

FROM SAVAGERY TO CIVILISATION

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by M. N. Roy

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*In Memory of the
Martyrs
for the cause of
Human Progress
and
Real Spiritual Liberation of Mankind*

FOREWORD

When M. N. Roy wrote *From Savagery to Civilisation*, he was still a self-proclaimed Marxist. But it is impossible to go through this collection of short essays without realising that he was already a Marxist with a difference. By far the larger part of this book is concerned with the contributions made to social advancement by philosophers, who acted as leaders of the enlightenment or made possible a clearer understanding of the place of man in the universe, and scientists, who gave men the power to control the material environment and thus bring about permanent changes in the structure of society. By contrast, comparatively little space is given to a consideration of class struggle. We have only to place Roy's treatment of the subject beside the standard Marxist account of the progress of man from primitive communism to capitalism to be struck by the difference in tone and emphasis.

In writing these essays, Roy was chiefly concerned with showing how the West came out of the Middle Ages and entered the modern age, so that those who were interested in modernising India could draw appropriate lessons from the historic experience of Europe. The idea that a social system is forced to change by internal contradictions, manifested above all through class struggle, has an apparent plausibility when one is thinking exclusively of the capitalist system. But it is much more difficult to explain the break-down of feudalism in these terms without falsifying the historical record. The dawn of the modern age in the West, along with its subsequent progress, had for its causes the remarkable revival and extension of trade after the Crusades and, more spectacularly, the geographical discoveries at the end of the fifteenth century, the development of the philosophy and the experimental methods of the new science with which the names of Roger Bacon, Galileo, Francis Bacon and Newton, for instance, are associated, and the impact of the new technology which

was dramatised in the industrial revolution. It is only by an extraordinary *tour de force* that these epoch-making developments can be explained in terms of the 'internal contradictions' of the feudal system. It is more honest to accept these as external to the essence of feudalism and as having produced momentous changes by their impact on society. The unfoldment of reason, or the progress of ideas, has its own dynamics, and, interacting with material conditions, it creates history.

When he wrote this book, Roy had not yet come to the conclusion, as he did later, that it is not 'proletarian culture', which he called 'a contradiction in terms', but the values of humanism which can serve as the basis of the struggle for a higher form of society in our times. He was yet a Marxist, and as such he did not deny the significance of class struggle; but, as a materialist, he always considered the progress of science and technology, as instruments of control over nature, and the emergence of a rational conception of morality to be even more fundamental to social advancement. He believed in the importance of a 'philosophical revolution' and a cultural renaissance as preconditions of modernisation, in that deeper sense in which the extension of human freedom and the recognition of the dignity of the individual are inseparable from the true meaning of modernity. Even before he wrote his *New Humanism*, when he complained that "there is no intellectual freedom in the communist movement", Roy recognised science and freedom as the foundations of all progressive movements in history. In this sense, *From Savagery to Civilisation* still retains a contemporary relevance. It is a link between the Marxist that the author once was and the 'new' Humanist that he was to be in later years.

AMLAN DATTA

PREFACE

The collection of short essays was written, as it were, by accident. It is a war-time production; but I venture to think that it will not be as cheap as that. Upon the out-break of the war, Indian journals stopped publishing my political contributions, either on home or foreign affairs. That placed me in some difficulty. I try to earn a living by journalism. The war threatened me with starvation. But some friendly and sympathetic editors advised me to write on anything but politics. Presumably, they meant weather conditions, travel impressions, domestic doings, or something harmless like that. But I am not as versatile as to compose readable essays on 'anything'. The result was this collection which is published with the purpose of creating interest for a study of the spiritual achievements of the Western world.

I have made the bold suggestion that the world has hardly entered the stage of civilisation. The traditions of savagery and barbarism still dominate human spirit. But the achievements, so far made by the progress of science, give a glimpse of the real civilisation which must inspire all lovers of spiritual freedom to join in the great task of re-making the world.

M. N. ROY

I

From time to time, various theories have been propounded regarding the origin of human society. Until the epoch-making discoveries of natural science, all the theories about the origin of human society were rooted in religion. Laws for governing human behaviour and social conduct were promulgated either on the authority of God or on an abstract Moral Principle. Later on, the democratic doctrine of the sovereignty of the people came to be the fundamental principle of legislation. Reason replaced God as the condition for the challenge to the divine right of kings. But even then, great ignorance prevailed not only regarding the origin, but even about the causes of the evolution of human society.

The origin of society can be traced far into the darkness of antiquity, and the long process of human evolution through the wilderness of time could be visualised clearly only in the light of modern science. Not until the nineteenth century, man had any clear idea about his original ancestry and progress from savagery to civilisation through the vicissitudes of history.

The great discoveries of Darwin definitely cleared away the religious prejudices shrouding the origin of man. Of course, prejudices still persisted with those to whom the light of knowledge was not available. But it was there to help those who wanted to see. The researches of Lewis Morgan threw a flood of revealing light upon the character and constitution of the primitive human society. It was no longer necessary for us to be acquainted with our distant progenitors through legends and mythologies. They lived even in our midst, so that those who preferred observation to imagination could get directly acquainted with their ways of life.

Hegel raised history to the level of science which revealed human society as in a continuous process. Finally, Karl Marx and Friedrich Engels developed the materialist conception of history. It became

evident that man is not a sinner driven out of Heaven by an angry God ; that human society did not originate with the blessed survivors of the latest of the periodically succeeding cataclysms ; that no arbitrary Supreme Being created the phenomenal universe in a fit of playfulness ; that social relations are determined neither by an inscrutable divine will, nor by an abstract conception of morality ; and that human society originated in the struggle for existence, and its subsequent evolution through ages had material causes.

The human being marks the culmination of a period in the endless process of biological evolution. Man is the animal which, in the struggle for existence, goes beyond organic adaptation and makes use of weapons outside its own physical organism. The animal grows fur to protect itself from cold. For the same purpose, the primitive man finds something to cover his body—leaves, bark, skin and, finally, manufactured fabrics. As soon as the animal reaches the stage of primitive man, it no longer develops sharp teeth and claws as the carnivorous do. He finds stone-flints and, later, makes bows and arrows for killing his prey. The monkey grows long and agile limbs for swinging from branch to branch. One fortuitously breaks a branch and uses it as an instrument for shaking down fruits. The forefather of primitive man is born.

CONQUEST OF NATURE

The ability to use an object outside the physical organism as a weapon in the struggle for existence puts an end to the long process of organic adaptation. In short, the descent, more correctly speaking, the ascent, of man coincides, on the one hand, with the termination of the process of organic adaptation and with the beginning, on the other hand, of the process of the struggle for the conquest of nature.

The exigencies of the struggle against the forces of nature oblige the primitive man to seek company and co-operation of his fellow-beings. The earliest human society comes into existence. The congregation takes place first for hunting, then for herding domesticated animals, and finally for cultivating the earth. So, society originates with the application of human labour to the available natural resources for the production of something new.

Man is not the creation of an angry or arbitrary or playful God. If there ever was a creator, it is man. Creation begins with him. The ability to create progressively distinguishes man from the lower animals. Some of these do create ; but their creation is static. Therefore, the means and modes of applying human labour for creation determine all social relations not only in the dawn of history, but throughout the successive stages of subsequent human progress.

Canons of religion, codes of morality and civic laws are evolved from time to time for establishing and maintaining a particular system of social relations growing out of the conditions of production of the given epoch. There is no eternal law governing human existence in all times and under all conditions. There is no divine hand shaping man's destiny. There is no divine will or supernatural principle to which everything in the phenomenal world must conform.

Although man begins to congregate already in the early stage of savagery, the foundation of human society is firmly laid only when he learns to make the earth bear fruit through cultivation. That epoch-making knowledge closes the period of migration in search of food and grazing ground for domesticated animals. Groups of human beings settle down in particular localities, and the organisation of society definitely begins. Each group marks out an area as its collective domain. There is no incentive for wanting more and more. The limit is set by the ability to make the land bear fruit. The ability, in its turn, is circumscribed by the aggregate labour of the given community. The ownership is common, because land is cultivated by the labour of the entire community. One single individual can achieve very little in that primordial stage of the struggle against Mother Earth. The mode of production—creation of food needed by all, by the joint labour of all—determines the relations of the primitive community. The fruits of collective labour belong to all equally. There is no distinction between mine and thine.

ORIGIN OF PRIVATE PROPERTY

Settled conditions gradually increase the productivity of human labour. Primitive tools are manufactured. These new means of production interfere with the collective performance of labour. Those

who make them can work with them individually. They become primitive owners of the produce of their labour. Private property originates.

Gradually, the community ceases to have common interest. There arises the necessity for laws to govern the relation of its members having diverse and conflicting interests. There must be some authority by setting up one or more superhuman beings who, by virtue of being superhuman, must know better than man. All the law-givers of the antiquity are "seers" supposed to have been inspired by divine vision. Ignorance about elemental phenomena, like the sun, moon, fire, rain, etc. provides the basis for ascribing divinity to them. There begins the speculation about the great cause of everything, and the existence of an omnipotent, omniscient, omnipresent being is assumed as the supreme authority for laying down laws to govern the conduct of the mortals. The object of those divinely ordained laws, however, is entirely mundane. It is to protect the newly created private property, and to establish those possessing it as the ruling class.

In course of time, private property extends to land, the main means of production in the primitive society. The fruits of land, cultivated with privately made and, therefore, privately owned tools, remain in private ownership. So, for all practical purposes, the land thus cultivated ceases to be common property. Primitive communist society breaks up into clans, composed of patriarchal families. The ownership of land is vested in the clan-chiefs, who, in course of time, grow into feudal lords expropriating the free cultivator of the land. Or, on the basis of patriarchal families, there rises the sacerdotal, theocratic kingship, claiming absolute right over everything by virtue of its divine descent. In any case, society completely ceases to be a congregation of free men.

It splits up into classes with divergent interests. Land still remains the main means of production. The creative power of man must be largely applied there. Therefore, the ownership of land becomes the foundation of social superiority. Those owning it maintain their domination by setting up a political authority under the shadow of the divine right of the king. The function of religion, theology and law is to defend the established order.

DIVISIONS OF SOCIETY

The division of society into classes with divergent interests inevitably breeds class struggle. It goes on continuously, and breaks out periodically into gigantic convulsions which subvert an established social order. That takes place only after an established order has decayed. In course of that process of decay, forces capable of creating a new order grow. Man's urge for creation asserts itself by bursting limitations on its creativeness.

A particular social order is based on a specific mode of production. Society is a creation of man. Its structure and function, therefore, are necessarily determined by the methods adopted in its creation. An established social order is threatened with destruction as soon as a new mode of production begins to develop inside it. Man is not God. He does not create to contemplate it. He wants to create ever greater and newer things. But it is also natural for the rulers of the old order to try to limit and even crush the nascent forces of progress. Conservatism and creativeness come into conflict. Man must choose between standing still and going ahead. Life is a movement. The first alternative means death. The latter must be chosen. Those standing on the way must be removed.

That is the essential feature of social evolution. Creativeness provokes conflict. Privilege and vested interest militate against new creations. Man cannot be conservative without ceasing to be man. The urge to create guides his steps from savagery to civilisation. If civilisation, as it is to-day, is still far from being perfect, the creative genius of man burns more ardently today than ever before. Man has created something great. He is destined to create something still greater. That is our hope.

II

The primitive communist society is based upon the cultivation of land by joint labour. It is disrupted, on the one hand, by the creation of private property in land resulting from the invention of agricultural implements, enabling individuals to cultivate separate plots of land ; on the other hand, by the development of handicrafts, in which the

individual producer can claim the ownership of the product of his labour, because he works with privately owned tools. Society is gradually shifted on to a new foundation. The social order based upon the private ownership of the means of production reaches its climax in the capitalist system. Various modes of production, that is, methods of applying human labour creatively, develop and disappear successively in the long intervening period.

In the earliest period of social evolution taking place on the basis of property, labour is performed in slavery, which assumes different outward forms under different conditions obtaining in different parts of the world. But everywhere the essence is the same. The essence of slavery is the employment of labour in return for the barest means of subsistence—subsistence not only of those actually performing labour, but of the entire species of the human beasts of burden. To be profitable, slaves must be allowed not only to live but also to procreate. The offspring of the slave also belongs to the slave-owner, just as calves and colts are the property of the cattle-breeder.

SLAVERY IN INDIA

It is maintained by some prejudiced or ignorant historians that the holy soil of India was never contaminated by the curse of slavery. Upon the break-up of the primitive communist society, slavery appears as an integral part of the next higher stage in the scale of social evolution. It comes into being as of necessity. To maintain that it did not develop in India is to deny that India ever came out of the stage of savagery. What is true is that in India slavery did not assume the classical form as in the West- Asiatic and Mediterranean countries. But apart from any theoretical assumption, practical evidences of the existence of slavery in ancient India are plentiful in the Epics and other classical literature. A large element of it is to be found in the original caste system. Not only the captives in war are enslaved ; entire conquered races are also put into slavery. The so-called Aryan conquerors did that in India. Aboriginal inhabitants of the conquered territories became slaves for all practical purposes, and later on were placed in the lowest rank of the caste system or were called outcastes. The *sudras* were called *dasas*—servants. The profession of exclusively serving others is clearly

servile. A society which contained a numerous class compelled to serve the rest cannot be free from slavery. Indeed, remnants of slavery still linger in the Indian social system. The hateful custom of untouchability is an ugly relic of the slavery of the aboriginal inhabitants of India subjugated by the nomadic invaders from Central Asia, glorified in history as the Aryans. As a matter of fact, the barbarian conquerors assumed that distinctive name after they established their domination in India. The Sanskrit word *Arya* means lord.

Slavery leads to labour being forcibly concentrated more and more on the production of luxuries, and construction of temples and monuments. Slave labour, having no or little value, is naturally squandered by the slave-owner. That happens particularly when slaves are available in plenty, thanks either to successful wars or conquest of populous countries. However, when a parasitic class rises on the foundation of slave-labour, the great bulk of it is employed in the production of luxuries or domestic services, luxurious existence being the token of superiority of the leisured class. Consequently, labour is withdrawn from the production of social necessities ; agriculture, particularly, is starved. Agriculture being the mainstay of social economy in those days, the latter loses its balance. A severe crisis over takes society. The system of production based upon slavery breaks down.

Slavery having not had assumed the classical form in India, the collapse of the antique social order was not so spectacular as in Babylon, Assyria, Egypt or even in Greece and Rome. But ancient India did experience gigantic social upheavals. A fragmentary record of them constitutes the historical background of the Epics. Even in the historical times, the rise of Buddhism was a tremendous revolt against the ancient Brahmanic social order. Buddha himself was the personification of revolt against parasitic luxury. The old social order collapsed to make room for the prosperity and higher culture of the Buddhist period. After nearly a thousand years, Brahmanic reaction appeared to overwhelm the Buddhist revolution. What was restored, however, was not the old Brahmanism. The old was revived only in name, but entirely with a new substance. The theocratic kingship was not to be revived. The new Hindu kings were incipient feudal monarchs with large patriarchal attributes.

FEUDAL SERFDOM

Out of the ruins of the antique society based upon slave-labour, there arises the feudal social order founded upon a new mode of production. Private property in land, created already in the antique society, lays the foundation of feudal production. In the new social order, labour is performed in serfdom which replaces the older system of slavery.

In India, serfdom also did not take the classical form as in mediæval Europe. Nevertheless, it was there essentially. The essence of feudal production is that the peasant cultivates the land with his own tools, but is obliged to deliver to the owner of the land all the produce over and above what is necessary for his bare subsistence and reproduction. Land is still the main means of production. Under feudalism, the cultivator is not the owner of the land. Feudalism results from the expropriation of the free tiller of the soil, or from the conquest of new countries by martial tribes. The soldiers settle down on land to cultivate it. The head or heads of the conquering band assume the ownership of the occupied land. The feudal system of exploitation not only obtained in India in the past ; it largely governs agricultural production even today.

The next stage of human progress is heralded by the capitalist mode of production within the framework of feudal social order. A new period of social upheaval sets in. Between the feudal landlord and the peasant held in serfdom, there arises the new class of traders. By keeping the peasantry, practically the entire population of the epoch, on the level of bare subsistence, feudalism obstructs the expansion of other industries. These cannot grow so long as the great bulk of the community exists on the lowest level of living. Growing power of consumption is the incentive to industrial production. The sterile virgin of simplicity does not attract civilisation. In order to guarantee luxurious existence to a small parasitic class, feudal culture extols the virtue of simple life.

RISE OF TRADING CLASS

The harbingers of modern civilisation knock at the doors of feudal society. The rise of the trading class cannot be successfully checked. The product of agriculture is no longer consumed entirely by the

producer. A growing part of it becomes commodity. It has to be exchanged for other articles. Markets develop, trade expands ; a new class appears on the scene. As a matter of fact, in the beginning the trader appears as an auxiliary of the feudal lord. Without his services, feudal dues wrung from the peasantry in kind cannot be converted into money, and subsequently, wealth. So, trade must be permitted, even if under restrictions which, by the nature of things, must grow less and less vigorous. When there is trade, there is profit. The trader grows rich, in spite of all feudal restrictions and exactions. He invests his accumulated wealth in industries other than agriculture which develop threatening feudal absolutism.

The limit is soon reached. The mode of production based on "free labour" cannot be firmly established unless labour is liberated—to move away from land. Yet another condition must be created : a certain part of the surplus produce of agriculture must remain in possession of the peasantry, so that they may buy the product of new manufacturing industries owned by the rising class of capitalists. Both the conditions can be created at the cost of the power and privilege of feudalism. The first presupposes abolition of serfdom, which constitutes the economic foundation of feudalism. The second represents an encroachment upon feudal preserves. Under feudalism practically the entire surplus produce is legally the share of the landlord. That legal right must be restricted, if peasants are to be given a larger share in the produce of their labour. Ordinarily, feudal rights and privileges are fortified by the monarchist State. The advent of modern civilisation, therefore, requires the subversion of the monarchist State. That is brought about by a social upheaval historically known as the bourgeois revolution, which establishes democracy. The Monarch may remain as a formality even after the passing of the monarchist State. Wherever that social upheaval ends in a compromise, democracy is defective, and civilisation remains burdened with the ballast of feudal mediævalism.

III

Wage-labour is the basis of capitalist production. The abolition of feudalism frees the peasant from land. Except in particular cases, for example in France at the end of the eighteenth century and in Russia

only two decades ago, the abolition takes place not all at once, but in a process. Therefore, modern civilisation is built up also gradually. However, the change in social relations is that the peasant is no longer obliged to toil on the lord's land. He is "freed"—to become a wage-slave. He can now sell his labour power in the open market. Whenever the feudal system is not destroyed by a single revolutionary blow, the peasant is "liberated" progressively. Serfdom may be abolished legally. But formal legislation seldom changes established economic relations. The serf may be raised to the status of tenant, and a tenant being always a tenant-at-will, he is "free" to move away from the land. His movement often is not voluntary but forced. As long as he remains a tenant, he is subjected to legally sanctioned exploitation and illegal exactions which, for all practical purposes, hold him down to the position of the serf inasmuch as virtually the whole of his surplus produce is taken away from him in one form or other.

That is the position of the bulk of Indian peasantry even today. Land is still the main means of production in our country. The great bulk of national income is derived from that source. But the productivity of labour devoted to agriculture is very low. The basic industry is overcrowded. Legally the peasants are free to go away from the land. But they cannot avail themselves of this legal freedom, because there is little demand for their labour elsewhere. Practically the entire surplus produce of agriculture is appropriated partly by the landlords and partly goes out of the country to settle the balance of foreign trade. Consequently, a very small part of the aggregate national income, representing the surplus labour performed on land, is applied to modern industries. India as a whole enters very slowly into the stage of civilisation in course of her social evolution. Legally, there is no feudalism except in limited parts of British India and in the Indian States. But for all practical purposes, more than half the peasantry live and labour in the state of serfdom. Even the rest in the *ryotwari* areas are hardly any better off. There the State being the landlord, rent and tax coincide. The economic consequences are almost the same; nearly the whole of the surplus produce of agriculture is taken away from the peasantry. A civilised society cannot be built on the foundation of the peasantry, which constitutes the overwhelming majority of the population in pre-capitalist society, economically

pauperised, even though legally above the state of serfdom. Serfdom of the peasantry, whether legal or virtual, keeps the society as a whole in the stage of mediaevalism.

The freedom of the peasant to move away from the land and sell his labour in the competitive market means a great accession of strength for the manufacturing industry. Free supply of labour enables the owner of the new means of production to purchase it at the lowest price. Another condition for the rapid growth of capitalism is the rise of the trading class which accumulates wealth by appropriating an increasing portion of the value of agricultural surplus labour. That represents an encroachment upon the preserves of the feudal landlord. The wealth accumulated in the possession of the trading class is converted into capital in the form of the new tools for manufacture which gradually develop into modern machinery. Labour performed with the help of this grows in productivity. The subsistence and procreation of the wage-slave are guaranteed by the expenditure of a small part of the value of his increasingly productive labour. The rest remains with the owner of the new means of production, to accumulate at an ever-increasing rate.

CAPITAL AND CAPITALIST

Wealth is not capital. It becomes capital when it is applied for stimulating production, when it becomes the means for the application of labour to the natural resources, so that new value can be created. Every rich man is not a capitalist. The non-capitalist rich is a parasite, living luxuriously at the cost of others without contributing anything to the production of national wealth or to any generally useful social value. The capitalist originally is a useful member of society. In the beginning, he may not even be rich, although endless riches may be accessible to him eventually. Capital accumulates by depriving the labourer of a portion of the value created by him. An artisan who employs an apprentice by paying wage is an incipient capitalist, though he is not rich. He becomes a full-fledged capitalist when in course of time he becomes able to employ so many wage-labourers that his own labour can be withdrawn from the actual process of production. Still, for some time he performs a socially useful function

as supervisor or manager. Ultimately, even these functions are performed also by hired labour. The capitalist, as known to-day, appears on the social scene as the predominating factor, although he has already historically outlived his social utility.

Since the value produced by labour over and above what is necessary for the maintenance and procreation of the worker, goes in the accumulation of new capital, the lower the price of labour, the higher the rate of accumulation of capital. Wages are the price of labour. As soon as labour comes to be a commodity to be bought and sold in the open market, it is subject to the law of supply and demand. The greater the supply, the lower the demand, and prices must go down. Hence the anxiety of the capitalist owners of the new manufacturing industry to free the peasant from feudal bondage. The supply of labour increases ; it can be purchased at a low price. Labour purchasable at such a low price as leaves a large margin of surplus production, is the economic foundation of capitalism.

LABOUR

Originally, man applies labour to the available natural resources for producing what he needs for his subsistence. Growth of private property changes the original purpose of production. Labour, again, is the moral as well as the legal foundation of private property. It is self-understood that one is the master of his own creation. As soon as man can create something by his individual labour, private property is created. In course of time, tools develop and one individual can produce by his own labour, with tools belonging to himself, also by virtue of being originally his creation, more things than he needs for his own use. Similar things may not be produced by others, not by many others at any rate. Experience includes them into the necessities of life. They are in demand. The artisan supplies the demand—in the beginning directly in exchange for other things he needs, but does not produce himself, and later on through some medium of exchange. Originally, the medium itself was some necessary article. In course of time, it becomes a mere token, carrying a generally agreed imaginary value. Finally, it develops into money, which itself is nothing more than a token with an imaginary value fixed by law.

COMMODITY

Under capitalism, the product of human labour becomes commodity for exchange, so that the owner of the means of production can make profit, a part of which goes to those engaged in the process, of distribution. Production altogether loses its original purpose. It takes place not even for profit to be made by the producer himself. The sole purpose of production, employing practically the entire bulk of social labour, is profit for a small group of individuals completely divorced from the process of production. That is the climax of capitalism. In course of its own development, capitalism, however, raises the entire society to a higher level, not only economic, but cultural as well. Civilisation is coincident, but not identical, with capitalism. The growth of modern industry marks the march of civilisation. Machinery is the fundamental civilising factor, because it is the most powerful liberator. But capitalism only lays down the foundation for a truly civilised society. Machine is a creation of man. Under capitalism, man is enslaved, not by the machine, but by the accident of the private ownership of the machine. Society enters a high stage of civilisation when man becomes the master of his creation. The relation between man and machinery changes, man becoming the master of the machine ; the latter's liberating potentialities are released, and a perspective of endless human progress, not only economic, but cultural and really spiritual, is opened up.

IV

Man's progress is proportional to his ability to supplement his own labour power by harnessing external energy. He begins with drawing upon animal energy, the total amount of which in the entire world is not inexhaustible. Simultaneously with harnessing animal energy, man shapes inanimate things into weapons, implements and tools which do not make additional energy accessible to him, but increase the productivity of his own energy. With the help of a bow, he can shoot an arrow with greater speed and power than a dart thrown by hand. He need not be stronger to do the former act. The shooting of an arrow from a bow is perhaps the first instance of man harnessing

physical energy (as distinct from animal energy which, in the last analysis, is also physical). An arc-shaped contrivance is made by drawing the two extremities of a log nearer with the help of a strip of hide or a stout string. That primitive implement becomes a focus of physical energy lying in inexhaustible abundance all around man. But thousands of years pass, even after the first act of harnessing physical energy, before mankind even becomes conscious of its existence, learns something about the laws of its being and becoming, and systematically employs it for creative purposes with ever-increasing efficiency and ever greater success.

Tools increase the productivity of man's own labour power. Machines place at his disposal the inexhaustible source of physical energy. Therefore, until he learns to manufacture machines, man's struggle against nature produces only limited results, and his progress is necessarily slow. If the extent of the conquest of nature by man is to be regarded as the measure of human progress, real civilisation begins with the rise of modern science which equips man with the knowledge about the laws of nature ; and knowledge is power. Experience gained in the age-long blind struggle for existence enables man to make tools and improve them in a laborious, purely empirical process. Modern science gives him the power to manufacture machines with the help of which he can harness physical energy. The process is no longer purely empirical. With the rise of modern science, mankind enters into the stage of intelligent advance, planned progress. It begins to be really civilised.

COMING OF MACHINE

Nevertheless, to malign machine has come to be the hallmark of humanitarianism. If machine is a monster which is killing the spirit of man, then the entire arduous march of mankind from savagery to civilisation should be condemned as a perverse process, and man must begin all over again from the point where he committed the initial mistake of trying to live differently from other animals.

Modern civilisation is condemned as the "machine civilisation", whereas ancient civilisation is glorified as something superior. But wherever there existed an ancient civilisation, it flourished only on

the foundation of some scientific knowledge and the corresponding technological progress. Civilisation, always and everywhere, is associated with more or less increased productivity of human labour caused by man's ability to manufacture primitive machines.

We have historical records of primitive technological development in ancient Babylon and Egypt. It reached a very high level in the Alexandrian period of Greek civilisation. There exists no historical record of such development in ancient India. But epics are full of tales which are today interpreted as indicating very high technological development in ancient India. It is obviously fantastic to contend that artillery was used in the battle of Kurukshetra, or that Ramachandra flew back from Ceylon in an aeroplane, or that the King of the Heaven was armed with a sort of a very powerful bomb, or that the traditional *Akashbani* was a superior type of wireless telegraphy. Any approximation to such technological achievements presupposes a very high level of scientific knowledge and of metallurgical and chemical industry. Ancient literature does not contain the slightest evidence of any such development in those days. However, the point is that even those who deprecate modern "machine civilisation" as inferior to the ancient "spiritual civilisation" find it necessary to claim legendary technological credit for this latter. The idea of civilisation is associated with the idea of the mastery of man over the forces of nature, and this mastery cannot be established except with the knowledge and power which enable man to harness physical energy.

FOUNDATION OF CIVILISATION

The foundation of civilisation is laid when man begins his efforts to explain the phenomena of nature without the assumption of some supernatural or extra-natural agency. That presupposes a mechanical conception of the Universe, which is regarded as a harmonious, law-governed, process of the being and becoming of physical elements including energy. As soon as energy, conceived as the motive power of the Universe, is regarded as a physical entity, subject to its own laws, which can be discovered by man progressively, man's creative instinct is quickened, and an endless vista of ever-increasing mastery over the forces of nature is opened up before mankind. Glimpses of that

ennobling vision were presented to particular communities well ahead of time, when the bulk of mankind was still groping in the twilight of savagery. Therefore, on the whole, the history of human development cannot be divided into watertight compartments. The stages of savagery, barbarism and civilisation overlap. But every epoch, taking humanity as a whole, has its distinctive features. Therefore, it can be said that the foundation of civilisation was laid in the midst of savagery or barbarism ; and, on the other hand, that the great bulk of mankind has scarcely outgrown savagery and barbarism even when all the avenues of endless progress have been thrown wide open by the ever-widening scientific knowledge and the ever-growing creative power of man.

NAVIGATION

The achievements of the early pioneers of civilisation, great as they are historically, were, however, purely theoretical—as a matter of fact, very largely speculative. Therefore, while affording a liberating vision, they gave man little of that concrete knowledge which is the source of power. Nevertheless, wherever the physical and mechanistic conception of natural phenomena gained ground sufficiently, some technological development did take place. So long as ancient mariners worshipped the wind as a god in the beginning of a sea voyage, ship-building might develop as a craft. Navigation thrived as a science, immensely quickening not only trade, but movement of ideas and broadening the human conception of the Universe, in consequence of the close observation of heavenly bodies, only when the wind came to be known as an expression of physical energy which could be harnessed through the manipulation of sails. Even the most primitive sail-boat represents a higher development of the creative power of man than the elaborately constructed relatively large vessels propelled by hundreds of oars arranged skilfully in several tiers. In this latter case, man's achievements are still limited by his own labour, the productivity of which is only increased a little by the use of tools. In the former case, a veritable revolution has taken place. Physical energy has been harnessed to the service of man. The service as yet may not be very great, but the harnessing itself is a great creative feat. It is an act of establishing man's mastery over a certain phenomenon of nature. Man

is freed from the fear of the supernatural ; he can now brave the vagaries of the whimsical god of wind.

IRRIGATION

Similarly is the wind-mill, for example, also a land-mark of civilisation, whereas an elaborate system of irrigation with canals and aqueducts does not necessarily mean the end of savagery or barbarism. Here again, in the latter case, man depends primarily on his own labour. In ancient times, or in backward stages, communities being less numerous, the total amount of social labour is limited. Therefore, when a disproportionate quantity is devoted to irrigation or other structural works (roads, temples, fortresses, palaces, etc.) which may evidence high engineering skill, more useful production is necessarily deprived of labour and deteriorates consequently. Therefore, monuments and structural works which are traditionally regarded as measures of ancient civilisation, actually had prejudicial influence on general social welfare and constituted checks upon real civilisation.

While the systematic harnessing of physical energy for the service of mankind did not take place until after the rise of modern science in the seventeenth century, first steps in that direction had been taken in the Alexandrian period of the Greek history. The origin of technology can be traced back to Archimedes who invented the lever and the famous "endless screw" for raising water.

COMMON HERITAGE

In the same period also lived great mathematicians and astronomers such as Euclid, Aristarchus, Hypparchus and others. Great as was the contribution made by those illustrious contemporaries of Archimedes to the store of positive human knowledge, the technological inventions of the latter were of more far-reaching importance. But those methods for harnessing physical energy could not come to general use until after well-nigh two thousand years, when modern science revealed the sources of physical energy and discovered more effective methods of tapping them. In the intervening period, the primitive speculative knowledge about the nature and laws of the physical world was all but extinguished by the exuberance of religiosity, and consequently

technology developed scarcely beyond the level on which it had been placed by Archimedes. General human progress was very slow. It was like the period of calm before the outburst of the tempest of theoretical and technological science which ushered in modern civilisation. That greatest event of human history took place in Europe. But it was an outburst of human creativeness, and, therefore, modern civilisation is not a European perversity, but a heritage of mankind. It is only a matter of time when mankind will come to its heritage, and, on the basis of that, begin a new era of even greater achievements.

V

The appreciation of the creativeness of human labour enables one to grasp the civilising significance of machine. The creativeness of man asserts itself effectively only when his age-long struggle against the forces of nature achieves initial victories. Without minimising the value of human achievements even during the epochs of savagery and barbarism, it can be said that man's creativeness did not begin to unfold itself in its true grandeur until the rise of modern science ushered in the Machine Age. Mankind, therefore, has entered the epoch of true civilisation only yesterday, so to say. Two hundred years are no longer than a few days in comparison with the history of human evolution, stretching back thousands of years. But the sum-total of the human achievement during the long preceding period is like a child's play as compared with that during the last two hundred years. This has been due to machine. Itself a creation of man, it immensely increases his creativeness.

All values are created by human labour. Nature is the storehouse of inexhaustible resources ; but these have no social value unless human labour is applied to them. If man lived on the spontaneous gifts of nature, he would never rise much above the level of sheer animal existence. The land, for example, has no value unless man cultivates it and makes it bear more fruit than in the state of primeval nature. A table is more valuable than the log of wood out of which it is manufactured. The additional value results from the labour applied in transforming a spontaneous gift of nature into a creation of man. That being the case, increased productivity of human labour is the lever of social progress. Whatever causes that increase, therefore,

marks an advance towards civilisation. Until the advent of machine, all agencies causing increase of the productivity of labour were limited in their scope. Machine enables man to harness physical energy and consequently removes all limitations to the increase of the productivity of human labour.

FINER ASPECTS OF LIFE

Society based on a limited productivity of human labour cannot evolve freely. It stagnates. The limited amount of values created is mostly appropriated by a small section of society. There is not enough wealth to go around the entire community, causing a general rise in the standard of life. In those conditions, the opulence of a few is only the measure of the poverty of the masses. Economic well-being makes it possible for the few to make some cultural progress ; but that again is the obverse of the cultural backwardness of the society as a whole.

Some relief from physical labour, necessary for the production of the means of existence, is the essential condition for the cultivation of what is called the finer aspects of life. Previous to the Machine Age, that condition does not exist in so far as the great bulk of the society is concerned. The majority lives a life hardly above the level of animal existence. It is compelled to devote its entire time and energy to producing the means of sheer physical existence. Any possible relief from the endless burden of physical labour is denied to the bulk of society by the cultural achievements of the thin upper strata. As a matter of fact, these achievements, usually celebrated as the monuments of the glorious civilisation of the past, are a deadweight upon the progress of the society as a whole. They compel the toiling masses to perform more labour than necessary for producing the means of their own physical labour precludes all possibility of cultural advance on their part. Having no leisure, they cannot cultivate the finer aspects of life, and are not, therefore, capable of even appreciating the cultural values created, in the last analysis, by their labour and based upon their deprivation.

Barbarism can be splendid, its splendour being manifested in the opulence and a certain degree of culture and refinement on the part

of the fortunate few. But that splendour, though itself a creation of man, is not the expression of that creativeness which liberates man from the bondage of the exigencies of sheer physical existence. Society enters into the epoch of civilisation only when a growing number of its members can have some relief from physical labour even after performing the surplus necessary for keeping the upper classes in comfort and opulence. That is possible only when the same amount of labour can be performed in less and less time. That condition is again created by the development of technology on the basis of the knowledge of the laws of nature and man's ability to harness physical energy. Machine frees man from age-long drudgery, which continues throughout the epoch of savagery and barbarism, and opens up before humanity as a whole avenues of an all-round cultural progress and real spiritual elevation. The Machine Age is not to be condemned as the age of materialistic civilisation. It is the age of spiritual liberation which is possible only on the basis of freedom from the anxieties of physical existence and material prosperity not only of the few, but of the entire society. Civilisation is real spiritual progress.

PRE-MACHINE AGE

The point will be made clear by casting a glance at the conditions of Europe in the pre-Machine Age. It is held by some that, in the Machine Age, man is not only degraded morally, but is deprived of the blessings of the freedom and simplicity of life in nature. Much has been written about the squalor, filth and suffering in the industrial centers of England, for example. Errant reformers and humanitarians agitated for the return to the idyllic life of "Merry England". But history gives us an entirely different picture of the conditions of England before the Industrial Revolution. Seriously dislocating established social relations, the Industrial Revolution, of course, brought much suffering in its train. The greed of the owners of the new mechanical means of production made human beings labour under revolting conditions. But the positive outcome of that historically necessary great social revolution survived all the incidental evils, and within less than a century raised the social and cultural level of the country far above that obtaining even in the middle of the eighteenth century.

ENGLAND IN SEVENTEENTH CENTURY

As late as the sixteenth century, England was far more backward in every respect than Italy, for example, where scientists and engineers, led by Leonardo da Vinci, had already resumed the work for technological development, stagnant ever since the days of Archimedes nearly two thousand years ago. While the populous Italian cities were thriving, the population of entire England did not exceed five millions. What is still worse is that it was stagnant at that very low figure. The country was economically so backward that it could not guarantee the minimum means of subsistence to the vast bulk of even that meagre population. Beggars and vagrants swarmed the entire country. But those derelicts of a decayed society were not treated in any humane manner. Vagrancy laws were passed, penalising begging, in the first instance, by whipping, then by slitting of ears; those caught for the third time were sentenced to death. The standard of education can be judged by the fact that many members of the House of Lords were illiterate, and they were the Lords of the Realm, belonging to the thin stratum of the upper class which enjoyed opulence and a certain measure of culture. As regards sanitation and public health, epidemic diseases periodically carried away large parts of the population. The death rate was several times higher than at present. The rural population was housed in huts thatched with straw, and only those in "prosperous circumstances" could have met once a week. Children as young as six years old were frequently set to labour. There were practically no roads. The common means of transport was bullock-carts dragged through gullies often knee-deep in mud. Naturally, pack horses were often preferred to the precarious vehicular traffic. The City of London itself was dirty, ill-built and without any sanitary provision. The country immediately surrounding it was still wild and marshy. Wild animals roamed freely throughout the country. The master artisan, as a rule, whipped his apprentices, the teacher his pupils, and the husband his wife.

That was "Merry England" in which the people were supposed to have lived in an idyllic simplicity. The conditions did not improve substantially until the end of the seventeenth century. But meanwhile, Newton had lived and died, having composed the famous *Principia*

and formulated the fundamental laws of the mechanics of nature and thus heralding the age of modern technology.

COMING OF SCIENCE

Other countries of Europe were hardly any better off. Until the seventeenth century, the home of modern civilisation was still shrouded in the twilight of mediaeval barbarism. There is no reason to believe that, during the same period, any other country in the world was nearer to civilisation. It was in Europe that modern science rose as the sun to dispel the darkness of social stagnation and the consequent cultural backwardness. With the power derived from the knowledge of nature, man began to build machines which increased the productivity of his labour at an immense speed, so that his long pent-up creative urge could burst out into manifold directions. He created the machine, in order to create an entirely new world. If the benefit of civilisation has not yet been made accessible to most of those who have built it, the responsibility thereof is not to be attributed to the mighty means man has wielded, but to the fact that the means still remain the private property of a few. As soon as this unnecessary institution of private ownership will be removed, entire humanity will come to its own and civilisation will be at the height of its glory.

VI

Successive periods of social evolution do not begin from definite points of time. Therefore, it is not possible to say exactly when the Machine Age began. Its spiritual foundation was laid over a period of approximately five hundred years, by the scientific discoveries and the development of the scientific mode of thought, made by a long succession of investigators, scientists and philosophers. As far back as the middle of the thirteenth century, the Franciscan monk Roger Bacon, drawing the inspiration neither from Mother Church nor from the scholastic wisdom of Christian theology, but from the ancient Greek tradition, kept alive by the Arab scientists and rationalists, appeared as the pioneer of the age of modern science. There began a hard struggle against mediaeval barbarism which

sought to retard human progress with sanctimonious religiosity, albeit demonstrated with a fanatical ferocity. The struggle was carried on over a period of four hundred years by the bold vanguard of modern civilisation which was led by such stalwarts as Leonardo da Vinci, Columbus, Giordano Bruno, Galileo, Kepler, Descartes, Robert Boyle and a whole host of others whose names have also been imprinted in golden letters on the pages of human history. The historic struggle finally culminated in the epoch-making revolutionary achievements of Newton who, on the basis of the works of his illustrious predecessors, not only formulated the fundamental laws of physical science, but established the "Natural Philosophy" which opened up before mankind a new perspective of real spiritual progress.

Newton lived in the seventeenth century, only towards the end of which his immortal work *The Principia* was published. Still another hundred years passed before the Machine Age was ushered in by the discoveries of Black about the nature of heat and the invention of the steam-engine by the modest mechanic James Watt. The application of heat for the generation of power in the form of steam opened up a period of an amazingly swift social development. The Industrial Revolution took place. That was perhaps the greatest event of human history. The discoveries of physical science provided man with more accurate knowledge about the origin of natural phenomena, a knowledge which contributed to increasing power, greater wealth and a higher culture.

Within the period of a few decades, the entire face of England was changed; a poverty-stricken, almost destitute, people became a prosperous, enlightened nation, standing at the van of modern civilisation which was soon to catch a considerable part of the world in the mighty sweep of a spiritual elevation. The imaginary "Merry England" disappeared with the rude reality of mediaeval barbarism. Mankind made that tremendous progress within a very brief span of time by virtue of its ability to harness physical energy, which gradually liberated it from the drudgery of daily life, a decisive obstacle to any real spiritual advancement. Of course, a price, indeed, a very high price, had to be paid for the freedom which, however, was precious beyond all calculations.

The immediate concrete result of the application of physical energy in the process of the production of social necessities was that, in the beginning of the nineteenth century, one man could produce in a day ten times more work than a man used to do in a whole year only half a century ago ! The economic advantage of that revolution is thus palpable ; but its cultural consequences are much more far-reaching. The inevitable dark side of the Industrial Revolution has been presented in lurid colours by well-meaning, but short-sighted, humanitarians. But the bright side made itself evident, even from the beginning, to those who were able to visualise a time when the positive outcome of the revolution would survive the incidental evils associated with its initial stages.

Even in the beginning, the beneficial results of the revolution were evident to those who could see beyond the tips of their noses. It relieved the labourer considerably of the burden of toil. The drudgery and pain of manual labour were passed on to machines driven by physical energy which could feel neither pain nor fatigue nor monotony. Thus, instead of "brutalising" him machine raised the toiling man from the traditional status of the beast of burden, and made it possible for him to perform his labour only in those parts of the process of production which needed power of observation and intelligent action. Not only did the comparative relief from the rigour of corporal labour afford working men the opportunity for acquiring the rudiments of education ; the kind of labour a growing number of them had to perform also quickened mental activity.

Brawn is enough to handle primitive tools efficiently ; but brain is required for manipulating machines. The provision for at least an elementary education was, therefore, a necessary consequence of the introduction of mechanical means in the process of production. Without some education, workingmen could not have the intelligence necessary for handling machine with efficiency. The standard of education was much higher in the case of skilled mechanics, the class from which most of the early inventors came. James Watt was an instrument-maker ; Harrison was a carpenter ; Brindley was a mill-wright ; Arkwright was a barber ; Hargreaves was also a mechanic ; George Stephenson was a steam engine stoker.

Throughout the last century (18th), the intellectual advance is most significantly marked, and surprising in the contrast between the beginning and the close. Ideas that once had a living force altogether died away, the whole community offering an exemplification of the fact that the more opportunity men have for reflection, the more they will think. Well, then, might those whose interests lay in the perpetuation of former ideas and the ancient order of things look with intolerable apprehension on what was taking place. They saw plainly that this intellectual activity would at last find a political expression, and that a power, daily increasing in intensity, would not fail to make itself felt in the end. (Draper, *History of the Intellectual Development of Europe*)

The power that brought about that revolution was derived from the knowledge acquired during the preceding century of epoch-making scientific discoveries. The sublime spiritual incentive, that underlies modern civilisation, ignorantly or willfully maligned as "materialistic", is clearly realised when an account of the lives and works of the pioneers of modern science and scientific thought is even partially known.

Since the days of Newton, science make a triumphant march. Huygens (the propounded of the undulatory theory of light), Muschenbroek (inventor of the Leyden Jar), Buffon (founder of modern geology), Black (discoverer of latent heat), Lavoisier (founder of modern chemistry), Herschel (the astronomer), Laplace (the mathematician), Volta (discoverer of electric current), Lamarck, Faraday, Darwin, not to mention the more modern savants, stood at the head of that march, as honourable citizens, not only distinguished by their scientific achievements, but often materially and socially rewarded for their merits. But that was not the fate with those who had done the more arduous spade-work before them. As rebels, heretics, disbelievers, they had to face persecution by religious fanaticism, and risk the dishonour of social ostracism. But burning with a veritable missionary zeal, inspired with the vision of man's spiritual liberation from the yoke of the phenomena of nature and from intellectual slavery, they blazed the trail which eventually was

to be broadened out as the magnificent highway of Enlightenment, scientific knowledge and social progress.

Ancient philosophers had felt the spirit of enquiry. They had begun the enquiry into natural phenomena, and even speculated about their origin. The Alexandrian mathematician, Hero, who was even greater than Euclid as a mathematician, had not only discovered the power of steam, but constructed a primitive steam-engine. Even before him, some of the Ionian forerunners of science had observed that, when a piece of amber is rubbed with a piece of soft cloth, it attracts very light objects such as feathers. The term electricity is derived from the Greek word for amber—*electron*.

Those were a few events in the fitting prelude to the epic drama of man's spiritual progress, which began to unfold itself more than a millennium afterwards, and the final acts of which are still to be staged. Indeed, it is an endless drama. The power of man to know and create is unlimited. It knows no finality. In its earlier stages, only a few fortunate members of the human race take part in it ; some more constitute the interested audience which grows as the drama unfolds itself ; but the vast bulk of mankind still remain ignorant of the process that weakens the chains of their spiritual slavery, and blazes the trail of human liberation. In course of time, the drama of scientific progress is enacted with the participation of larger and larger masses. Only then, humanity begins to taste the blessing of civilisation which, however, will attain the fullness of its glory only when every single member of the human race will have his share of scientific knowledge, and, consequently, be able to assert his or her native creativeness to an ever-growing extent.

VII

The age of scholastic learning, which immediately preceded the scientific renaissance of Europe, embodied venerable religious prejudices and all the fundamental errors of theology, known at that time as philosophy. Further progress was possible only by shattering that rigorously dogmatic system which choked the creativeness of man. The period of transition from sterile scholastic learning to the resurgence of stimulating and productive scientific inquiry has been aptly described as follows :

It is a time which enthusiastically clings to the efforts and traditions of antiquity, but in which, at the same time, there are everywhere present the germs of a new, a great, an independent period of thought (Lange, *The History of Materialism*).

The Christian Church was still the supreme power. She dominated not only the spiritual, but also the worldly life of the entire European humanity. She was naturally alarmed by the signs of a scientific resurgence which heralded the spiritual liberation of man from the thralldom of traditional prejudices and of organised religion. At first, the Church tried to lure the learned away from the universities by offering them exalted and lucrative ecclesiastical positions. But the spirit of science, the burning desire to knock and to break the fetters of faith, could not be corrupted. The Church then made a determined effort to check the spread of knowledge. But the tidal wave, though still in its infancy, could not be checked.

SCIENTIFIC INQUIRY

Positive knowledge and the spirit of scientific inquiry penetrated the darkness of mediaeval Europe, coming from the magnificent seats of learning in the Arabic kingdom of Spain. The intermediaries were mostly Jewish physicians, whom the laws of barbarian Europe declared as enemies of society. But the age-long spiritual stagnation had been disturbed ; religion was losing its hold on the educated ; the hypocrisy of religiosity was driving the cultured classes to cynicism. These cultivated the company, though secretly, of the pioneers of the coming scientific resurgence, even when these were excommunicated, to be sent to the stake eventually.

AGE OF BACON

The honour of boldly heralding the coming age of science belongs to Roger Bacon who was born soon after the death of Albertus Magnus, who represented the climax of scholastic learning. Having studied theology, and entering the monastic life, he took the study of science and before long incurred the displeasure of the powerful clergy, by insisting that every statement of truth must be tested by experiment. His motto was : Take nothing on trust. That was the declaration of

independence of human spirit and the announcement of the coming age of science. He wrote extensively on the various branches of science and contributed to the rise of technology by constructing different kinds of instruments and primitive machines. His writings were condemned as containing dangerous doctrines. He was accused of magical practices and selling himself to the Satan. One of the offences for which he was punished was that he had proposed to construct astronomical tables for the purpose of predicting future events. He was condemned to imprisonment for ten years, when he was nearly seventy years old. He had friendly relations with Pope Clement IV, who protected him against the fanaticism of the clergy for sometime. On his advice, Bacon tried to defend himself, but his very defence was a condemnation of the enemies of knowledge and progress. By way of defending himself, he wrote :

Because these things are beyond your comprehension, you call them the work of the devil ; your theology and theologians and canonists abhor them as the productions of magic, regarding them as unworthy of a Christian.

So powerful were the forces of ignorance and fanaticism that even the bold rebel thought it wise to hide behind the profession of Christianity. Nevertheless, he met the fate of all the great pioneers of knowledge and progress.

Bacon was the first to suggest the application of optical instruments for astronomical observations. It is doubtful whether he actually constructed telescope and microscope ; but he suggested the theoretical possibility of constructing these very useful instruments and even went to the extent of indicating how lenses could be made. He visualised the possibility of the propulsion of vessels through water and of carriages to be driven on the road by some mechanical means. He even speculated about the possibility of man travelling through the sky in flying machines. He made some discoveries about the properties of gases which, in those days, were taken for "ghosts with leather ears". He demonstrated the property of oxygen by showing that a lamp extinguishes when put under some air-tight cover. These are the most outstanding of the innumerable achievements of that forerunner of modern science. For that great contribution to human progress, he was subjected to the suspicion of the ignorant

and persecution of the fanatic, practically for the whole life, the last ten years of which were spent in prison.

GUNPOWDER

Perhaps the greatest of Bacon's achievements was the manufacture of gunpowder out of charcoal, saltpetre and sulphur. The invention was not his. In Europe, it is ascribed to Marcus Graecus. But after the destruction of ancient Greek civilisation, the art was practically lost. Later on, it was rescued by the Arabs who guarded it as a secret. Bacon recognised the great Arabian physicians and rationalists as his preceptors. Having had intimate connection with them, he most probably came to know of the possibility of making gunpowder, and, on the strength of his own knowledge of chemistry, made it in a more perfected form. The manufacture of gunpowder is one of the most outstanding landmarks in the process of man's establishing his mastery over nature. By making the bow for throwing the arrow, the primitive man perhaps for the first time harnessed physical energy for his purpose without being conscious of the significance of his simple achievement. The manufacture of gunpowder was the result of the knowledge that small quantities of simple substances contain enormous stores of energy which could be liberated by the ingenuity of man. The epoch-making invention of gunpowder might have mostly been used for destructive purposes. But in so far as it represented the knowledge of the potential properties of certain substances, and of the method of releasing latent energy, it was a triumph of man's efforts to wring out nature's secrets.

ARABIAN TORCH BEARERS

So powerful was the urge for creativeness felt by the harassed and persecuted pioneer of modern civilisation, so insatiable was his thirst for knowledge, so far-reaching was his vision,—that he was not satisfied with all his great accomplishments. In one of his letters to his friend Pope Clement, he wrote : "It is on account of the ignorance of those with whom I have had to deal, that I have not been able to accomplish more." This in a single sentence gives some idea of the laborious struggle against the traditions of savagery and barbarism, which the heralds of the age of knowledge had to carry on over

several centuries, before the dawn of civilisation broke upon the world.

Of the sciences, astronomy is the oldest. Man cannot do without some sort of a cosmological conception. The ancient Greeks had developed some methods for observing the movements of heavenly bodies, and had acquired some positive knowledge about their relations with the earth. All through the dark Middle Ages, the science was cultivated by the Arabs for abstract philosophical purposes as well as for the practical purpose of navigating the seas. Astronomy requires two different kinds of skill : accurate observation and mathematical calculation. The Arabs excelled in both the branches. Consequently, they were greatly free from the prejudices about the shape and position of the earth and its relations with other heavenly bodies, which prevailed in Europe until the sixteenth century. But more than a hundred years earlier, the teachings of the Arabian scientists had penetrated Europe. In the fifteenth century, the educated classes of Europe were agitated by the momentous question : is the earth a moving globe, a small body in the midst of suns and countless other heavenly bodies ; or is it the central and the greatest object in the Universe, flat and covered with a vast blue dome, itself motionless while all the countless heavenly bodies are moving around it ?

For the Christian Church, with the elaborate system of its dogmas based on prejudices and speculative theories, which gave spiritual guarantee to the barbarism of mediaeval society, the question was of supreme importance. The cosmological conception of the Christian theology was reared upon the Polemic and Aristotelian geo-centric conception of the Universe. If the earth was to be deposed from its proud position as the centre of the Universe, the very foundation of the magnificent structure of scholastic learning would fall to pieces. Consequently, the powerful Church put up a fierce resistance to the propagation of astronomical knowledge which had vindicated the older helio-centric doctrine of Pythagoras and Aristarchus. In the period preparatory to the resurgence of science, "the earth moves" became the formula by which the belief in science and in the infallibility of reason was distinguished from the blind adherence to tradition, which was regarded as mostly based upon ignorance and prejudice.

LEONARDO DA VINCI

But still another condition, perhaps of even greater importance, had to be created before the helio-centric theory could be established on a clear exposition of the laws governing the movement of the earth, as a mere member of the solar system. The science of mechanics had still to be developed ; technology had to come to the help of man. Mechanics and technology, developed by the Alexandrian scientists, had been all but lost in the wilderness of the centres of mediaeval darkness. They had to be created anew. The credit of performing that great task belongs to Leonardo da Vinci, generally renowned for his genius as an artist, but who was also a great scientist, a skilled mechanic, and a successful engineer. Leonardo has been described by the historian Hallam as "his knowledge was almost preter-natural". That single short sentence graphically depicts the man whose ingenuity resurrected technology to serve as the auxiliary of theoretical scientific investigation, which prepared the ground for the advent of the Machine Age.

VIII

The revival of science, which marked the arrival of man at the gates of modern civilisation, was associated with the new philosophy of Naturalism as against Super-Naturalism—the most outstanding feature of human culture in the earlier stages of social progress. The Christian Church, which had completely dominated European society for more than a thousand years, dreaded rather the new philosophy than its scientific and technological foundations. As a matter of fact, so long as scientific investigation was a matter of intellectual curiosity or recreation, and contributed to material benefit on a necessarily limited scale, it was not altogether prohibited. Monks, clergies and Church dignitaries were among the forerunners of the revival of science. But as soon as the disruptive significance of science became evident in the spread of the new philosophy of Naturalism, the Church was alarmed, and declared war upon science. That war was waged over a period of several centuries, and ended in the triumph not only of science, but also in the establishment of the new philosophy which eventually came to be the spiritual outfit of civilised man.

STARTING POINT

The starting point of founders of modern science was to regard the phenomena of nature as 'natural' phenomena, instead of admiring or fearing them as the expressions of the benevolence or wrath of supernatural beings or as manifestations of some inscrutable supernatural force. The next step was to cultivate the habit of observation and experimentation with the object of making discoveries. That new habit was a challenge to authority. The last word of knowledge and wisdom had not been pronounced either by the ancient sages like Aristotle, or by the scholastic divines of the Middle Ages. That challenge to authority, traditionally believed to be infallible, sounded the death-knell of a long period of spiritual stagnation and closed a long chapter of human history—that of barbarism.

EXPERIMENT AND OBSERVATION

Lord Bacon has been credited with the inauguration of the experimental methods of observation and the inductive system of reasoning. How far the credit really belongs to him, has been questioned. Whatever might have been his contribution, the fact is that nearly a hundred years before his time Leonardo da Vinci had laid down the maxim that experience and observation must be the foundation of all knowledge and reasoning. He held that experiment was the only reliable interpreter of nature, and could, therefore, reveal her laws. Indeed, the great artist was a universal genius; his contribution to the revival of technology was even greater than was known in his time. Living in the liberal atmosphere of the Florentine Republic of the Medicos, he was not subjected to the barbarous persecution which was the lot of so many of his great contemporaries. Yet, even there he was not altogether beyond the reach of the dreadful tentacles of Christian Spiritualism which put up such a desperate resistance for defence of barbarism against the disruptive forces of science and the liberating spirit of the philosophy of Naturalism. Therefore, Leonardo did not dare to publish all the results of his versatile scientific research, and refrained from expressing all the views deduced from the reform. However, his actual contributions included a great improvement of the all but forgotten technological achievement of Archimedes. By giving a clear theoretical exposition

of the mechanism of the forces involved in its operation, Leonardo made of the lever a perfected machine which could now be put to general application. Moreover, he discovered the laws of friction, and formulated the principles for the construction of the "camera obscura". He visualised the possibility of deriving mechanical power from flowing water and, therefore, can be called the founder of the science of hydraulics. He manufactured water-wheels, paddle-wheels, breach-loading guns, mining machinery and numerous other mechanical appliances. He was acquainted with the phenomenon of magnetism and the power of steam. Briefly, he accomplished most of the spadework necessary for the rise of the all-important science of mechanics, definitely founded by Galileo before long.

HELIO-CENTRISM

The new philosophy of Naturalism grew in the midst of the long controversy about the position of the earth in the cosmic scheme. Long before Copernicus, the traditional theory, that the earth was the greatest and the most noble body situated, immovable, as the centre of the Universe, had been disputed. The Christian Church upheld the traditional geo-centric theory, which was the corner-stone of the teleological conception of the Universe. This was the climax of the spiritual advance of man in the age of barbarism. It is the highest and noblest form of religion. It still persists in the midst of modern civilisation as Pantheism.

The very foundation of the Christian Church, and consequently the entire structure of the barbarian society of mediaeval Europe, were menaced when the teleological view of the Universe was questioned by the revival of the helio-centric theory. If the earth was not the centre of the Cosmos, it could no longer be maintained that the sun and the other innumerable heavenly bodies had been created by a benevolent God in order to minister to the needs of man by their light and other mysterious qualities made available to the inhabitants of the earth through the multifarious phenomena of nature. Should the earth be degraded to the lowly position of an insignificant planet, whose very physical existence depended upon the mechanism of the attraction of the sun, how could one defend the omnipotence of a

God created after the image of man? The throne of God as the original creator of the Cosmos rested upon the theory which placed the earth in the centre of the Universe—a theory maintained by no other knowledge or argument than the authority of Aristotle and the learned Christian disciples of that pagan sage. Therefore, helio-centrism came to be condemned as a heresy. But, in the meantime, it had gained ground and penetrated even into the inner circle of the family of Mother Church.

Nearly a hundred years before Copernicus, Cardinal De Gusa had expressed himself against the orthodox theory about the position of the earth, and had favoured the revival of the ancient views of Pythagoras who had preached helio-centrism. Later on, yet another Church dignitary, Cardinal Alliacus, in his efforts to co-ordinate astronomy with theology, was also persuaded to reject geo-centrism, and tend towards the heretical view. Columbus is reported to have conceived the idea of reaching China from another direction from the Cardinal's work *Imago Mundi* (The Image of the World).

HALLEY'S COMET

In 1456, the appearance of "Halley's Comet" caused a tremendous commotion and consternation in Europe. Until another two hundred years later, comets used to be regarded as casual celestial wanderers, and taken for evil omens. In 1682, the astronomer Halley observed the movements of a comet which appeared in that year, and formulated the law of the periodicity of comets. According to that law, it was the comet observed by Halley which had appeared also in 1456. Constantinople had just been taken by the Muslims. The comet was dreaded as the herald of the Muslim conquest of entire Europe. It was imagined that "the heavenly monster" rained "disease, pestilence and war" upon the earth from its long tail which "reached over a third part of the heaven". The superstitious people were naturally terrified, and appealed to Mother Church for protection. The Pope issued ecclesiastical fulminations against the heathen conquerors of the capital of the Holy Roman Empire, and ordered special prayers throughout his spiritual kingdom. Church bells were to be rung continuously in order to "scare away the devil"; it was anathemised;

all the fervent prayers offered by millions of terrified souls in thousands of the temples of God, however, proved to be vain. "But the comet in the heavens, like the Sultan on the earth, pursued its course undeterred" (Draper, *The Intellectual Development of Europe*, Vol. II).

European humanity was still revelling in that orgy of superstition, promoted by the highest spiritual authority, even when a distinguished Cardinal of the Church was favouring the revival of helio-centrism in consequence of his studies of the movements of heavenly bodies through space, and the deductions made from observed facts.

VOYAGE OF COLUMBUS

Less than half a century later, the first staggering blow was dealt to the venerable doctrine about the shape of the earth by the voyage of Columbus. Whatever doubt was still left, was removed by the exploit of Magellan who actually circumnavigated the globe in 1519. Those epoch-making discoveries, broadening the scope of human knowledge, and giving a tremendous incentive to the economic development of Europe, were made possible by the invention of a simple mechanical contrivance—the mariner's compass. This modest-looking instrument enabled man to dare the dangers of unknown and uncharted seas. While the discovery of Columbus was of great practical importance, the much greater exploit of Magellan provided the most decisive empirical evidence in favour of the "heretical" doctrines of modern astronomy.

But for the compass, a mechanical appliance made by man, those epoch-making events would not have happened. And the compass could not be manufactured, unless man was equipped with knowledge which could be derived only from careful observation and the resulting discoveries about the real properties of the observed objects. The "loadstone" or the "leading stone" had been known almost from time immemorial, and it was believed to possess magical properties. It had been observed that a certain kind of stone pulled iron objects towards it. The Arabs discovered that the magical stone was found frequently in the magnesia deposits of Asia Minor. Consequently, the stone came to be known as the "magnetic stone"; later on, the word "magnet" was derived from it. It is said that the Chinese identified the "loadstone" with a metal, and that they actually

manufactured the mariner's compass. Whatever they might have done, the properties of the mysterious thing were well-known to the Arabs, and the mariner's compass was used by practically all Arab sailors in the fourteenth century. Man's success in wringing out a secret of nature and using it for establishing his mastery over natural elements was again confronted with superstition—the heritage of his barbarian past. The compass was dreaded as an evil thing, and ships equipped with it often had difficulty in finding the crew.

It was in the face of such tremendous practical difficulties, in addition to the fierce resistance of the all-powerful Christian Church, that the forerunners of modern civilisation had to blaze the trail of the spiritual liberation of man.

IX

Modern science grew, in the face of the fierce opposition of traditional ignorance, sanctified by religion which kept the mind of the multitude in the deadening grip of superstition, as the outcome of man's irresistible inquisitiveness and the instinctive desire to discover the cause of phenomena. The rise of modern science, therefore, originally was a philosophical movement—a spiritual renaissance. But the creative significance of modern science became evident when, as Lord Bacon put it, it was "increasingly able and willing to assist in the relief of man's estate". The philosophical revolution, heralded by the rise of modern science, could triumph only after the conditions of man's physical and social existence were radically changed by the practical applications of scientific knowledge in the form of engineering, metallurgy, navigation—in one word, through technology.

A new outlook of life quickens the creativeness of man, new achievements of which, in their turn, lead to the realisation of that outlook. The genius of some individuals opens up before mankind new avenues of progress, and entire communities, having advanced sufficiently on the new avenues of progress, become the possessors of the original inspiration. Traditional ideas and ideals cannot be replaced by new ideas and new ideals, until and unless man acquires the power to change the conditions of his existence. Modern science

armed him with that power, and, therefore, enabled him to come out of the twilight of barbarism and begin the triumphant struggle against the forces of nature, which constitutes the foundation of modern civilisation.

TECHNOLOGY

On the background of the ominous rumblings of a great resurgence of ideas, technology had been making steady, but necessarily slow, progress ever since the days of Roger Bacon who, learning from the heathen Arab philosophers, reminded the piously barbarous European humanity of the forgotten heritage of the ancient scientific knowledge. But the "devilish devices", though often invented by ecclesiastical brains, and made by pious monastic labour, could not come to general application so long as man's mind generally remained circumscribed by the vanity of his being the flower of God's creation. Man had to be humiliated by the knowledge of his insignificance in the grand scheme of the Cosmos, before he could be conscious of his power to travel on the endless road of ever-increasing greatness.

COPERNICUS

In the middle of the sixteenth century, appeared the epoch-making work of Copernicus—*On the Revolution of the Celestial Orbs*—the monumental product of thirty-three years' quiet meditation and patient labour, inspired, in their turn, by the movement of ideas during the preceding two centuries. Once the earth was degraded from the position of the centre of the Universe to the lowly position of a minor planet, revolving around the sun, it was no longer possible to regard man as the crown of the entire scheme of creation. If man was created really after the image of God, as the administrator of His Imperial Will, then certainly he would not be subjected to the indignity of inhabiting the most insignificant of all the heavenly bodies. By setting forth the truth about the revolution of the heavenly bodies, the great work of Copernicus celebrated the triumph of a great revolution of ideas. An endless scope was opened up for the science of astronomy. The correct appreciation of the position of the earth before long led to the discovery that the sun also was not the centre of the Universe,

but one of the countless luminous bodies which constituted it. Man's ego-centrism had to go with the traditional view of geo-centrism. Freed from the limitations of the anxieties for his own petty self, glorified as the immortal soul, man could apply himself to his native task of questioning nature, with the object of acquiring knowledge, which gave him the power to attain real greatness and march towards real spiritual freedom.

The earth revolves upon its own axis, and moves around the sun. this is a commonplace knowledge of our days, accessible to schoolchildren. But only four hundred years ago, to tell this truth was heresy, and more than one torchbearer of this truth were condemned and punished with barbarous ferocity for the crime. Copernicus himself was very reluctant to make the revolutionary result of his labour known publicly, fearing not only the displeasure of the Church, but also the dreadful punishment almost sure to be meted out to one holding such heretical views. He kept them to himself for thirty-three years, during which time he gave them such a rigidly scientific form, as made them indisputable when they were ultimately published. Even then, he did not dare take that step except on the entreaty and the august patronage of a Church dignitary—Schomberg. A preface added to the published treatise presented it as a mere hypothesis. For a long time, it was believed that Copernicus himself adopted that stratagem to protect himself against scholastic dogmatism and ecclesiastical fanaticism. But later on it was ascertained that he was no party to that concealment of truth, which was done by a friend of his, out of anxiety for the old philosopher's safety.

FROM ANCIENT SAGES

It is, however, a fact that the work was dedicated by the author to the Pope. In the dedication, Copernicus actually disowned any originality, and stated that he had learned the helio-centric doctrine from the writings of ancient sages. It can easily be imagined how oppressive must have been the atmosphere of ignorance, and how terrifying the fanaticism of religion, which could compel a man to disown the credit for his own great work. Yet, knowledge had to struggle hard against

the tenacity of ignorance, and the might of reigning superstition. Oppressively thick was the darkness of barbarism, which tried to engulf the dawn of knowledge breaking out as the herald of civilisation.

A glimpse of the great danger, which beset the path of the forerunners of civilisation, can be had from Copernicus' introduction to his work. Having stated apologetically that he was going to present what he had only learned from ancient sages, he wrote :

Then I too began to meditate on the motion of the earth, and, though it appeared an absurd opinion, yet, since I knew that in previous times others had been allowed the privilege of feigning what circles they chose in order to explain the phenomena, I conceived that I might take the liberty of trying whether, on the supposition of the earth's motion, it was possible to find better explanations than the ancient ones about the revolution of the celestial orbs.

Humboldt in his famous work *Cosmos* holds that "an erroneous opinion unfortunately prevails, that Copernicus from timidity and from apprehension of priestly persecution, advanced his views regarding the planetary movement of the sun in the centre of the planetary system as a mere hypothesis" ; nevertheless, he admits that the singular words "but which need not necessarily be either true or even probable" do occur in the preface to the book. But Humboldt points out that "they are quite contrary to the opinions expressed by Copernicus, and in direct contradiction with his dedication to the Pope". However, the fact is that Copernicus started from the admission that the view about the earth's motion he was going to propound "appeared an absurd opinion". That shows the obstinate prejudice that truth was still to contend with. Any effort to explain natural phenomena except as the manifestations of supernatural forces was still regarded as a "privilege" to be "allowed" by the custodians of ignorance and superstition. Copernicus was compelled to accept that humiliating position so that he could have the opportunity of letting the world know the great truth he had discovered. Finally, he did not ask for the liberty of expressing his views as a matter of right, but on the ground that it had been granted as indulgence previously.

A CHALLENGE

Beginning in an apologetic tone, the dedication, however, proceeded to assert the independence of philosophical thought which could dare disregard the verdict of the ill-informed. He wrote :

Though I know that the thoughts of a philosopher do not depend on the judgment of the many, his study being to seek out truth in all things as far as is permitted by God to human reason, yet, when I considered how absurd my doctrine would appear, I long hesitated whether I should publish my book, or whether it were not better to follow the example of the Pythagoreans who delivered their doctrine only by tradition and to friends.

The urge to tell the truth could not be suppressed by the fear of the ridicule of futile scholastic learning, nor by the danger of persecution in the hand of religious fanaticism. The spirit of man, emboldened by the power of knowledge, rose in revolt against the tyranny of tradition and the oppression of ignorance.

Having still appeared to admit that truth was accessible to human reason only by the grace of God, Copernicus ended his address to the representative of God on earth with a challenge which heralded the mighty voice of man rising against spiritual slavery. The following is the concluding passage of the dedication :

If there be vain babblers who, knowing nothing of mathematics, yet presume to pronounce judgment, through an intentional distortion of any passage of the Scriptures, and who blame and attack my undertaking, I heed them not, and look upon their judgements as rash and contemptible.

Those were bold words to pronounce in that atmosphere of ignorance, bigotry and fanaticism. They would have brought the old scientist to great grief, had death not intervened, to spare him that grim fate, and human history of yet another act of barbarism, committed to arrest the triumphant march of science. Copernicus died only a few days after his book was published. But the tragedy was still to be enacted. Others had soon to pay the penalty with their lives for holding high the torch of truth and the standard of human freedom.

X

The advance of modern science meant an extension of the knowledge of nature, and eventually led to the discovery that the Cosmos was not a teleological order. The result was the liberation of the spirit of man from the bondage of the belief in the supernatural. The discovery that the movement of heavenly bodies as well as other natural phenomena were determined by mechanical laws inherent in nature itself eliminated the necessity of assuming the harmonious operation of supernatural agencies or a Universal Will as the cause of the being and becoming of things.

It is an old idea that the Universe is a law-governed system. It is not a chaos, but a Cosmos. The scholastic learning of the Middle Ages had developed that ancient idea into the teleological conception of the world, according to which every single event of life, as well as of the inanimate nature, is predetermined by the Providential Will. That Final Cause of the world was assumed to be inaccessible to human intelligence, and, therefore, the endless succession of predetermined events was not to be anticipated, but accepted *post factum* as the best thing that could have possibly happened. That philosophy was the highest achievement of the religious mode of thought. Its logic was very rigorous : the Final Cause being assumed as the generally accepted premises, the rest followed necessarily.

The belief in the supernatural had to be so very highly intellectualised in order that man, no longer to be impressed by the childish fantasies of the Natural Religion, could "rationally" reconcile himself to the degrading idea that he was but a mere cog in the gigantic wheel of the Universe, which moved mercilessly and inexorably according to the dictates of the will of some unknown and unknowable agency. The net of man's spiritual slavery was very beautiful big woven. Only modern science could open his eyes and give him the power to get out of that humiliating position of an age-long spiritual stagnation. Starting with the ancient idea that the Universe was a law-governed system, science set about the task of proving that the laws were inherent in the physical system itself, not to be traced to some imaginary Final Cause.

KEPLER

The work of Copernicus extended the iconoclasm of science beyond the investigation into man's immediate physical environment, to the movement of the remote heavenly bodies. Kepler observed and speculated about the helio-centric movement of those bodies, and eventually stated the laws which govern those movements. Son of a lowly inn-keeper, his boyhood was spent in poverty and ignorance. Later on, he managed to study theology, the most respectable and paying profession of the time. But, having been of a lowly origin, he could not prosper in his profession, although at the youthful age of twenty-three he was appointed as the Professor of Astronomy in the University of Gratz. But in the popular mind, astronomy was yet identical with the pseudo-science of astrology. Lay learning still received little appreciation, and young Kepler, even as a professor, did not earn enough for bare subsistence. He was compelled to keep his knowledge of astronomy and mathematics to himself, and take to the trade of casting horoscopes—those meaningless and mysterious charts which gave the ignorant multitude the poor satisfaction that, even in the midst of the miseries of the life on this world, the Gods in Heaven were interested in their affairs.

Though driven to the practice of charlatanism by the prevailing ignorance and superstition of the time, Kepler continued his scientific labour without any danger of incurring the displeasure of the all-powerful Church. Having completed the work of "charting the heavens",—begun by the Danish astronomer Tycho Brahe, known as the "Rudolphine Tables", Kepler turned his attention to the exact nature of planetary motion. Eight years of hard but peaceful work, carried on at Prague under the patronage of a liberal-minded Emperor, led him to the discovery that the planets moved round the sun not in circles, but on elliptical orbits. His laws of planetary motion gave concrete shape to the philosophical and mathematical abstractions of Copernicus, and laid down the foundation of modern astronomy.

That was in the beginning of the seventeenth century. But even then, Europe was still dominated by the spirit of barbarism which dreaded the breaking dawn of civilisation, and tried to resist the advance of knowledge with a pious ferocity. Soon after he had accomplished the epoch-making work of enunciating the laws of

planetary motion, Kepler lost his powerful patron and friend. The Emperor Rudolph died, leaving the scientist not only again in penury, but at the mercy of the bigotry of ignorance and the fanaticism of religion. His wife died and his three young children were attacked by the virulent disease of small pox. The blessing of modern medicine was still unknown to Europe. Whatever medical care was available could not be had for the service of the poor, however meritorious these might be in other respects. Kepler's children died without any medical care.

But the worst was still to come. His old mother was accused of sorcery and condemned to torture, for no other crime than having inflicted Christian Europe with a son who dared look into the mysteries of the heaven. With great efforts made by the harassed scientist with the aid of some liberal-minded high-placed priests, the old lady was saved from the rack, but could not escape imprisonment.

The closing years of Kepler's life were a tragedy. For earning his livelihood, the "legislator of the heavens" had again to write pamphlets on astrology. Worn out in mind and body, Kepler died of brain-fever at the comparatively early age of fifty-nine. By that time, European history was well advanced in the middle of the seventeenth century. In the introduction of his "Rudolphine Tables", Kepler had hailed Copernicus as "the man of free soul". In the face of tremendous difficulties, and swimming against the crazy current of learned ignorance, he rendered signal services to the cause of the great philosophical revolution heralded by the work of Copernicus, and thus gave a big impetus to the movement to set human soul free.

GIORDANO BRUNO

"The earth moves"—came to be the slogan of the mighty movement based upon the belief in science and in the power of the human mind to discover objective truths. The most dramatic figure of that age of struggle between science and religion, knowledge and ignorance, was Giordano Bruno whose martyrdom in 1600 manifested the crassest form of the fierce antagonism to human progress represented by traditions and antiquated ideas. Behind its occasional climaxes, which have been recorded prominently in the history of that epoch, a legion

of less known persons participated in the drama which stands out as the most brilliant chapter of European history. While astronomy and mathematics led the search for the laws of inanimate nature and were presently reinforced by the rise of physics, human mind was breaking also into the mysterious realm of the structure of the human body and trying to ascertain the laws of its internal functioning.

MODERN MEDICINE

For nearly two thousand years Aristotle dominated the intellectual life of Europe, as the highest authority of knowledge in all physical matters. A similar position was occupied by another Greek as regards everything concerned with disease, cure and the general state of human body. In these matters, it was heretical to question the wisdom of Galen. Until the sixteenth century, the University of Salerno was the main seat of medical learning in Europe. It had been founded by Arab physicians who had learned their lessons from Galen. That Alexandrian physician had certainly made some investigation into the structure of the human body, and had enunciated some of the rudimentary principles of medical science. But in the course of centuries, his teachings, like the teachings of many other ancient sages, were so much mixed up with all sorts of superstitious notions that, at the close of the Middle Ages, humbug and fraud very largely passed as medical science in Europe.

Paracelsus was the first to raise the standard of revolt in this respect. He lived in the earlier part of the sixteenth century, and harnessed whatever knowledge of chemistry existed in those days for the service of medicine. Until then, chemistry was identical with alchemy, that vain chase after the conversion of base metals into precious gold. Paracelsus dared dispute the authority of Galen, and fought for commonsense in the treatment of disease. He also got into trouble, but in his case the resistance came not from the Church but from the seats of "classical medical learning". His heresy was to teach that nature was the greatest healer and that the function of medical science was to help the normal functioning of the mechanical processes inherent in the structure of the human body. Although not said in so many words, the implication of that sound doctrine, since

then recognised as the fundamental principle of therapeutics, was to regard the human body as an organism which lived independently by itself. That was a mortal blow to the doctrine of the soul. Another step towards the spiritual liberation of man.

The foundation of modern medical science, however, was laid by Vesalius, whose famous book on *The Structure of the Human Body* appeared in the same year as the revolutionary treatise by Copernicus. Galen was the first to dissect the human body with the object of finding out how it was really constructed. In the sixteenth century, Vesalius emulated that heretical act in the University of Padua. He discovered that Galen's observation had been perfunctory and had led to wrong conclusions. He established the scientific method of observation and empirical deduction in the realm of the study of the human body, by dissecting it before the students when he taught them anatomy. Apart from the direct result of the method, he drove home the larger philosophical lesson that, if the actual dissection contradicted the teachings of the Alexandrian sage, then the latter's doctrines must be ignored. His book contained the result of a sober study—an objective approach to the mysteries concerning the structure and functions of the human body—independent of traditional notions fortified by an uncritical acceptance of authorities, and free from all the then prevailing speculations about alleged correlations between planets and human bodies.

The daring to penetrate into the mysteries of the sinful abode of the soul produced far-reaching philosophical consequences as well as the contribution made to the art of healing. The traditional supernaturalism had persuaded man to believe that there was some mysterious relation between the macrocosm and the microcosm. To tamper with the latter was considered to be heretical, because that amounted to interference with the providential cosmic law which had predetermined even the minutest events regarding the disease and cure of the human body. All that vain and venerable notion was thrown to the winds when information, received by dissecting dead human bodies, proved to be fruitful for the purposes of healing. Once again, knowledge gave man power. Diseases were not predetermined events. They were not caused by the wrath of God. Their causes could be discovered by human intelligence, and eradicated by human ingenuity. Man was not a helpless

plaything in the hand of a whimsical God ; on the contrary, he possessed in himself the source of endless power derived from knowledge of the real nature of his being and becoming.

XI

As the founder of modern physics and mechanics, Galileo deserves the honour of having ushered in the age of science and thrown open before Europe the gates of civilisation. It is well known how he was persecuted practically throughout his life, and was condemned to die in prison, a blind old man. But the services rendered by Giordano Bruno to the cause of the spiritual liberation of man are not so well known, though his martyrdom was the most dramatic event in that long struggle between knowledge and ignorance, reason and prejudice which had to be fought to bring European humanity out of the wilderness of barbarism and inspire it with the vision of the dawn of civilisation.

Bruno perhaps was one of the greatest rebels of history. The significance of his stormy life can be fully appreciated only by those who know that revolt against traditional beliefs is the most powerful lever of human progress. For having the courage to tell the great truth that orthodoxy had neither morality nor belief, he received the atrocious sentence to be burnt alive. That barbarous act was committed less than three hundred and fifty years ago in Rome, the centre of the holy world of Christianity. But the sentence passed upon him was really a sentence of death against the forces of ignorance and intolerance, which for centuries had stubbornly resisted the spiritual liberation of man. The truth he calmly pronounced, when the barbarous sentence was passed upon him, must have made his vindictive judges feel like criminals shuddering before a thundering verdict of history. He said : "Perhaps it is with greater fear that ye pass this sentence upon me than I receive it."

Intolerance is not an expression of power. The fear of truth makes those trading in ignorance and falsehood take shelter in intolerance. The martyrdom of the pioneers of modern civilisation was caused by a mortal fear of the light of reason and science, bound to dispel the darkness of ignorance which had kept human spirit in bondage for so many centuries.

DISCOVERY OF TELESCOPE

Only eight years after the martyrdom of Bruno, man made a simple instrument which gave him the power to peer into the depths of the heaven and establish the truth which he had propagated as the logical consequence of the restoration of helio-centrism by Copernicus. In 1608, a Dutchman named Lippershy made the first telescope. The next year, Galileo manufactured a better instrument, and turning it towards the sky, he found that the moon was a physical object constructed more or less like our earth. Making bold deductions from the Copernican theory, Bruno had delegated the sun itself to the position of one among an endless number of fixed stars. That was one of his heresies. With his primitive telescope, within the course of one year, Galileo discovered no less than forty fixed stars, each of which was found to be as luminous as or more so than the sun.

Until then, those glorious heavenly bodies were unknown to, and unscen by man. The old belief was that the stars were made by God to illuminate the night and that the starry dome was there to afford man the pleasure of looking at it, and singing the praise of a benevolent Creator.

The simple contrivance of fixing two lenses at the ends of a narrow cylinder enabled man to discover that the stars were situated so far away from the earth that only a minute fraction of their brilliance could ever reach it. If a slightly larger part of their brilliance reached the earth, the terrestrial beings would be blinded instead of being benefitted by that gift of God. If the stars were created for illuminating the earth, why were they placed so far away ? The discovery, thanks to that early achievement of technology, naturally raised such questions, and created doubt about the time-honoured doctrine of the human destiny of the Universe. The human being is not the crowning glory of God's creation.

The Universe with all its grandeur and beauty is not created to instil in man a reverential awe for its Creator. It is there, for no other reason than to exist. Man is a part of this eternal existence, and is potentially possessed of the power to unravel its mysteries, the power derived from the knowledge enabling him to make ever-greater conquests. This endless vista of progress, knowledge and power was opened up before man already in the beginning of the age of science.

Those who suffered, and sacrificed everything, often to the extent of their lives, for helping man realise the power to make his own destiny, are, therefore, to be honoured and commemorated more than the numerous tribe of saints and sacerdotes who, from time immemorial, pretended to be the promoters of the spiritual well-being of man, but actually kept him in the darkness of ignorance and prejudice. Even today the world is not altogether free from the quackery of those doctors of divinity who disparage science because it undermines their position of power and privilege. Europe could enter the age of civilisation only by repudiating the authority of those agents of God. Bruno was the most dramatic figure in that historic rebellion.

LIFE OF GIORDANO BRUNO

Born seven years after the death of Copernicus, that is, just about the time of the making of the first telescope, Bruno entered the monastic order which alone in those days offered the leisure indispensable for learning and scientific investigation. He became a Dominican monk, but, like so many other thoughtful men of his time, was soon suspected of heresy, and since then his life became a long chain of persecution and hostilities.

He was too courageous a rebel to compromise his conviction and hide his opinions. Consequently, he had to run away not only from the monastery, but out of Italy, to be beyond the reach of the Pope. But even abroad, religious intolerance and orthodoxy haunted him, compelling him to fly from one country to another, and everywhere he lived the life of a destitute and vagabond. First, he went to Geneva, but there Calvinist bigotry would not tolerate his teaching that the earth rotated around the sun. His heretical views proved to be too advanced even for the seat of classical learning in Paris. From there, he went to Oxford and for sometime lectured on Cosmology. Before long, he was driven out also from England and went to Germany to find things equally too hot. Finally, he decided to brave the bigots in his native land and in 1592 returned to Venice.

There he fell in the hands of the Holy Inquisition. After eight years of imprisonment, he was sentenced with the famous but fearful formula—punish him as mercifully as possible, and without shedding of blood—which meant that he was to be burnt alive.

In his memoirs he left some highly interesting record of the cultural corruption of that age of sanctimonious suspicion against everything new and enlightening. Wherever he went, he found "scepticism under the polish of hypocrisy"; therefore, he declared, he was fighting "not against the belief of man, but against their pretended belief". The central thesis of his book *The Triumphant Beast*, for which he was condemned of heresy, was that the orthodoxy of the age had neither morality nor belief.

DANGEROUS HERETIC

But Bruno committed not one "heresy". His heresies were innumerable. He was a prodigious spirit. Though not a scientist in the technical sense, he personified the spirit of science which was the new philosophy raising its head as the terror for religion, because it proposed to set the spirit of man free.

He taught that space was infinite and it was filled with self-luminous bodies. That doctrine, subsequently demonstrated by modern astronomy, was expounded in his work called *The Plurality of Worlds* in which he maintained that every star was a sun, and there was an infinite number of stars.

He believed that the world was animated by an intelligent soul which was the cause of forms, but not of matter, which lived in all things, even such as seemed not to live. That particular heresy of his was not at all irreligious. He preached Pantheism, which is the highest form of religion inasmuch as the latter is based upon a sincere faith, not afraid of its own logic. But being the highest form of religion, Pantheism liquidates religion. It is only an inverted form of Materialism. No wonder Bruno was considered to be the most dangerous heretic, and therefore, punished with exemplary cruelty.

He further held that everything was ready to become organised; that, matter was the mother of forms and also their grave; and that, matter and the soul of the world together constituted God. Though the idea of God was still retained. Bruno's philosophy was out and out materialistic. Therefore, he incorporated, more than anybody else, the spirit of science which enabled man to be encouraged by the dawn of civilisation.

AHEAD OF HIS TIME

Like all really great men, Bruno was much ahead of his time. He was a real pioneer, and, therefore, he was such an intrepid rebel. The scholastic learning of the Middle Ages had elaborated the simple dogmas of primitive Christianity into an imposing system of theology with the aid of the teachings of the semi-materialist Aristotle. For several centuries that rationalised irrationalism put up an apparently learned resistance to science. So long as the rational foundation of orthodoxy remained unchallenged, science had to put up with a condescending toleration. Bruno dared to strike at the very root of the system of orthodox learning which he characterised as the *Triumphant Beast*.

Aristotle had taught that a thing was composed of form and matter ; but he subordinated the latter to the former by holding that matter had only the potentiality of becoming whatever the former by holding that matter had only the potentiality of becoming whatever the form might make of it. Bruno revised the relation, and maintained that matter was not the potential but it was actual and the active. Matter was conceived as the true essence of things, capable of bringing forth all forms out of itself. Thus, he not only knocked the philosophical bottom off religion, but laid the philosophical foundation of modern science. The sovereignty of man's creativeness cannot be asserted unless matter is regarded as the essence of everything created.

Bruno preached : "The infinity of forms under which matter appears, it does not receive from another and something external, but produces them from itself and engenders them from its bosom." That was an exceedingly bold idea for that age. Bruno did not stop at that ; he went to the extent of anticipating the discovery of organic evolution. He taught that nature produces its objects not by subtraction and addition, but only by separation and unfolding ; not by composition, but by separation and development. He developed this remarkably clear idea of organic evolution also to establish the sovereignty of matter. He concluded : "Therefore, matter is not without form—nay,—it contains them all and since it unfolds what it carries concealed within itself, it is in the truth all nature and the mother of all living things."

The philosophy so very boldly heralded by Bruno has not fully come to its own. But it inspired scientific investigation, the epoch-making results of which, in their turn, contributed to its development. Without the materialist conception of the Universe, no science would be possible. On the other hand, the advance of scientific knowledge continually reinforced that conception. The two must go hand in hand, in order to make civilised man really civilised, that is, convinced of his power to remake the world that he has made himself.

XII

A historian of European culture writes : "Never can moral interests, however pure, stand against intellect-enforced truth. On this ill-omened question, the Church ventured her battle, and lost it." (Draper).

The historical conflict between reason and religion, knowledge and prejudice, science and the Church, reached its climax in the life of Galileo. The one was represented by his works, and the other by his persecution. His life was not only the climax of a historic struggle ; it marked the end of that conflict. The forces of organised religion, based upon popular prejudice, were defeated. Reason, knowledge and science came out victorious. The foundation of civilisation having been laid on the martyrdom of its pioneers, European humanity was free to build the superstructure which, though sufficiently imposing already, is yet only the beginning of the glorious creation of man, set free by knowledge and emboldened with evergrowing power.

After Leonardo da Vinci, the progress of science had been mainly confined to the realm of pure mathematical abstraction. That preparatory stage was necessary. Galileo made decisive contribution to that preparation, but his distinctive merit was to show that man could derive great power from the knowledge of nature. By manufacturing the telescope and popularising the method of observation and experiment, Galileo broke down the forbidding wall of prejudices which had blocked the spread of the new ideas to the common people, who were not attached to the established social order so as to refuse to see things when they were clearly presented before

them. Only those who were deriving benefit from the established social order were fanatical defenders of the traditional ideas which provided the moral, metaphysical and divine sanction for prevailing notions and established institutions. As far as the people at large were concerned, prejudice alone stood on the way. They were not capable of appreciating the value of science, so long as it remained a matter of mathematical abstraction. The knowledge was accessible to, and often appreciated by, some distinguished members of the priestly class, whose intellectual convictions could not get the better of their loyalty to the established order. Galileo made scientific knowledge accessible to the common man, and consequently, started it on its triumphant march.

MODERN PHYSICS

While finally establishing Copernican astronomy on the strength of empirical evidence gathered with the help of his telescope, Galileo was the founder of modern physics. His contributions in this respect stimulated the growth of the revolutionary sciences of mechanics and hydraulics. Thanks to that epoch-making achievement, Galileo "ranks with Archimedes as one of the most illustrious scientific men the world has ever seen".

The science of physics describes Nature mathematically. Mathematics deals with quantitative values. If Nature is composed of such entities as can be quantitatively measured, its laws should be accessible to discovery, and possible of concrete formulation, so that man's struggle against nature need no longer be a blind groping in the dark, but an intelligent search for truth and a practical quest for power. To treat Nature mathematically, that is to say, to reduce her to quantitatively measurable entities, was the fundamental contribution of Galileo's genius.

Such a treatment is not possible unless Nature is conceived as a mathematically constructed machine. Galileo's point of departure was that of a profoundly revolutionary conception. Indeed, the conception itself was not altogether new. It was not born with Galileo. It is as old as the speculative genius of man. But it was Galileo's genius which demonstrated the grand conception through the observation of

phenomena, and experimentation with physical entities isolated from their setting in the coordinated scheme of nature. Everybody knows that Galileo was the discoverer of the three Laws of Motion. But only a few realise that those elementary principles of physics, empirically deduced, verified the speculative conception that Nature is a mathematical machine. The immediate consequence of Galileo's discovery of the Laws of Motion was to give a convincing explanation for the movement of heavenly bodies as pictured in the mathematical abstractions of Copernicus and Kepler.

The movement of bodies cannot be correctly described, their past cannot be reconstructed and their future predicted, unless the Law of Motion itself is understood. If the Universe is a Cosmos, and since it is made of measurable entities, it should be possible to discover a law of Motion. Galileo began his investigation with the observation of the behaviour of falling bodies. His observation was fruitful because he isolated one particular phenomenon to study by measuring it mathematically. Motion could not be properly studied so as to reveal its laws, before there was a clearness and precision about the idea of motion itself. Only through that method, natural phenomena, physical entities, can be subjected to a mathematical treatment. To formulate these fundamental principles of the scientific method of enquiry, was the real contribution of Galileo to the advancement of human knowledge.

ATOMS

From the commonsense knowledge that everything has size, shape and weight, Galileo assumed that all the important properties of natural phenomena could be mathematically described. As a scientist trying to explain phenomena, he also assumed that the world was ultimately composed of atoms. Being the basic constituents of every physical entity, the atoms have size, shape and weight. They are in a constant motion in course of which they combine into all sorts of physical entities. So, the discovery of the Laws of Motion should enable one to explain phenomena as they are. The conclusion of the fundamental hypothesis of physics is even more farreaching. Knowledge of its laws should enable man to manipulate motion. And

the ability to do so would give him the power not only to harness the forces of nature, but also to create new things out of the resources available in nature.

MECHANICS

The science of mechanics, thus, is the practical aspect of physics. Galileo's mind worked in both the directions of conceiving the universal mechanism in mathematical abstraction, and also of making practical deductions from that conception. The discovery of the Laws of Motion and eventually the identification of power with the physical content of the metaphysical concept of force, led to the development of technology which opened up the floodgates of human creativeness, and enabled man to be really civilised.

Turning his telescope on the planets, Galileo discovered that Venus and Mercury also went through phases just as the moon. The telescope settled for ever the controversy between geo-centrism and helio-centrism. The weightiest objection against the Copernican theory was: "If the doctrine be true, the planet Venus ought to show phases like the moon." Copernicus himself was not able to overcome the difficulty. Man's ability to enlarge the reach of his vision with the help of two lenses overcame that difficulty. Very soon Galileo's telescope made still other discoveries. He found that just as the earth has its satellite, similarly Jupiter had four satellites. It was immediately seen that the planet offered a miniature representation of the solar system as depicted by Copernicus. Through the telescope he demonstrated to his pupils that the Milky Way was composed of thousands and thousands of stars; and finally, he discovered spots on the sun, and maintained that it revolved on its own axis once a month.

The old controversy could no longer be carried on. It was no longer a matter of argumentation and authority, but of observation, and mathematical deduction from observed facts. The custodians of ignorance and the enemies of human progress were at the end of their wits. They sought to stifle the voice of Galileo. His martyrdom was not so dramatic as that of Bruno. But the effort to stifle the voice of science by practically burying the great scientist was the last act of spiritual barbarism which only quickened the progress of knowledge and hastened its own downfall.

GALILEO'S ACHIEVEMENTS

Before proceeding to recollect the martyrdom of Galileo, it is necessary to appreciate his achievements in some more detail, so as to have a proper understanding of the significance of modern science. Galileo's experiment at the Tower of Pisa is known to every schoolboy. The tower is 179 feet high and overhangs its base by sixteen and a half feet. Galileo carried to the top of the tower two weights, one of hundred pounds and another of one. He released them at the same moment, and they struck the ground simultaneously. That experiment, simple enough to be watched and repeated by anybody, should have been recognised as a definite repudiation of the traditional notion that a heavy weight came down to the ground more rapidly than a lighter one. But the old notion was based upon the authority of Aristotle, whose doctrines had been so very useful for the Christian Church to rationalise its irrationalism. If anybody tried to prove that Aristotle was wrong, so much the worse for him. He was a heretic, and should be sent to the stake.

The young scientist did not meet that fate rightaway. But his pretension to refute Aristotle was the object of ridicule from the "learned". They had their Classics written by the infallible sage of antiquity, which had satisfied the learned throughout the world for two thousand years; why should they now throw away that old wisdom simply because a crazy young man had the foolishness of abandoning the clothiers' trade for the pastime of dropping stones from the Tower of Pisa? So impervious to reason was the prejudice of learning of the Church dignitaries, that Galileo gave them up as incorrigible and went to the mercantile Republic of Geneva to be appointed the Professor of Physics in the University of Padua.

There he demonstrated the power of his primitive telescope, which could reveal the legendariness of the traditional wisdom inherited from Ptolemy. His discoveries were declared to be mere optical deceptions. It was maintained by the wise men even at that seat of liberal learning that, since the satellites discovered by Galileo were not visible to the naked eye, they must be useless, and, being useless, they could not exist. Such childish arguments could be advanced only by people who knew that they were fighting for a lost cause. The

new ideas challenging traditional authorities and venerable prejudices were no longer matters of speculation. They could be demonstrated to be corresponding with objective realities. Science could no longer be resisted. The deathknell of barbarism was sounded ; civilisation was knocking at the door. All the frantic efforts to stem the tide of human progress since then have proved of no avail. But entire humanity is still to be benefited by the sublime heritage of that heroic struggle fought by the pioneers of civilisation against the blind forces of ignorance and prejudice.

XIII

By the end of the sixteenth century, Europe was nearing the end of her long, tortuous and painful journey through the centuries of barbarism glorified as the age of pure Christian culture. The trail, blazed by Roger Bacon three hundred years before, had been followed up by a band of brave pioneers, whose heroism, martyrdom and achievements culminated in the final victory of the revolution in the idea about the location of heavenly bodies, and the foundation of modern physics and mechanics. Galileo died the year Newton was born. His Laws of Motion, together with Kepler's laws, enabled Newton to construct the Theory of Universal Gravitation as the cornerstone of the system of Natural Philosophy which replaced the traditional teleological conception of the world buttressed upon the primitive faith in the supernatural.

Galileo's genius opened up another line of development which led to consequences equally or even more revolutionary, because they concerned the immediate environments of man, and increased his power to react upon them. Less than a hundred years intervened between the construction of the telescope by Galileo and the formation of the Law of Gravitation by Newton. Scientific discoveries, made during the brief span of time, had the accumulated effect of stimulating an outburst of man's creative energy during the Eighteenth Century, which placed Europe at the forefront of human progress, as the creator of the incalculably powerful agency—machine—which is bound eventually to civilise entire humanity.

PRECURSORS OF NEWTON

The appearance of Newton, as the prophet of the new philosophy, was heralded by a number of scientists, all of whom were inspired by the discoveries of Galileo. Kepler deduced the laws of planetary motion. Francis Bacon gave a tremendous impetus to scientific investigation by establishing the method of reasoning from observed facts as the only reliable guide to the discovery of truth. Harvey discovered the circulation of blood. Drebbel manufactured the thermometer, the principle for the construction of which had already been discovered by Galileo. Learning from the unpublished papers, also of Galileo, Torricelli invented the barometer and discovered atmospheric pressure. Von Guericke invented the air-pump. Pascal carried on investigations into the pressure of the atmosphere. Robert Boyle discovered the law of gas pressure, and founded modern chemistry. Van Helmont discovered the conservation of matter and Carbon Dioxide gas. Roemer calculated the velocity of light. Mayow discovered oxygen in the air, and later nitrogen. In the midst of that imposing company there stood out the romantic figure of Descartes who, together with Galileo and Newton, shares the honour of the spiritual fatherhood of modern Europe. His talent as a mathematician and a physicist may have been surpassed by others, but as a philosopher, he remained the source of inspiration until the recent rise of scientific materialism which itself owes a good deal to Cartesian criticism.

Those were the progeny who carried on the work so very successfully commenced by Galileo. The immediate result of his investigation, apart from the triumph of the mechanistic conception of the Universe, were equally imposing. A practical problem of experimentation which had baffled Galileo, led one of his pupils to the discovery of the principle of the barometer. While editing his papers dealing with the Laws of Motion, Torricelli discovered some notes referring to Galileo's failure to pump a column of water above a certain height. The investigation of that problem led him to the discovery of the relation between atmospheric pressure and the rise of the column of water. The result was the invention of the barometer. That invention also represented a long step, taken perhaps as yet without knowing, towards the eventual discovery that motive power could be generated from pressure.

AIR-PUMP

The manufacture of the barometer immediately led to the invention of the air-pump. In making the barometer, Torricelli found that a space at the top of the tube contained nothing. It was a vacuum. Experience dispelled another venerable prejudice : *Nature abhors vacuum*. Nature may do so. But she could not prevent man from creating one. If some space can be without air, air can be removed from any place with a suitable device. That device was presently manufactured. It was the air-pump. It was a machine which was to undergo a whole process of improvements to become a powerful instrument in the hand of man in his struggle for the conquest of knowledge and power.

That is a very brief statement of the achievements of Galileo. How was he treated for arming man with the knowledge to open up a new chapter of progress ? Only posterity could judge him by the positive merit of his works. But during his life-time, he had to face the fury of the enemies of the spiritual liberation of man. Scientific knowledge equipped man with the power to march ahead, and in order to do that, he had to turn his back upon traditional ideas, and rise in revolt against established institutions and prevalent standards of value. Therefore, instead of being rewarded, Galileo was persecuted and punished.

CAREER OF GALILEO

It is not generally known that the Laws of Motion were not published until after his death. And they might not have ever been included in the accumulated store of human knowledge, had the heavy hand of bigotry been able to reach them. After Galileo's death, his papers were smuggled out of Italy, and sent for publication in Holland, where there was no Inquisition. The harassment that he suffered for his astronomical views must have discouraged Galileo to publish his epoch-making theories of mechanics, although he had begun formulating them already from early youth.

Born in Pisa in 1564, he studied mathematics, and became acquainted with the work of Copernicus which was then creating wide-spread sensation. At the age of twenty-six, he became Professor of Mathematics in the University of his native city. It was there that he discovered the principle of the pendulum, observed the law of

falling bodies, and consequently collected the data which eventually enabled him to discover the Laws of Motion. But his telescope got him into trouble. He not only himself peered into the mysteries of the heaven, but exposed them to the vulgar vision of the ordinary mortals whom religion had taught to raise the eyes to the starry dome only with a reverential awe.

He left his native city in disgust, because the learned there would not learn the obvious lesson deduced from this simple experiment at the Tower of Pisa. His heretical views of astronomy were expressed in the University of Padua, where the secular power of a mercantile Republic at least to some extent protected science against the vindictiveness of the Vatican. But a heretic like Galileo, who dared conceive the Universe as a mathematical machine, could not be tolerated even there.

CONDEMNED AS HERETIC

As all his opponents argued on the authority of the Scriptures, Galileo overcame his temperamental timidity, and publicly declared that the Scriptures were not intended as a scientific authority. Thereupon, he was condemned as a heretic from all the pulpits throughout the Christian world. At that time, he received an invitation to become the astronomer of the Duke of Tuscany. Hoping that the powerful Duke would protect him against the wrath of the Church, he accepted the invitation, but only to find himself within the jurisdiction of the Pope. Presently, he was summoned to Rome to appear before the Inquisition for explaining his conduct. He had to obey. He was accused of having taught that the earth moved, that the sun was stationary, and of having attempted to reconcile those heretical doctrines with the scriptures. The charges themselves showed how woefully ignorant were the men who presumed to judge the opinion of the scientist. However, they judged and found him guilty. The sentence was passed that he must renounce his heretical opinion and pledge himself not to preach them or publish them in the future. The alternative was life-long imprisonment. In that tragic moment, Galileo failed to attain the moral height reached by Bruno. But perhaps his timidity was a blessing in disguise for posterity. He lived to accomplish the great work of laying the foundation of modern physics.

RECANTATION

The recantation of Galileo encouraged the pious custodians of ignorance to deliver their last fierce but futile attack against the unshakable monument of knowledge raised by the liberated spirit of man. The Copernican system was condemned as heretical. Its poaching was prohibited. Kepler's work suffered the same fate. Galileo's letters were withheld from circulation. The Copernican astronomy was denounced in a Papal Bull as late as in 1616 as "that false Pythagorean doctrine, utterly contrary to the Holy Scriptures". Bruno's *Triumphant Beast* was still raving. But it had just the contrary effect.

CONVICTED AGAIN

After several years of quiet work, Galileo's spirit again burst out into open revolt. In 1632, his main philosophical work, *The System of the World*, was published. The object was to re-affirm the truth of the Copernican doctrine. It was written in the form of a dialogue, three persons participating in the conversation. Two of them were depicted as true philosophers, while the third, named Simplicio, was the defender of the orthodox view. He was made to look ridiculous. It was generally believed that the third person was meant to represent the Pope. Galileo was again summoned to appear before the Inquisition. He was an old man by that time. He was accused of heresy, in addition to having violated the pledge given previously to the Holy Inquisition. But once again he was offered absolution "if with a sincere heart he would adjure and curse his heresies". Haunted by the dreadful spectre of death by being burned alive, the old man again recanted. But then the vindictiveness of the *Triumphant Beast* at bay manifested itself. Even after his self-humiliation, the old man was condemned to spend the rest of his life in prison, so that his offences might not go altogether unpunished, and as a warning for others. People concerned with the publication of his book were also severely punished. The sentence against Galileo and his abjuration were ordered to be read publicly in all the Universities.

LAWS OF MOTION

On the intervention of powerful sympathisers, who lacked the courage of conviction, after seven years of imprisonment, the old man was

allowed to live a prisoner in his own house. He was very ill. But the permission for his removal to Florence for medical treatment was refused. The order was to treat him with inexorable severity. Quite naturally, the old man fell into a state of melancholia. After five years, he was allowed to go to Florence. But there also he was forbidden to leave his house or to receive any friends. He lost his eyesight. The only pleasure of looking at the sky was also gone. That again was perhaps a blessing in disguise. Blindness compelled him to devote himself exclusively to the study of physics. It was during those dreary years of infirmity and untold misery that he wrote on the Laws of Motion, which were smuggled by friends to be published later on in Holland. "The exquisite refinement of ecclesiastical vengeance pursued him remorselessly, and now gave him permission to see his friends when sight was no longer possible."

DEATH

In the last years of his life he became completely deaf; but even then, he carried on investigations into the nature of the force of percussion. He died in 1642, an old man of seventy-eight, for twelve years a prisoner of the Inquisition. Ecclesiastical vindictiveness pursued him even beyond the grave. He was denied the right to make a will, and was not allowed to be buried in a consecrated ground.

The desire of his friends and admirers to build a monument to his memory could not be fulfilled until the nineteenth century. By that time, his martyrdom had borne fruit. Ennobled by the knowledge for the sake of which he suffered torment, tyranny and humiliation all his life, Europe could appreciate his great services. But the age of science itself is the monument to the honour of Galileo. The monument recently constructed in the churchyard of Santa Croce is superfluous, except to remind mankind of their barbarous past. Galileo will be vindicated only when barbarism, still rampant over a large part of the world, is completely destroyed, and mankind as a whole marches triumphantly towards the goal of a real civilisation.

XIV

The martyrdom of Galileo only helped to stimulate enquiry into the mathematical structure of nature. Galileo's achievements opened up

two parallel processes of development. They can be conveniently described as of theory and practice. Before the mathematical conception of nature could be elaborated on a sufficiently large scale, mathematics itself must grow to measure up with the enormous task of giving a theoretical explanation of nature. That most powerful intellectual instrument was developed during the seventeenth century. Again it was not the genius of any one single individual that equipped mankind with that powerful instrument of spiritual liberation. Apart from many others, three men have come down in history as the founders of modern mathematics,—Descartes, Leibniz and Newton.

The laws of motion, formulated by Galileo, eventually enabled Newton to penetrate into the mysteries of the mechanics of the Universe. But in the meantime, mathematics had to be developed to serve as the instrument in that investigation. Newton himself was one of the founders of modern mathematics. But before him, Descartes had invented analytical geometry which helped Newton to formulate the laws of celestial mechanics, after he had discarded Euclid as worthless.

DESCARTES' ADVENT

Descartes was born at the end of the sixteenth century, more than thirty years younger than Galileo. He concerned himself mostly with the theoretical process of scientific development. He died at the comparatively young age of fifty-four, and was a contemporary of Galileo during the closing period of the latter's life. The speculations of Descartes were even more subversive than the doctrines of Galileo. He developed the mechanistic concept of the Universe into an elaborate system of philosophy. He escaped martyrdom thanks to his desire to avoid a clash with the Church. For that, he has been accused of cowardice or lack of conviction. The compromise was made by his postulating God as the Ultimate Creator, after his own speculations had dispensed with the very idea of creation. But that was not a weakness of Descartes alone. Newton also suffered from it. And most of the great scientists still for a long time found it very difficult to free themselves from the venerable religious prejudices.

Although Descartes came to be honoured as the founder of modern idealism, in reality he elaborated the fundamental principles of

materialism. His corpuscular theory made no essential distinction between organic and inorganic nature. He described plants and even animals as machines. But he stopped there. In order to avoid a quarrel with the Church, he arbitrarily excluded man from the mechanical scheme of nature. His most brilliant disciple, De Lamettrie, maintained that Descartes' doctrines were carried to their logical conclusion in his (Lamettrie's) book *L'Homme Machine* (Man is a Machine). According to De Lamettrie, "the wily philosopher, purely for the sake of the parsons, had patched on his theory a soul which was in reality quite superfluous". The fact that a great thinker like Descartes even in the seventeenth century found it necessary to do so, proved that the spiritual liberation of man from the tyranny of prejudice was still a distant cry.

The question that agitated the minds of scientific and thoughtful men in the seventeenth century was, how the earth came into existence. Unless that question could be answered except by assuming a creator, either as a personal God or as some mysterious metaphysical principle, the predominance of the religious mode of thought could not be successfully challenged. The religious doctrine of creation, in the last analysis, deprived man of any creative power, and consequently placed an insuperable obstacle on the road to progress and civilisation, opened up by the discoveries and inventions of science. The answer to the question about the origin of things came from various directions. The one given by Descartes was perhaps the most comprehensive and convincing among all others of that time.

LAWS OF MOTION

It was generally felt that Galileo's Laws of Motion provided the clue to the solution of the problem of the physical universe. Bruno had conceived of the idea that motion, once generated, never really ceased to exist, but was only passed from one body to another. Descartes developed that idea. If a motion never ceased to exist, then, logically it could be assumed that it had no beginning. What is noticed as the generation of motion, is simply its transference from one body to another. From this, it could be deduced that motion was eternal, and the different kinds of motion observed in physical investigation were ultimately of the same nature.

LEIBNIZ AND SPINOZA

Descartes reduced all forms of physical motion to the movement of fine corpuscles which entered into the making of all things, and therefore in that of the whole world. What came to be known as the mechanistic view of the world, was really originated by him, although as a system of philosophical thought it received much impetus also from Leibniz and Spinoza. Descartes is said to have proved the logical and philosophical possibility of natural science. Not only the physical, but also the intellectual functions of life were regarded by him as the product of mechanical changes.

Even before Newton, he realised the difficulty of action at a distance, which difficulty appeared to be fatal for the mechanistic view of the world. Newton simply set aside the difficulty, and built up his natural philosophy purely on empirical evidence. Action at a distance could not be conceived; it was difficult to explain how one body could influence another through a void; nevertheless, their mutual interaction was observed, and from that observed fact, their future movements and locations could be predicted. For Newton, those empirical facts were sufficient. But Descartes was more a philosopher than a physicist in the technical sense. For him, the problem was not practical, but theoretical. Of course, in his time, science was still far away from the stage where it could rest theory on practice. In those days, theories were very largely speculative. But with Descartes, speculation was given a mathematical form. It was not wild fantasy, but logical deductions from certain assumptions which he called "clear ideas".

The problem of action at a distance is involved in the old atomist theory. The atomist assumption is indispensable, if all physical phenomena are to be reduced to matter and motion, or matter-in-motion. In order to move, material particles must have space. Consequently, Newtonian physics had to postulate an empty space.

MYSTICAL EXPLANATION REJECTED

Grappling with the more fundamental problem, Descartes found it necessary to revise old atomism. His physical theories were rejected by the great physicists who followed him. Nevertheless, philosophically, the doctrines of Descartes were very sound, and were

destined to survive the mechanical natural philosophy of Newton. More than two hundred years ago, modern physics found it necessary to postulate some pervasive medium filling up the space. Descartes had the audacity to make a similar postulate.

Rejecting the old atomist theory, he conceived space as filled with matter. The conception was rather curious, but very bold. It gave an unambiguous answer to the question how the world came to be. By maintaining that the atoms were not indivisible, he anticipated later developments of physics. He postulated moving corpuscles as the ultimate physical units, but visualised the interstices between those corpuscles as filled with a finer matter. To explain the origin of this matter, he introduced a rather arbitrary device which rendered his whole physical theory unacceptable to later scientists.

He conceived the fine matter filling the space as a sort of splinters thrown off by the corpuscles rubbing one another. Once that assumption was made, the rest was to be deduced mathematically. He explained how the movement of the corpuscles, as well as of all bodies composed of them, resulted from their movements strictly according to the laws of mechanical impact. According to him, all bodies were subjected to motions, and all natural phenomena consisted merely of the conduction of the motion of one body to another. The most audacious part of Descartes' speculation was that he made no distinction between organic and inorganic phenomena. Thus, the sum total of his doctrines was complete rejection of all mystical explanation of nature. He provided the rising physical science with the basis of a self-contained philosophical system.

"Give me matter and motion, and I will construct the Universe." That was Descartes' answer to the question how the world came into existence. But at the same time, it was a challenge to the whole body of religious beliefs, which started from the assumption either of a Creator or of an inscrutable Final Cause. It is a strange story how he eventually accommodated in his round-up mechanistic view the idea of a God, and consequently came to be known to posterity not as a great physicist, but as a metaphysician. But it was not any weakness of his reasoning that compelled Descartes to make that compromise. His hypothetical explanation of the beginning of things was so very

rigorously mathematical that it made no room for any supernatural adjunct. It is recorded that he himself did not attach any importance to the metaphysical theory which was subsequently associated with his name. He was primarily concerned with physical and mathematical enquiries, and his sole object was to construct a mathematically rigid mechanistic theory of all natural phenomena. That object he accomplished in his work *Cosmos*. About that time, Galileo's martyrdom shocked and terrified the whole of Europe. It is said that, receiving that news, Descartes developed his metaphysical doctrines with the object of hiding the immensely revolutionary implications of his earlier work.

FROWN OF CHURCH

But timidity and weakness on the part of scientists cannot check the ruthless operation of scientific truth. The fear to tell the truth again was not due to any moral inferiority on the part of the scientists. Human intellect was still terrified by the form of established authority which was growing all the more fierce, the more it was assailed by the triumphant march of science. The revolutionary significance of Descartes' philosophy could be fully appreciated only in the light of modern physics, whose foundation it laid. But immediately, the genius of Descartes enabled Newton to formulate the fundamental laws of physics and mechanics on the strength of empirical evidence. By contributing to the theoretical aspect of scientific progress, Descartes also quickened the progress of scientific practice which ushered in the age of civilisation.

XV

The assertion of the creativeness of man presupposes recognition of the reality of the physical world. If the physical world is dismissed as unreal, then man's own existence ceases to be a reality; life is a dream. And what can man do when he lives only in a dreamland? Therefore the possibility of science is conditional upon the establishment of the reality of the physical world.

Fullblooded religion does not regard the world as unreal. Religion without a God is the real God. The world is created by God. God is

the supreme reality. His creation cannot be unreal. Therefore, the world also is real. As a part of the world, man is also real. This realistic view of the world as well as of life dominated the intellectual life of Europe throughout the Middle Ages. The Scholastics were realists. But religious realism degrades the dignity of man. He exists really as a tiny cog of a gigantic wheel. The slave is not helped by the recognition of the reality of his slavery.

Realism becomes the philosophical foundation of science when the reality of the physical world is conceived as independent of any other existence. Man can dare conceive the idea of conquering nature when the latter is no longer regarded as a divine creation, not to be tampered with by any impertinent mortal. So long as the physical world is regarded as real because it is the creation of the Supreme Reality (God), man cannot ever think of the possibility of remaking it. Yet, man becomes civilised only when he acquires the power of remaking the world. Religious realism permits man to regard the world as real, and submit himself to the vicissitudes and tyrannies of that reality. It does not inspire him with the courage to free himself from the bondages of his environments, social as well as physical. It does not help him to assert his creativeness so as to transform ugly realities into beautiful ones and replace harmful realities by useful ones. In order to feel that he is free to act if only he has the knowledge which gives the power to do so, he must start with the conviction that he is a part of a reality which exists independently by itself. That is the realism which makes science possible and thus inspires man in his advance towards civilisation.

DESCARTES' CONTRIBUTION

Descartes' contribution to modern science was the recognition of the reality of the physical world. Indeed, he made that revolutionary contribution by a very curious method. But his point of departure was very sound. And whatever is not consistent with that may be discarded as superfluous, interpolated perhaps with the purpose of hoodwinking the prejudiced. Apparently, Descartes called in the authority of God to prove the reality of the world. But he did not adopt the traditional method of doing so.

Having expressed dissatisfaction with the state of knowledge in his time, Descartes laid down the principle that reliable knowledge must be deduced from clear and distinct ideas. He found such ideas only in mathematics—in its axioms, definitions and postulates. He proposed to introduce mathematical methods into philosophy, and searching for a sure point of departure, he set up the famous *Cogito ergo sum* (I think ; therefore I am). On the face of it, this formula appears to be a subjective approach to the problem of knowledge. As a matter of fact, it did become one of the fundamental principles of modern idealistic philosophy.

But it is interesting to know the process of reasoning which led Descartes to the formula. The reasoning was scepticism *par excellence*. He held that, for finding the truth, we must doubt everything. Then he reasoned that one might doubt everything but he could not doubt the reality of his own doubt. This again appears to be just the opposite of scepticism. But it is not so. If doubt is the only reality, all tradition and authority are not only challenged but practically thrown over. Descartes' definition of truth was : "Whatever I apprehend very clearly and distinctly is true."

His list of clear and distinct ideas was a curious catalogue. It included God together with the axioms of geometry and, definitions and postulates of mathematics. On the other hand, the list excluded all "eternal truths" except the one that "nothing can result from nothing". Obviously, Descartes made a concession to the idea of God, possibly because he could place the conception of God in the category of his clear and distinct ideas together with the axioms of geometry.

In order to discard the predominating cosmological and teleological arguments for the existence of God, he reverted to the earlier, ontological argument. The former two had been elaborately rationalised and had gone into the making of the scholastic philosophy, which stood on the way to any new intellectual departure. According to one, the existence of God was proved by the assumption of a First Cause, which existed by itself. The other maintained that things could not happen in such an orderly fashion, unless there was a purposiveness or a Universal Mind behind everything. That postulated universal motive was the proof for the existence of God.

The earlier proof was simple. Faith had not yet been prostituted by sophistication. According to it, the proof for the existence of God was the existence of the idea of God in man's mind. By reverting to that simplicity of pure and primitive faith, Descartes indirectly discarded the whole elaborate system of scholastic learning and the teleological view of the world, which made of man a helpless puppet in the hand of an inexorable force beyond his understanding.

HIS RATIONALISM

In any case, his re-assertion of the classical maxim of ancient Greek rationalism that "nothing can result from nothing", struck at the root of any idea of God. The positive formulation of the maxim is : Everything must have a cause ; something cannot come out of nothing. It is evident that no idea of God can be reconciled with this maxim, which was included in Descartes' list of clear and distinct ideas. All evidence about the existence of God, whether ontological or cosmological or teleological, proves one thing if it proves anything at all ; it proves that God is the ultimate existence, or that the existence of the world cannot be explained without assuming the existence of God in some form or other. The formula that "nothing can result from nothing" demands that, in order to be accepted as a truth, the existence of God must be traceable to some other cause. So, all argument about the existence of God is vitiated by the fallacy of *reductio ad infinitum*, which is the same as *reductio ad absurdum*.

PROOF OF GOD'S EXISTENCE

Besides, if the idea of God appeared to Descartes to be distinct and clear, then he would not find it necessary 'to prove' the existence of God. In his opinion, clear and distinct ideas were those which could not be denied. Nevertheless, he found it "desirable to prove the existence of God", because that would make the reality of the physical world undeniable. Descartes' method of proving the existence of God in reality had just the contrary effect. Voltaire said that he had known many who were led by Descartes' doctrine to the denial of God. Therefore, his realism, though formally established on the authority of God, was fundamentally different from religious realism.

That was still clearer from his physical theories. But there still remains his peculiar method of utilising the authority of God for providing the reality of the physical world. He did not advance the traditional argument that since the world is created by God, it must be real. He deduced the reality of the physical world from the clear and distinct idea of it that everybody has in his mind. In other words, his argument was : The physical world is real, simply because it is there. I exist, because I think. The physical world, therefore, exists, because we all think about it. If it really did not exist, there could not be any thought about it.

This argument obviously excludes the authority of God. In order to smuggle in the idea of God, in his self-contained physical realism, Descartes advanced the curious and thoroughly unconvincing argument that, if the physical world was not real, then in giving us the idea about it, God has deceived us. So, the reality of the physical world is not proved on the authority of God. On the contrary, the existence of God is made conditional upon physical reality. Because, if it was not there, then God would be a deceiver. The reality of the physical world thus guarantees not necessarily the existence of God, but only his morality. This, indeed, is a matter of frivolity. While trying to avoid a clash with the clergy, the wily philosopher could not resist the temptation of pulling their legs. He introduced his theory of the development of the world from small particles with the observation that, of course, God has created the world at one time, but it was very interesting to see how the world might have developed by itself.

ORIGIN OF THINGS

Having proved that the world is real, and its reality is to be derived from the fact that we perceive it, Descartes went on with his physical speculations about the origin of all natural phenomena. In that, he expounded a thoroughly mechanistic view. His mechanistic view went to the extent of rejecting the venerable doctrine of the immortal soul.

Insisting upon the independent reality of the physical world, simultaneously with the concession to the idea of God, Descartes set up a system of absolute dualism : matter and spirit, body and soul, were two parallel lines of Euclidian geometry which never met. So, the former became the reality and the latter was relegated to the

position of a venerable fiction. The movements of matter and consequently of the body were all produced by mechanical impacts of motion. Neither the spirit nor the soul had anything to do with them. Mental activities were included in the movements of matter.

Although Descartes arbitrarily did not carry his mechanistic view farther than the animal worlds, yet, from the time of Montaigne, animal psychology had become an object of investigation. The animals are machines ; but Descartes could not deny that they could think. The step from the animals to man was a very short one. He himself did not take that step, directly. But indirectly, he destroyed the doctrine of the soul when he drew attention to the important fact that a dead body was dead not only because the soul was absent, but because the bodily machine itself was partially out of function. Once the phenomena of life were traced to physiological functions, the idea of soul could be easily dispensed with. It may still exist for the sake of prejudice. But the functions of the human body were entirely independent. Descartes still retained the idea of the "vital spirits". But they were like the "animated matter" of Spinoza. In other words, Descartes dimly conceived, and Spinoza later on developed,--- both with a mathematical precision---the idea that the vital phenomena were inherent in matter, being its functions in a certain state of organisation.

The recognition of the reality of the physical world and the explanation of its mechanism enabled man to conceive the idea that his environments could be the objects of his knowledge and that knowledge would give him the power to establish progressively his mastery over them. Without the philosophy of physical reality and a mechanistic view of the world, there could be no physics. And without physics, there could be no technology which empowers man to assert his creativeness endlessly, and thus build up a really civilised society.

XVI

It has been said that no single man in modern history has influenced the world so much as Newton. That was certainly true for two hundred years, during which time, what is known as modern civilisation scored successive triumphs. Newton died in 1727. His great work *The Mathematical Principles of Natural Philosophy* was published forty

years earlier. Those principles guided the intellectual life of Europe, and moulded material development throughout the eighteenth and nineteenth centuries. Yet, Newton was neither an inspired prophet nor a magician.

By discovering the Law of Gravitation, he definitely ended the controversy about the location and movement of heavenly bodies. But the influence of Newton resulted from the far-reaching philosophical consequences of his epoch-making contribution to astronomy. The central point of the Natural Philosophy established by Newton was the mechanistic conception of nature. The Universal Law of Gravitation was, so to say, a declaration of independence of the physical world from any external sovereignty. The publication of the *Principia* is one of the most outstanding landmarks of modern history, because it closed the long chapter of struggle, still dominated by the traditions of savagery, and marked the definite victory of the forces of civilisation.

The fundamental achievement of Newton was to answer the question: How is the world made? The question was answered without any metaphysical assumption. The world developed from a primordial state wholly according to physical laws inherent in itself, completely independent of any standing interference from outside. The sovereignty of man was established. Whatever might have been the past, the future belonged to him. He was destined to make it. Since the world had not been made as it is by God, it could be remade by man. And civilisation is nothing else but the success of man in remaking the world according to his own convenience.

NEWTON'S GOD

Newton was a religious man. He postulated a God to give the first push which set the universal mechanism in motion. But his God was outside the machine, and once the latter was in motion, it went on completely independent of the God. Everything in nature happened according to the laws inherent in nature itself, and the laws could be expressed in mathematical terms. Granted that the original impulse of force came from God; but once it became a part of the world, it itself was governed by the laws of the world. Consequently, the

assumption of a First Cause, outside the world, was completely superfluous for the purpose of answering the question how the world had developed to its present state. The development having been completely mechanistic, governed by laws which are integral parts of the physical system, for the purpose of answering the question how the world happens to be as it is, the *ad hoc* hypothesis of the "dues ex machina" could be conveniently disregarded. The only hypothesis necessary for the purpose is that the primordial substance of the world is not an inert mass, but a mass with motion. That assumption is as old as the attempt to give a physical explanation for natural phenomena. That was the hypothesis of ancient atomism which, revived by Descartes and Gassendi, became the foundation of the Newtonian systems.

THEORY OF CREATION

The religious dogma of creation having been very much shaken by the pioneers of modern civilisation, the old question—how the world was made—assumed new and greater significance at the time of Newton. The power of the Church and the authority of Scholasticism were still to be reckoned with. Therefore, philosophers and scientists started from a formal profession of the faith that the world had been created by God; and then went ahead to see how the world could have developed by itself. The process of mechanistic explanation, thus begun, proceeded quietly, setting aside the Creator. That sly stratagem was adopted not only by Descartes. The famous theological Marsenne, a friend not only of Descartes, but of the professed English materialist Hobbes, composed his *Commentary on Genesis* also in the same way. He set forth all the arguments of the atheists and naturalists, ostensibly with the object of refuting them. But the impression created by the whole work was that divine creation was a meaningless formula. It was not necessary, for answering the question how the world was made. The faith in divine creation had to be professed, because religion demanded it. The doctrine of the mechanistic development of the world was expounded even more elaborately by yet another French priest, Gassendi. Philosophically, he was the immediate predecessor of Newton.

MECHANISTIC ATOMISM

Francis Bacon had held that the ancient atomist Democritus was the greatest of ancient philosophers, even greater than Aristotle. The materialist Hobbes also drew his inspiration from Democritus. But owing to its *ad hoc* picturesque procedure of solving the problem of the first impact of atoms, Democritan atomism could not serve the purpose of a working hypothesis for modern science. Descartes' effort to expound a more plausible atomism ended in a new system of rationalist metaphysics. Gassendi found the way out of the difficulty. He received the atomism of Epicurus, who had held that the first impact of atoms resulted from a slight deviation in their rectilinear motion downwards.

The original work of Epicurus had been lost, or destroyed by priestly fanaticism. It was later on reconstructed by the Roman poet Lucretius who pictured each atom as having an immortal and incorporeal spirit. Gassendi was not a poet, but a physicist. He rejected the poetic extravagance of Lucretius, but postulated the existence of God, which, however, could be kept entirely out of his explanation without weakening it in any way. Gassendi regarded the world as one ordered whole, completely self-sufficient as regards its structure and laws of operation. The only question he allowed was, if the world possessed a soul. That was evidently a question of psychology, not of physics. As regarded physics, Gassendi identified the weight and gravity of atoms, and consequently maintained that their motion was self-determined. So, the problem of the first impact was solved. He argued : The first cause of everything is God, but the whole physical enquiry is concerned only with the causes which produce the changes of the phenomenal world. They must be corporeal : the atoms, therefore, must be regarded as self-moving principles.

Atomism, thus restated and elaborated by Gassendi, constituted the foundation of Newtonian Natural Philosophy. God remained a superfluous postulate ; but the physical world asserted its sovereignty, and having been raised to that position of freedom and dignity by man, it was bound to come more and more under his domination. The imaginary Kingdom of Heaven was to be replaced by a real heaven of freedom and happiness to be created by man in this terrestrial world.

LAW OF GRAVITATION

Newton's Law of Gravitation was the generalisation of the Laws of Motion discovered by Galileo. Gravitation, however, was conceived as a universal principle. On the one hand, not only the members of the solar system, but the countless heavenly bodies scattered through infinite space were also visualised as subjected to the Law of Gravitation. On the other hand, that would not be possible unless every particle of matter attracted every other particle according to the same law. The science of mechanics thus restated, not only with mathematical accuracy, but on the strength of increasingly accumulating empirical evidence, the fundamental concept of philosophy, namely, that of substance. The sub-stratum of the world was revealed to be material, and laws causing the change of its states were discovered as physical laws, capable of being formulated in terms of mathematics. The theoretical foundation of a new science—technology—was laid. Having known how the world was made, man could now apply himself to the task of remaking it. But for the purpose, he required powerful instruments. They had to be made out of the rich store of natural resources. Steady penetration into that treasury of nature resulted from the scientific knowledge acquired during several hundred years by a whole succession of pioneers.

FIRST ERA CLOSES

According to Francis Bacon, science has two functions, luciferous (light-giving) and fructiferous (fruit-bearing). By the time of Newton, science had performed the first function far enough so that the performance of the second could seriously begin. In the earlier stages of scientific development, human mind had to be cleared of the cobwebs of superstition and religious prejudice accumulated into a formidable mass during centuries of ignorance. That was a long bitter struggle which ultimately ended in a triumph of knowledge over : ignorance, of reason over faith. That period was concluded by the achievements of Newton, whose great work, *The Mathematical Principles of Natural Philosophy*, ushered science into its fruit-bearing stage. The more fruit it bore, the brighter became its illumination.

The history of science since the time of Newton was a magnificent demonstration of the old maxim : Knowledge is power. The power of man, attained through scientific knowledge, not being imaginary or a metaphysical illusion, enabled him to penetrate deeper into the mysteries of nature and gain great knowledge, which, in its turn, gave him more power. That was the march of civilisation. Armed with scientific knowledge, man created powerful instruments for harnessing physical energy to an ever-growing extent, and revolutionised his conditions of living. That, naturally, brought him face to face with new problems, but he is no longer to be baffled by any problem. The ability of man to solve all the problems that will crop up in course of his progress is the positive value of civilisation. That value is still potential. But the future of mankind will be determined by a continuous unfoldment of that value produced by man's own creativeness.

XVII

So long as the world is regarded as a providential arrangement, man's creativeness cannot be asserted to its fullest extent. Therefore, the discovery that the world was a self-contained mechanism, governed by laws inherent in itself, removed all inhibitions restricting the fullest development of the potentialities of man. By compelling the rejection of time-honoured beliefs, discoveries of science brought about perhaps the greatest revolution of all ages. It was a philosophical revolution. Its effect was to set human spirit free. There was a tremendous outburst of human creativeness which made the two hundred years after Newton the most fruitful period of human history.

ERA OF CREATIVENESS

Natural phenomena which had for ages baffled human understanding and, therefore, been attributed to whims or emotions on the part of supernatural beings, one after another came under the scrutiny of human mind and revealed their secrets. They were all by and by fitted into an all-embracing mathematical description of nature. To begin with, the verification of the universal Law of Gravitation was a miracle—perhaps the greatest miracle experienced so far. Events like

the tides of the ocean, phases of the moon, solar and lunar eclipses, movements of other heavenly bodies, the succession of weather—all these and many others occurred regularly as predicted by scientists who studied nature as a mathematical machine. What was still more surprising was that the existence of other heavenly bodies unknown until then was deduced mathematically from the peculiarities in the movement of known bodies. Turning their telescopes to the region of the sky, where, according to their mathematical calculations, unknown bodies should exist, astronomers discovered that they really existed there. Several new planets were thus discovered.

ELEMENTS REVEALED

With the confidence in his power, gained from the successful penetration into the secrets of the heaven, traditionally believed to be the special domain of the Gods, man turned his attention to terrestrial environments, the knowledge and the consequent mastery of which were necessary for the well-being and progress of the race. The God of the Wind was the first to be dethroned. The discovery of the earth's atmosphere led to the knowledge about the mechanics and chemistry of air. The winds, with their more violent expressions such as storm, tempest and tornado, were traced to the influence of the sun. They were no longer to be dreaded as manifestations of godly wrath. The knowledge of the mechanism of wind greatly lessened the dangers of navigation, and the frequency and growing length of maritime voyages quickened the art of ship-building. On the other hand, the same knowledge enabled man to extend the scope of his understanding to other phenomena until then regarded as mysterious problems. The monsoons, causing tropical rains, were traced to the alternate heating and cooling of the continents of Asia and Africa, which events were subsequently connected with the amount of snowfall in the Arctic regions of the North. Tides, currents and ocean-streams were no longer to be the grief of unwary mariners. They could all be anticipated and their locations fixed.

STEAM AND MACHINE AGE

The development of chemistry represented the application of human quest for knowledge and power to more immediate environments.

The Water God was soon decomposed into two gases, which, in their turn, were analysed down to atoms, that is, small particles of matter. The credit of providing the conclusive empirical evidence to Newtonian Natural Philosophy belongs to chemistry. The atomic theory was finally established by Dalton on the strength of the accumulated result of chemical investigations. It was the work of the English Chemist Joseph Black which led to the discovery of latent heat—a discovery which influenced more than any other factor the entire development of a whole historical period.

The application of steam as a motive power ushered in the real Machine Age. Steam, therefore was one of the greatest revolutionary agencies of human history. The revolution resulted from the passing of yet another God. The real material nature of heat had to be discovered before steam could be generated in sufficiently large quantities to make a large-scale application of machine possible. Identically, the knowledge about the nature of heat contributed considerably to the solution of the problem of motion. Study of the physical phenomenon called heat led to the discovery that motion was a property of matter. It was no longer an *ad hoc* assumption that all the physical bodies resulted from the combination of a mass of material particles in a state of perpetual motion, in course of which there were mutual impacts. The atomic theory was established as an empirically verified hypothesis.

LATENT HEAT

Black discovered that heat was latent in every object, being the sum total of the motion of the atoms composing it. What is known as fire is simply an expression of heat which is a property of matter. Another God gone, although even today there are people who worship fire.

Improved by Rumford, the founder of the Royal Institute, and Humphry Davy, the discovery of latent heat eventually led to the knowledge that heat was a mode of motion. An object is heated when the motion of its component particles as composing water, but has power because it occupies a much larger space, because the increase in the motion of the particles causes them to fly farther and farther apart. By forcing the steam to pass through some narrow channel, the heat contained in it could be transformed into power for moving

other things. That is the principle of the steam-engine which was invented before James Watt, who only improved it while trying to remove the effect of Neucomen's engine. He was helped to do so by his friend Black, who had propounded the theory of latent heat. Ultimately, the motive power is not the steam. It is heat, which again is an expression of the motion of matter. The insight into the structure of the substratum of the physical world and its mechanism ultimately enabled man to discover the inexhaustible source of energy, which equipped him with the power to march from victory to victory in his age-long striving for the conquest of nature.

CONSERVATION OF ENERGY

Next it was discovered that neither mass nor energy, both of which are ultimately the same, could be exhausted. They are simply transformed from one state to another, the quantity of both in the world always remaining constant. The ability to harness physical energy, to tap its unknown sources, therefore, placed in the possession of man unlimited power. The question was about the process of generating energy, that is to say, transforming latent energy into kinetic energy. The discovery that coal contained a large quantity of potential energy made it possible to use steam on a large scale for running engines. The potential energy of coal could be transformed into heat which, in its turn, transformed water into steam. That knowledge about the inter-relation of several physical objects contributed to a rapid development of technology. The process was completed by the discovery of the relation between heat and mechanical labour. The laws of thermo-dynamics were formulated as the key to the mystery of universal mechanism.

DISCOVERY OF ELECTRICITY

Another line of development dispelled the superstition and terror about the cause of lightning. The phenomenon called electricity had been observed for a long time. But it was only in the nineteenth century that it was discovered that the lightning in the sky and the electric phenomena observed by Galvani, Volta and others were ultimately disclosed by chemistry. Before long, electricity could be generated in laboratories and even transported from one place to another. Its

numerous uses are too well known to require description. But the fact to be mentioned is that electricity also provided man with a source of power. It contributed to further development of technology which had already received tremendous impetus from the application of steam and the use of coal for the generation of heat.

Technology brought about a tremendous revolution in man's mode of living. Machine created the possibility for man to have his necessities satisfied through the expenditure of a small fraction of his time and energy. That possibility creates conditions in which man enters the stage of real civilisation, in which a new race of supermen may eventually replace the race of ordinary mortals. But the revolution which opens up such a fascinating perspective at the same time places before man a new set of peripisms. Civilisation, ushered in by a philosophical revolution, and quickened by the successive triumphs of man during the Machine Age, makes a social revolution necessary. The victory of that revolution will make man the master of his creation and remove all obstructions to human creativeness which is really unlimited.

Modern machine is the result of man's spiritual liberation. It cannot, therefore, be a bondage for him. The proper appreciation of the social and historical significance of the machine enables one to see how it has enabled man to move away from the neighbourhood of animal existence in which he lived during the dark ages of savagery and barbarism, how it has raised him to the dignified status of manhood, and how it can take him even further nearer to godhood, if that is conceived as the liberation from all the restrictions upon the spiritual potentialities inherent in human existence.

XVIII

It is generally agreed that man is a social animal. Civilisation is identical with social progress. The level of civilisation, therefore, is to be measured by the degree of social progress. Society originates in the realisation that collective effort is more effective in the struggle for existence. The effectiveness of collective effort, in its turn, increases in proportion as it is made through the intermediary of more productive instruments. The degree of the productivity of human labour is the measure of man's success in the struggle for existence.

The greater the productivity of human labour, the less is the amount of energy, individual as well as social, necessary for procuring the means of subsistence. The productivity of human labour becomes unlimited when it can be supplemented by physical energy, an inexhaustible store of which is to be found in inanimate nature. From the earliest day of human history, the need for harnessing physical energy has supplied the impulse for all creative human activity. After thousands of years of hard struggle, that basic impulse of human existence is given the fullest freedom by modern technology, which itself is a creation of that impulse. Therefore, technology is the lever of progress of modern society. It has laid the foundation on which a really civilised society can be built.

Man must exist physically before he can progress intellectually, morally or spiritually. As a matter of fact, all these developments constitute the spiritual life of man. Therefore, it is easy to see how physical existence is the basis of spiritual development. It is also easy to see how spiritual development is promoted or arrested by the conditions of physical life. Let it be observed that here I am not concerned with the life of a disembodied soul. Questions in that respect belong to the domain of metaphysics, being utterly irrelevant to the problems of social being and becoming.

HUMAN CREATIVENESS

Assuming that endless spiritual possibilities are inherent in man, man must become conscious of them before he can apply himself to their development. He must have the time for cultivating them. That essential condition for all human progress is created only when man's entire time and energy need no longer be devoted to winning the bare means of existence. That condition has attained the highest stage of maturity in our days when technology, rationally applied, can provide every member of the entire human community with all the necessities of life, in exchange for a small fraction of his or her time and energy. This position, attained in consequence of man's struggle against nature for ages, is confused by a number of new problems of a social nature. Those problems must be solved before man can be the master of his own creation, before he can come to his heritage. But the beautiful

perspective of the present position, created by man's ability to harness physical energy, are blurred only for those who cannot find the proper approach to the social problems of our time. The problems are put in their proper perspective and are found to be easy of solution as soon as the positive achievements of the Machine Age are appreciated independent of its negative appearances.

If there is anything divine, it must be detected in human creativeness. The machine is a creation of man. It has already enabled him to travel far towards real freedom. It alone again possesses power to bring him even greater freedom. One simply ignores the facts of history when he asserts that the man of our age is depraved or degenerated in comparison with his ancestors. The comparison cannot be made abstractly. There is a concrete standard which must be applied for making an intelligent and reliable judgment. The standard is the amount of time and energy he is required to devote to the exigencies of his physical existence. In other words, the possibilities and actualities of his spiritual life must be judged by the conditions of his physical being. If those conditions today are found to be more favourable than in the past, the possibilities of his spiritual development must be admitted to be greater, and impartial and unprejudiced observation must compel the admission that actually the modern civilised man is spiritually more advanced than his ancestors, who did not possess the advantage of winning the bare means of subsistence in return for a smaller amount of time and energy.

LONGER RECREATION NEEDED

The positive value of modern civilisation is realised when it is known that even today no adult individual anywhere in the world should perform more than four hours' physical labour a day, if the mechanical productive apparatus, developed in a comparatively few countries, were employed to the purpose with which it has been created. With the help of modern machine, a unit of human labour can produce today many hundred times as much as it could do previously, when technology had not yet enabled man to harness physical energy for his benefit. Who would assert that a man is spiritually more elevated when he is compelled to work twelve hours

or more a day for earning his barest livelihood? Assuming that spirituality is inherent in man, it must be somehow cultivated. Only a few can have the privilege of withdrawing from society and living the life of the recluse devoted to the contemplation of the spiritual. The vast majority must remain in society, and shoulder social responsibilities. If the entire human race is ever to attain a high level of spiritual development, that will be achieved only by individual human beings acting most effectively as social animals. The question, therefore, is how they can do so. They can do so when their physical necessities and social responsibilities are discharged so as to leave them plenty of time to be devoted to the cultivation of their spiritual potentialities; and what is of more importance is that they should have the facilities for doing so.

THE LEVER OF PROGRESS

The argument is illustrated by a very familiar instance. It is generally believed that free primary education is an indispensable condition for the progress of any nation. But that freedom has no value unless favourable conditions for enjoying it are created. If the bulk of the population is so poor as to require the productive employment of the labour of their children as soon as they are sufficiently grown up, free primary education would be of no avail to them. Moreover, even if they can send the children to school, there still remains the question of finding the money for buying books and other facilities for the children to educate themselves properly. So, the two conditions for building up a spiritual structure on the foundation of the physical and social existence of man are: free time, and facilities for employing it to the purpose of cultivating the finer aspects of life. Both these conditions are created by modern technology. Therefore, machine is not only the lever of social progress, but it has brought mankind to the beginning of endless spiritual progress.

MACHINE AND CAPITALISM

The spiritualising significance of civilisation is not realised only by those who fail to distinguish it from capitalism. The apparently evil effects of the application of machine to the process of social production result not from the nature of the machine, but from its

association with the capitalist mode of production. The concern of this latter is not social progress or human welfare, but to make profit. For that purpose man has been made a slave of the machine. Therefore, to condemn the machine for its selfish use by some is as wise as to throw the baby with the bath-water. Having created the instrument for endless social progress and his spiritual elevation, man is confronted with the problem of liberating it from the greed of the few which is choking its liberating possibilities. Having triumphed in the age-long struggle against nature, man must now win the struggle against nature, man must now win the struggle for social freedom. Capitalism sets a limit to endless possibilities of civilisation. Itself a bye-product of the human urge for social progress, as the condition for spiritual development, capitalism now has become an obstacle to further progress; and in the atmosphere confused and vitiated by that contradiction, false ideals of humanitarianism appear plausible, trying to prove that man's laborious but triumphant march towards civilisation was a mistake, and therefore he should retrace his steps to seek blessing in the drudgery of barbarism and darkness of savagery.

But the accomplishments of the past endowed man with the power to win the new struggle for social freedom, and the vision of a nobler and brighter future of real civilisation to be attained by a community, no longer of social animals, but of enlightened human beings, masters of what they have already created, and inspired with the ideal of creating still greater things.

XIX

The great revolution, caused by the application of steam power and machinery to manufacture, dislocated old social relations. It completely transformed the life of the masses of the population. Until then, in Europe also, the great bulk of the toiling population was engaged in agriculture, and partially in handicraft industries. Application of machine led to the concentration of production. Machine could not be applied to spinning and weaving, for example, if these were done in every home. It is not profitable to set up some power-driven device for running the domestic looms or the spinning-wheels. On the other hand, yarn spun and cloth woven by the application of mechanical power were much cheaper. Because, with

the aid of machine, the same unit of human labour could produce much more. Mechanical factories produced for exchange. Goods made there were sold in the market and, being cheaper, drove the handicraft product away. The artisan, consequently, was compelled to give up plying his trade at home and accept employment in the factories. There was shifting of population from the countryside to the industrial centres situated in urban areas. The process was inevitable. Machine was not an adventitious appearance. It did not suddenly appear as a devil, to disturb social harmony. It had been created by man in course of his struggle for existence. Society must be reorganised in order to enable man to be benefited by his own creation. Reorganisation means disruption and process of transition is bound to be unsettled and painful.

Speculations, theories and thoughts regarding the reform and readjustment of the chaotic conditions grew out of the social turmoil brought about by the industrial revolution. That was the beginning of the growth of modern Socialist thought, which holds out the perspective of a reorganised society in which man will be fully benefited by the civilising mission of the Machine.

EARLY SOCIALIST THOUGHT

Socialist thought of utopian and speculative nature first developed in England, where the industrial revolution was the most decisive. In France, on the other hand, rationalism was applied to the examination of social problems. Finally, German thinkers raised Socialism to the status of philosophy and science. The process of the evolution and the final formulation of Socialist theories, however, was a composite whole. It grew dynamically out of the background of changing social conditions. It was the intellectual reaction to social problems created by the advent of modern civilisation. The fundamental problem of modern civilisation is how to make man the master of his creation. As a social being, man is bound by social relations. Therefore, the solution of the problems of modern civilisation required a readjustment of social relations. But that could not take place arbitrarily. Humanitarianism was not the proper approach to social problems. The social problems confronting modern civilisation have their causes. The problems themselves were not the result of anybody's

selfishness, or not created by evil men. So, moral approach was equally unavailing. The causes of those problems should be discovered in the structure of the society, and even in the process of previous social evolution. The solution of the problems was conditional upon the removal of those causes. Therefore, a scientific appreciation of the forces operating behind the entire development of human history was the guide for finding a proper approach to the social problems of modern civilisation. That was done by the pioneers of the Socialist thought. They were helped by the light thrown on their problems by human knowledge acquired in all the branches of intellectual activity.

While the theories of scientific Socialism were finally elaborated and perfected by Karl Marx and Friedrich Engels, great thinkers in the diverse realms of economics, natural science and philosophy had laid down, stone after stone, the foundation of the great structure. Particularly, the gigantic strides made by the natural sciences in the first half of the nineteenth century destroyed the speculative basis of social theories.

Socialism ceased to be a utopia or a reformist humanitarian cult only after the great discoveries of natural science. Without Darwin, there would be no Marx; and Morgan's discoveries about the nature of ancient society contributed greatly to the study of the institutions of private property and family. Finally Hegel supplied a new revolutionary method of reading history. The Hegelian dialectics in the hands of Marx became a deadly weapon of social criticism. A dialectic view of social evolution enabled Marx to prove that the contradiction of the capitalist society would eventually cause its dissolution, and the capitalist mode of production laid down the foundation for a new social order. The spectacle of man enslaved to his own creation was no longer an anomaly. That positive significance of the creation of man was bound to make man the master of his creation, in course of time.

The French materialism of the eighteenth century was a negative school of thought. It disrupted the theological foundation of philosophy. Having done that, it tended to degenerate into agnosticism and philosophical anarchism. The epoch-making advance of the geological, astronomical and biological knowledge accentuated the positive character of materialism. Feuerbach raised the standard of

revolt against Hegelian idealism. Improving upon Feuerbach, Marx and Engels laid down the fundamental principles of historical materialism as the philosophical basis of Socialism. A new perspective was opened before civilisation. The Machine Age could outgrow the fetters of capitalism, and technology become the lever for an endless progress, not only socially, but spiritually, in the broader sense.

In England, Socialist ideas originally grew not so much as a positive factor, but as criticism of the conditions created by the industrial revolution. There was complaint, but no effective remedy was suggested. Social problems were approached from the moral and humanitarian points of view. Their real nature not properly understood, the solutions offered were only mechanical plans for building up a jester, more equitable, more humane social order. But all the plans proved to be impractical, and Socialism remained either a pious desire or a subject of ridicule.

The most miserable conditions, under which men, women and children laboured in the factories, the filth and squalor of the slums in which multitudes of human animals were herded together, flaunted at the lofty moral doctrine of the "greatest good for the greatest number", preached by the ideologists of the new capitalist order. So flagrant were the evils that even John Stuart Mill questioned the teaching of his master, Jeremy Bentham, sought to revise the philosophy of utilitarianism, and went to the extent of suggesting some restrictions upon the excesses of capitalist exploitation.

Gradually, there rose social reformers denouncing capitalist greed, and questioning the morality of the institution of private property and cut-throat competition. A generation before Karl Marx, English economists and social reformers like Hall, Gray, Thompson and Hodgkin proclaimed that it was not capitalism, but Socialism which could secure the greatest happiness to the greatest number. They maintained that, by right, the workers were entitled to the full product of their toil. They called upon the authority of the classical economist, David Ricardo, who had taught that labour created all values. In the hand of William Godwin, philosophical radicalism transcended the limits of parliamentary democracy in politics, and *laissez faire* in economics. He developed it to the verge of philosophical anarchism disputing all authority and challenging private property. Cobbett

appeared as a comet on the political firmament of the early nineteenth century. His biting criticism not only exposed the hypocrisy of the current social doctrines, but touched the dogmas of philosophy also. His popular journalism appealed straight to the victims of the new order, and incited them to revolt.

That was the background on which Socialism rose as the ideological outcome of man's triumph in the age-long struggle against nature. Having established his domination of nature, man set to himself the task of reorganising society so as to guarantee the welfare of the entire community.

XX

It was with Robert Owen that Socialism stepped out of the realm of emotion, and sought application in practice. Owen is conventionally chronicled as the father of the Socialist movement in England. But in reality, he was not the pioneer of the Socialist movement, but a reformer of capitalism. The untrammelled application of the doctrine of *laissez faire* had made England the workshop of the world and the proud mistress of the seas. That power and prosperity, however, had been bought at a very high price. Even in 1940, Lord Russell informed the House of Commons that the people of the British Isles were in a worse condition than the negroes of the West Indies. During the Anti-Corn Law Campaign, Cobden told stories of people living on stewed nettles and decayed carcasses. Hungry and destitute multitudes were leaving the shores of "Merry England", filled with the bitterest hatred for the old country. If the conditions failed to be somewhat improved, on the initiative of the ruling class, the workers might be swayed by the disruptive ideas of Socialism which was telling them that, as creators of all wealth, the world belonged to them, and that they should undertake the task of building a new social order on the foundation laid down also by the labour of their class.

THE CHARTIST MOVEMENT

The storm was gathering on the social horizon, to burst out as the Chartist Movement only a few years later. Robert Owen came forward with a prescription for curing the social evils, without radically

changing the relations of capitalist production. He was not a revolutionary; he was a reformer who proposed improvement in the conditions of the workers, constitutionally and on sounder economic principles. He thought that the evils of capitalist industrialism could be cured by benevolence on the part of the employers. While assuming the management of a textile mill at Manchester, young Owen declared that his policy would be to take as great care of the living machinery as of the inanimate. The policy stood him well, and incidentally his operatives as well, for the time being. But his example was not followed by other employers. In his old age, Owen spent his fortune in promoting co-operative efforts. His schemes ended in failure and disappointment. Any appreciable reform of the social conditions brought about by the industrial revolution did not take place until after England had been driven to the verge of a revolution by the Chartist Movement.

In the middle of the Nineteenth Century, in England, Socialism was diluted with a strong dose of religion by Maurice and Kingsley. Thrones were tottering all over Europe. No head was safe which wore a crown. The waves of revolution were dashing also upon the battlement of English conservatism. Fergus O'Connor, with his advocacy of "physical force", overwhelmed the preacher of the gospel of "moral force", Lovett, as the leader of the English working class. At that critical moment, the Christian Socialist Maurice frankly distrusted revolution, and defended monarchy as against republic. He advocated a strong government. According to him, it was the duty of the State to protect the individual citizen and his property. Non-violence is an old story. And it has always had the same social significance. It only discourages revolt against the system of standing violence. Man should not assert the right of enjoying the fruits of his own labour. He should rather cultivate the virtue of simple life, and abandon the "greed" for the amenities of physical existence.

Maurice and Kingsley preached that all citizens should live harmoniously, instead of being divided into two warring camps. But they failed to say how the ideal State could be attained. They only advised the workers to organise co-operative producing associations "to eliminate the excessive profits of dead capital, and the ferocity of the competitive struggle". The Christian Socialists died with their dreams, but scientific Socialist thought was shaped by the bitter

experience of the working class. There could be no social harmony so long as, by virtue of monopolising the ownership of the product of the creative genius of man, a small section of society acquired the power and privilege of keeping the bulk of society in economic servitude.

REFORMISM IN FRANCE

Similar tendencies of reformism were represented by Saint Simon and Fourier in France. Utopian Socialism, the dream of reforming the world into an ideal State, reached its climax in the hands of those French thinkers, whose imagination was not limited by the commonsense of the Englishman. Their condemnation of capitalism was more rational than moral. Nevertheless, Saint Simon also held that the society of his time needed only mending. In a way, he was right. Because, technology would still develop within the limits of capitalist production. So long as capitalist society could do that, it had still a historically useful function to perform. Therefore, it could not be brushed away by the indignation of the humanitarian reformers. Saint Simon did not visualise a revolution, although he was altogether hostile to private property. He preached harmony between capital and labour; but in the same breath, he called upon the industrious to declare war upon the idle. He held that society should be so reorganised that all its members must work. His ideas were so confused because his approach to social problems was sentimental, though very largely rationalist. In his criticism of the established conditions, he was rational. But in suggesting the remedy, he let emotions prevail. But even then, he did hit upon the right solution when he suggested that every member of society must perform some labour. But the mechanical means of production must develop still further before the reorganisation of society suggested by Saint Simon could be actually undertaken. Man must still apply himself to the initial task of forging the weapon which would ultimately free him from social bondage.

Fourier also found the existing social system fundamentally wrong, and set out to picture an ideal society to replace it. He advocated social experiments by small communities which he arbitrarily limited to eighteen thousand members. He, however, failed to visualise

industrial production without capital. In his ideal society, capital would exist for the common good, receiving a very reduced profit. The father of classical political economy defined capital as congealed labour. Therefore, when capital would really exist for the common good, there would be no room for profit. The accumulated store of human labour congeals in the form of the productive apparatus of the given period. The totality of the mechanical means of production, that is, all the machines made by man, represent the capital which is performing a social function. The money withheld from the productive purpose is not capital. Socialism proposes the common ownership of whatever has been created by the collective labour of the entire community. When that is done, there will be no individual owner to receive profit even at a reduced rate. Fourier failed to see that. Therefore, his theories could only have a temporary influence upon the forces making for the realisation of the ideal he vaguely visualised.

FORERUNNERS OF MARX

After 1848, the greatest and the conclusive contribution to Socialist thought came from Germany. Rodbertus took up the threads left by Hodgkin in England. He developed the theory of Ricardo that labour produces all value, and by so doing prepared the ground for the revolutionary economic theories to be formulated later on by Karl Marx. Analysing the past and present, Rodbertus predicted the coming of what he called the "Christian Social Era", when land and capital will cease to be private property, and will belong to the user for the benefit of the community.

Ferdinand Lassalle followed Rodbertus as the leader of Socialist thought in Germany. He attacked capitalism with weapons supplied by Adam Smith, the father of classical political economy. The latter had expounded doctrines which served as the foundation for the infamous "Iron Law of Wages", invented for the exigencies of capitalist production. Lassalle pointed out that the "Iron Law of Wages" kept the workers perpetually on the subsistence level. The implication of the law is that there is a limit to the increase of wages. This law, therefore, exposes the impracticability of all the schemes for reforming capitalism. Such being the case, the condition of the

workers cannot be improved under capitalism, which, therefore, must be abolished in order to reorganise society as the home for a really civilised, free human race.

But Socialism still remained a utopia. Even after finding that the social problems created by modern civilisation demanded a revolutionary solution, Lassalle failed to advocate that solution boldly. He suggested that the reorganisation of society should take place with credits supplied by the State. What should that State be, which would usher in the Kingdom of Heaven on earth? Lassalle did not answer the question.

The defect of Socialist thought up to the time of Lassalle was its subjective nature. People, horrified at the evils of the early capitalist exploitation, called for some remedy. The imaginative workers dreamt of an order of justice and brotherhood. Capitalism was criticised for its inequities, or denounced as an immoral system. But ignorance about its genesis prevailed, and its historic role was not appreciated. The exploited workers were the objects of pity. They were to be led into some ideal paradise by benevolent prophets, mostly hailing from the upper classes.

But the dignity of labour could be really appreciated only by associating it with the creative genius of man. It was not a matter of the poor workers having their share. It was a question of man coming to his own.

XXI

Karl Marx and Friedrich Engels entirely changed the character of Socialism. It ceased to be a utopia, and became a science, also a comprehensive system of human thought. It was no longer the figment of some imaginative brain. It was the mission of an entire class. Marx and Engels were not carried away by the ugly symptoms of capitalism. They applied themselves to the study of its nature. The result of this study was the discovery that capitalism was not an immoral system devised by a few perverse individuals working against the "just" laws of nature and the goodness in man. It is an inevitable stage of social development and, as such, makes valuable contributions to the progress of mankind. Its contributions consist in the development of

technology which lays down the foundation of a really civilised society—a voluntary association of free men, all occupied with productive and creative pursuits. Like every other stage in the progress of social evolution, capitalism also is not permanent. In course of time, it plays out its progressive role and becomes an obstacle to any further development of society. At that stage, its overthrow becomes a social necessity. The germs of its destruction grow in its own womb. The development of technology carries the collective performance of labour to the extreme. Thus, it destroys the moral as well as economic foundations of private property. One of the revolutionary significances of modern machine is that by eliminating the primitive method of performing labour individually, it disrupts the economic justification of private property. As the potent agency for abolishing private property, the mechanical means of production herald the collective ownership of themselves. In this sense the foundation of Socialism is laid by capitalism.

INEVITABLE RISE OF THE PROLETARIAT

Capitalism creates its own grave-digger, in the new class of the proletariat, completely expropriated and engaged in fully socialised production. A new social order, based upon the common ownership of the means of production, is not a utopia. It is inevitable, just as the rise of capitalism was also inevitable.

Private property originated with the claim of the individual to the product of his labour, performed with tools made also by himself. Tools having attained the stage of development, when they no longer can be made by individuals or manipulated by individuals, their private ownership can be maintained only through violence—through the expropriation of their collective producers. With such highly developed tools, production ceases to be individual. Modern machine is the most effective emblem of unity. It unites men on the most essential and intimate plane of their existence, namely, on the plane of creativeness. Creation is the justification for ownership. Collective creation, therefore, lays down the foundation for collective ownership. With the establishment of collective ownership, all reasons for discord and disharmony disappear, and society enters into a period of peaceful development. That will be possible only upon the establishment of

Socialism, which is nothing more or nothing less than the collective ownership of the collective creation of mankind.

The basic principles of Socialism, and the cardinal points of the programme of the Socialist movement, were formulated in the Communist Manifesto, written by Marx and Engels, and published in 1848. That document contains the quintessence of the teachings of the founders of scientific revolutionary Socialism. Scientific Socialism is revolutionary, because everything scientific is revolutionary. Science is the most powerful weapon of revolution.

Originally, Marx and Engels preferred the term Communism, in order to distinguish their views from the reformist doctrines and utopian dreams that passed as Socialism at that time. Eventually, the theories as formulated by them and the programme as elaborated by them came to be known as the most authoritative school of Socialism.

MARXIAN SOCIALISM

Marxian Socialism is not an arbitrary economic doctrine, nor is it a bundle of social dogmas. It is a complete and comprehensive system of philosophy, science, economics and politics. In short, it is a revolutionary conception of life in all its branches. It is the ideology of a truly civilised society. It has been made possible by the accumulated store of human knowledge acquired in course of man's age-long struggle against nature. It sets forth the picture of a society to be created by really free and really enlightened human beings. It opens up before mankind the perspective of an endless development. It brings eternity and immortality within the comprehension of mortal men.

An exhaustive scientific investigation of the entire human history led Marx to the conclusion that "it is not the consciousness of man that determines his being, but it is his being that determines his consciousness". This is a revolutionary view which throws an entirely new light upon the past, present and future of humanity. This is the basic principle of the philosophy of historical materialism which is the foundation of scientific Socialism.

The history of civilisation is the history of two struggles carried on two fronts : a struggle against nature, and a struggle for the benefit derived from the successes in the former struggle. The physical history

of mankind is the history of the struggle against nature. The social history of mankind is the history of class struggle, that is, the struggle of the majority of a community against the minority, which, thanks to the position of power fortuitously acquired, tries to monopolise the results of the creations of collective labour. Since the establishment of private property, society has been split into two antagonistic classes. In the ancient world, there were the slaves and their owners ; in the Middle Ages, feudal lords and serfs ; in the modern world, capitalists and the proletariat. So, in the struggle for social liberation, mankind must look ahead ; there is no hope in the past. Because, it cannot retrace its steps to a position where there will be no class struggle, unless it is prepared to go beyond social existence itself. The cure for the evils of the capitalist civilisation are not to be found in a return to savagery. If man had the power to advance from savagery to civilisation, today he has immensely greater power to advance from capitalist civilisation to a real civilisation.

By virtue of the ownership of all the means of production, the capitalists appropriate the entire new value created by labour, the worker being left only what is necessary for his subsistence and reproduction. With the development of industrial technique, the basis of capitalist ownership narrows down. It tends to be concentrated in fewer and fewer hands. That accentuates the contradictions inherent in the system, and the class struggle sharpens in consequence.

ANTAGONISM OF CLASSES

The birth of capitalism coincides with the birth of the proletariat. The triumph of capitalism aggravates the antagonism of classes. Being a system of production for exchange, capitalist economy is chaotic. It cannot be planned, because uncertainty of the relation between supply and demand is the very condition for competition, which is one of the fundamental principles of capitalism. Thanks to its own chaotic nature, capitalist production is overtaken by periodical crises. Over-production coincides with under-consumption. There is want in the midst of plenty. Continuous technological developments increase productivity to such a degree that, in order to create demands necessary for the sale of commodities at a profit, industrial plants are

kept idle for a major part of the time. On the other hand, larger and larger amounts of commodities, again thanks to technological development, can be produced with a smaller and smaller amount of labour. The two factors taken together create mass unemployment which gradually becomes a chronic disease, eating into the very vitals of the social organism. The glorious heritage of humanity, the epoch-making conquests of man, the greatest monuments of civilisation built by human labour performed through centuries,—all these are threatened with destruction. The root-cause of all evils is the monopolist private ownership of the powerful agency of human liberation and human progress, created by the collective labour of men. Those who claim the ownership of the machine have not created it. Their ownership is based upon the violent act of expropriation. The situation calls for the expropriation of the expropriator. Otherwise, human society will fall into ruins, and mankind will be deprived of a glorious future, the power to build which belongs to it by virtue of having laid the foundation in the form of the omnipotent god of the modern machine.

