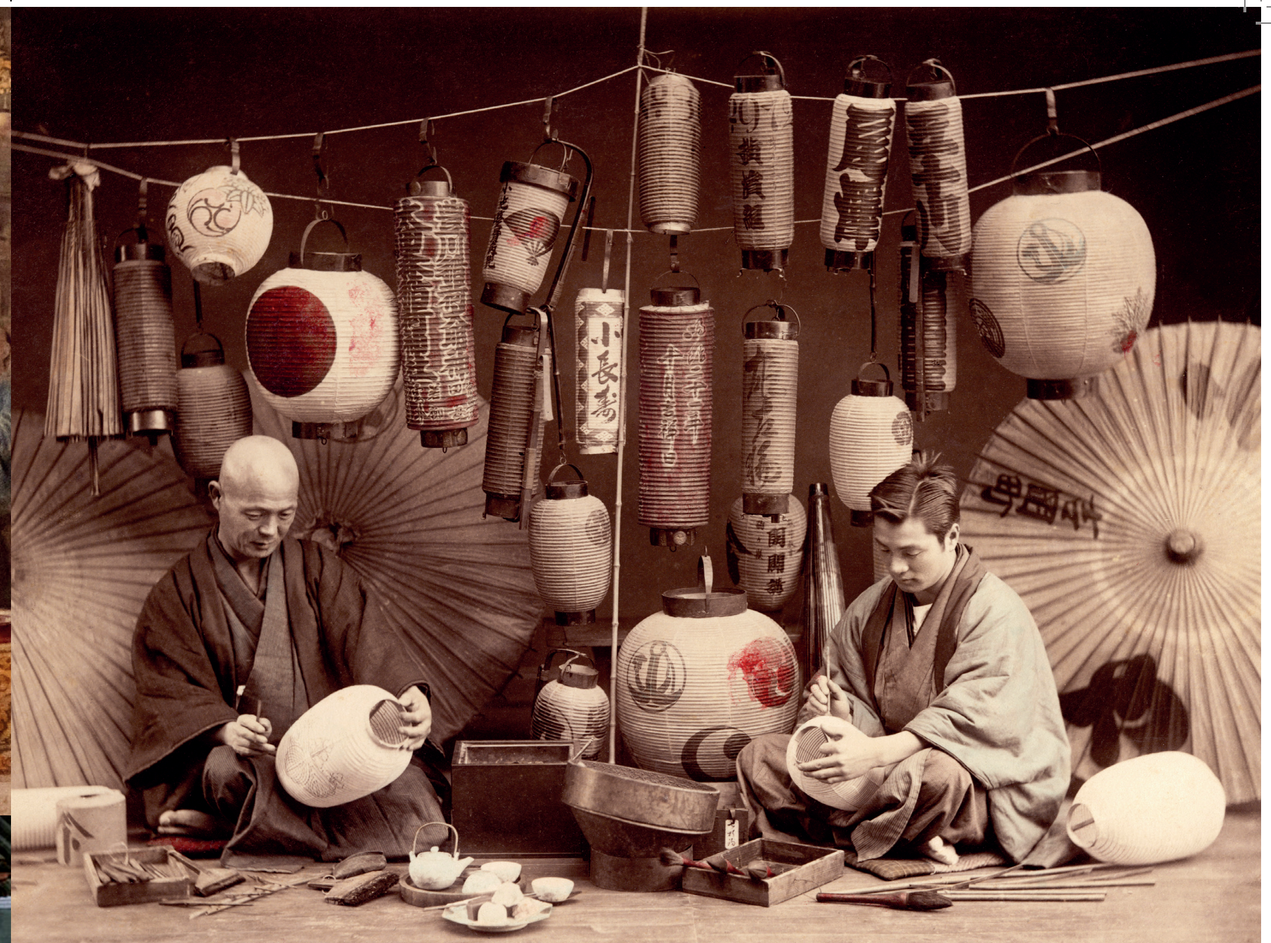


Right top: A candle-maker practising his craft. Paraffin could be used to make inexpensive candles of high quality. It was a bluish-white wax, burned cleanly and left no unpleasant odour, unlike tallow candles. By the late nineteenth century, Price's Candles, based in London, was the largest candle manufacturer in the world.

Right bottom: A Chinese candle-maker. Early Chinese candles are said to have been moulded in paper tubes, using rolled rice paper for the wick and wax from an indigenous insect that was combined with seeds. In Japan, candles were made of extracted wax. While in India, candle-wax was made by boiling the fruit of the cinnamon tree.

Facing page top: Pilgrims to a Greek church purchasing candles.

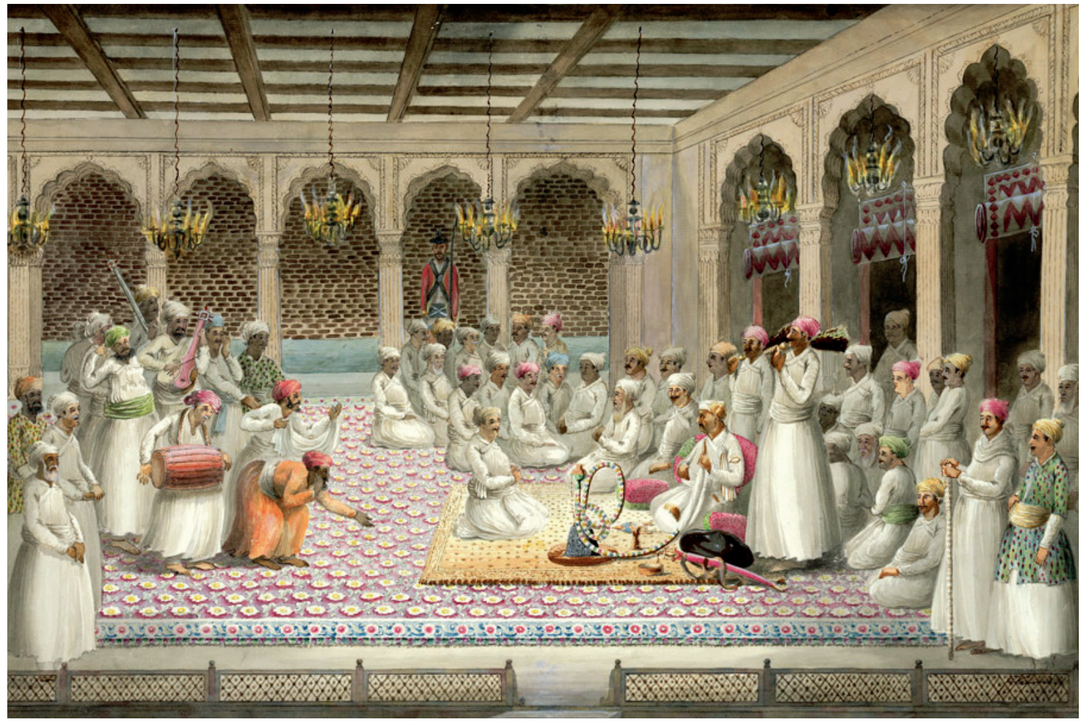
Facing page bottom: A Chinese lantern painter. During the reign of the Song Dynasty, a lantern festival was celebrated for five days and it began spreading to large Chinese cities. Colourful glass and even jade were used to make lanterns, with figures from folk tales painted on them.

Preceding spread left top: An old lantern shop in China. In ancient times, the lanterns were fairly simple and only the emperor and noblemen owned large ornate ones. In modern times, lanterns are embellished with complex designs. The lanterns are almost invariably red to symbolise good fortune.

Preceding spread, left bottom: A Chinese lantern shop. During the Lantern Festival celebrated on the fifteenth day of the first lunar month in the Chinese calendar, sales soar. On other festive occasions, kongming lanterns float high up into the sky. The Chinese Lantern Festival is now becoming popular in Western countries too. London, celebrates the Magical Lantern Festival.

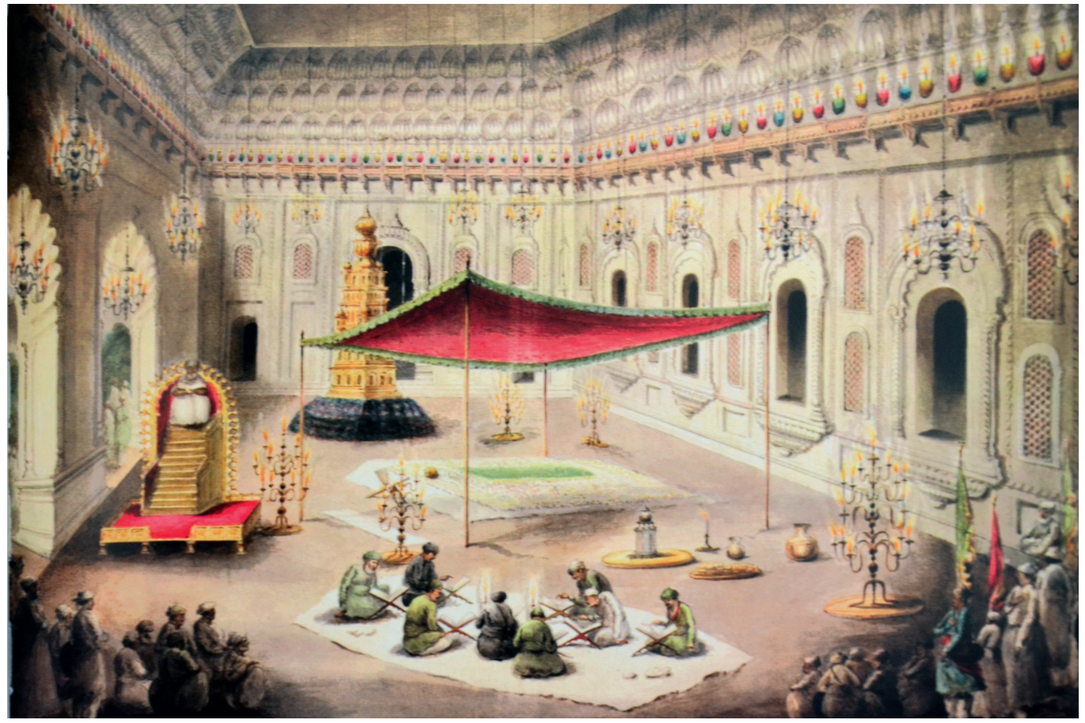
Preceding spread right top: A traditional Japanese lantern shop. The Lantern Lighting Festival encompasses Japanese tradition through music, dance, crafts, martial arts and lanterns. Lanterns or small fires are also lit outside the house to symbolically guide souls to their homes.

Preceding spread, right bottom: A workshop of handmade candles. Candles started to be manufactured by the Romans around 500 BCE. In India, wax from boiling cinnamon was used to manufacture temple candles. The popularity of candles is shown by their use in the Christian festivals of Candlemas and Saint Lucy. In pre-Christian times, candles were used in the pagan Festival of Light celebrated in ancient Britain. The popularity of candles today continues to increase. The flickering light of a candle exudes an atmosphere of enchantment that seems to draw people together. The ambience of a room is enhanced with their simple, timeless beauty. Their only drawback is that they must be protected from wind to prevent them from flickering or being extinguished.



was provided by Herodotus around 480 BCE. He mentioned that asphalt or slime was used in the construction of the walls and towers of Babylon. Noah's Ark was supposedly coated with pitch both inside and outside. The Tower of Babel apparently used slime as mortar. Nehemiah is said to have used naphtha for altar fires. Asphalt was used to pave the streets of Mesopotamia, on the banks of the Euphrates River, in the area that now largely constitutes modern Iraq. Excavations at the sites of ancient cities such as Kish, Ur and Nineveh have revealed that asphalt was used as a waterproofing agent for baths and boats, as cement for pottery, and as paint. The Red Indians used oil as war paint. Oil-soaked arrows were said to have been used as weapons of war during the siege of Athens. Historical records also mention the use of asphalt by the Sumerians and Chaldeans, the town of Hit on the Euphrates being stated to have possessed an enormous supply. Findings on the banks of the river Issus, a tributary of the Euphrates, confirmed that asphalt was used in the caulking of boats and as mortar.

The Old Testament alludes to 'leaping fires' that were occasionally seen on the surface of the Dead Sea on which stood the cities of Sodom and Gomorrah. Legend has it that the Greeks poured oil on the sea and set fire to it to prevent an attack by an enemy fleet. The 'Greek fire' is said to have contained sulphur, potassium nitrate, unslaked lime and asphalt. Pliny, the first century Roman historian, reported that oil lamps were lit in the temple of Jupiter. There are references to show that during the Roman Empire oil was used for medicinal purposes, religious ceremonies, ship-building and repairs, and as lamp oil. A Roman general is said to have defeated the Vandals by applying generous amounts of oil to the skins of pigs and then driving them alight into the enemy ranks. It is even said that a Shah of Persia in the seventh century used iron horses with burning oil which were mounted on wheels to attack an Indian army led by elephants. After the fall of the Roman Empire, archaeological findings in Iran dating to 400 BCE show that asphalt was used to set jewels, and Persian



tablets indicate the use of petroleum for medicinal purposes and lighting.

'Eternal Fires' and 'Burning Water'

Oil wells were first said to have been drilled in China around 350 CE or earlier by attaching iron bits to bamboo poles for drilling. They also rubbed petroleum as a preservative on the ropes of ships. Evidence confirms the use of oil and gas for heating and light. Indeed, most of the early evidence found relates to the use of asphalt as it does not evaporate. Synonyms for asphalt in early records were bitumen, tar, pitch, slime and burning tar, while liquid petroleum was often referred to as nephthar, nafta, maltha and burning water. Ancient Egyptians applied petroleum to dead bodies before burying them, apparently importing the petroleum from Palestine. Occasionally, some areas in the Dead Sea seemed to boil and asphalt was thrown up in large quantities.

Mention is made in Japanese history of 'burning water' in the seventh century. However, even prior to the Christian era, the burning gas seeps known as the 'eternal fires' in the Persian city of Baku, Azerbaijan, on the west coast of the Caspian Sea, were worshipped by fire worshippers. The Arab geographer Abu al-Hasan and Marco Polo wrote of such findings in the twelfth and

A brilliantly lit hall with coloured girandoles attached to the parapet beneath the ceiling. Three rows of chandeliers are suspended from the latter in this spectacular interior portrayed by Indian artist Sita Ram. Various devices have been devised to hold candles, from simple tabletop candleholders to elaborate chandeliers.
Facing page: Musicians are seen entertaining an Indian maharaja in this candlelit scene. At royal courts, musicians entertained the king and his courtiers with the sound of their music. The effect would, however, never have been the same without the light of the humble candle, for which it is so appropriately said: 'There are two ways of spreading light: to be the candle or the mirror that reflects it.' Thus, figuratively speaking, the musicians embodied the candle and the audience, the mirror.
Following spread, left top: Fire *mashaals* were used to guide the *palkhis* or palanquins in India. They date back to circa 250 BCE, as the Ramayana mentions them.
Following spread, left bottom: The mode of transportation of early geologists comprised horses, camels, donkeys and elephants. The 'Camel *Palkhi*' was also popular in Gulf countries.
Following spread, right top: Returning from the grape harvest with oil *mashaals*.
Following spread, right bottom: Roman oil lamps were one of the most common household items of ancient times. Lamps made of stone or shell were used as early as the Stone Age. Ceramic, similar to this, were used throughout the Mediterranean area from 2,000 BCE onwards through the Middle Ages.