PREFACE

The Tata Institute of Fundamental Research was formally inaugurated on December 19, 1945 in a portion of a building known as 'Kenilworth', at Pedder Road. However, the activities of the Institute soon expanded both in scope and magnitude until the 6,000 square feet of usable floor space in this building was no longer adequate. In 1948 the activities of the Institute were moved to a portion of the building vacated by the Royal Bombay Yacht Club at Apollo Pier Road. Although the area then available was 35,000 square feet, even this six-fold increase in space proved inadequate very soon and the Institute, so to say, began bursting at its seams. After a careful search, a suitable plot for the Institute's permanent buildings was located at Colaba in 1951 on land belonging to the Government of India. The foundation-stone of the Institute's new building was laid at this site by the Prime Minister on January 1, 1954.

While the building was under construction, the needs of the Institute kept growing, necessitating the occupation of various portions of the building as they were completed. New additions to the building, involving principally the construction of an auditorium and a museum, are already in hand; but an important phase of construction may be considered to have been completed by the end of 1961. To mark this important stage in the history of the Institute, a function was arranged at which the new building was formally inaugurated by the Prime Minister, Shri Jawaharlal Nehru, on January 15, 1962 before a large and distinguished gathering. This souvenir is intended to commemorate that landmark in the history of the Tata Institute of Fundamental Research.

HOMI J. BHABHA

Director

The Tata Institute of Fundamental Research

Inauguration of New Buildings

Bombay . January 15, 1962

TATA INSTITUTE OF FUNDAMENTAL RESEARCH

FORMAL OPENING OF THE NEW BUILDINGS BY

THE PRIME MINISTER

January 15, 1962

PROGRAMME

4.45 The Governor of Maharashtra

4.50 Shri J. R. D. Tata, Chairman of the Council

5.00 The Chief Minister of Maharashtra

5.10 Dr. H. J. Bhabha, F. R. S., Director of the Institute

5.35 THE PRIME MINISTER

6.00 Refreshments

6.10 The Prime Minister leaves

Portions of the buildings, and selected laboratories and equipment will be on view to the guests after the Prime Minister leaves

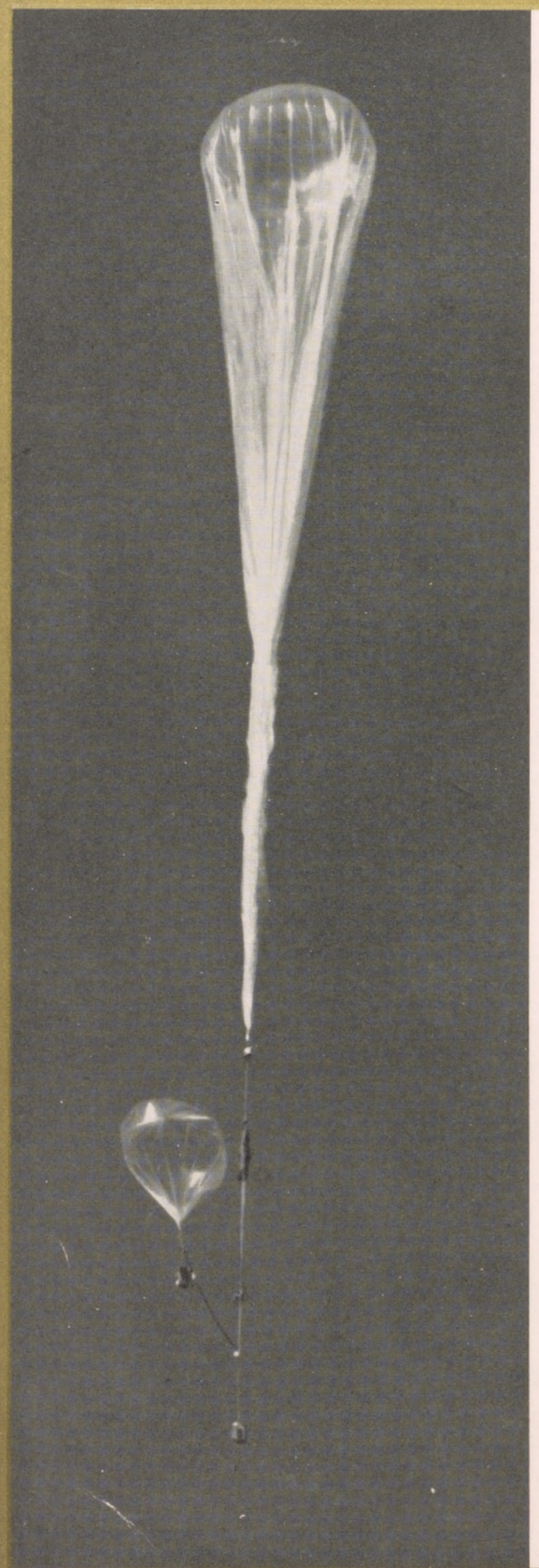
The Naval Band will be in attendance by courtesy of the Indian Navy

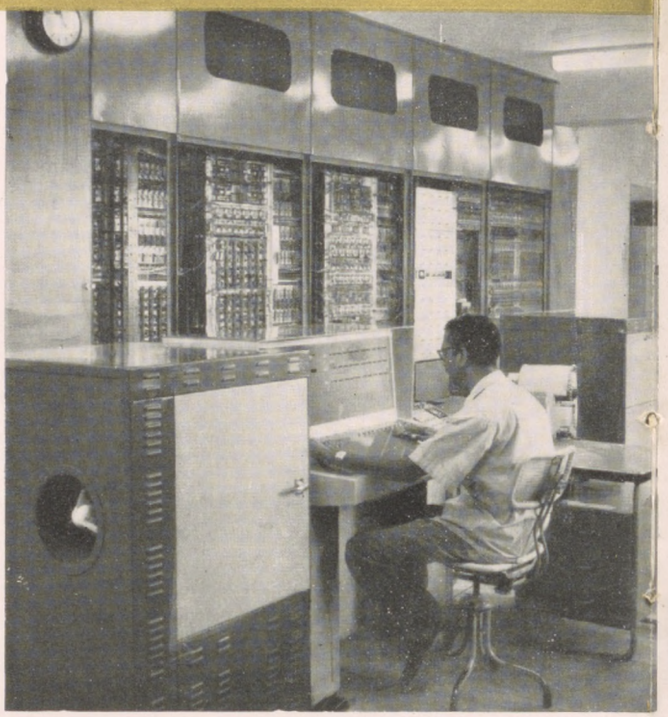
ARCHITECTS AND ENGINEERS

Architects	Holabird and Root, Chicago, U.S.A.
Associate Architects	Master, Sathe & Bhuta, Bombay upto 13-3-1956 G. M. Bhuta & Associates, Bombay from 1-4-1956
R. C. C. Specialist	Shri K. V. Kini, Bombay
Building Project Officers	Shri S. H. Mehta upto 31-7-1958 Shri S. A. Kikkeri from 20-10-1957

CONTRACTORS

Principal Contractor	Shapoorji Pallonji & Co. Pvt. Ltd., Bombay
Airconditioning	Voltas Ltd., Bombay
Aluminium windows and louvres ..	Godrej & Boyce Mfg. Co. Pvt. Ltd., Bombay
Plumbing	B. Bamboat & Co. Pvt. Ltd., Bombay
Lifts	Otis Elevator Co. (India) Ltd., Bombay
Structural works	Structural Engineering Works, Bombay
Marble setting and terrazzo ..	R. Lorenzoni Pvt. Ltd.
Painting	Kapadia Brothers, Bombay
Electric installation and fixtures ..	Bombay Electric Supply & Transport Undertaking, Bombay Phillips India Ltd., Bombay Engineering Enterprises Pvt. Ltd., Bombay Glolite Electricals, Bombay
nal roads	Bombay Construction & Engg. Co. Pvt. Ltd.

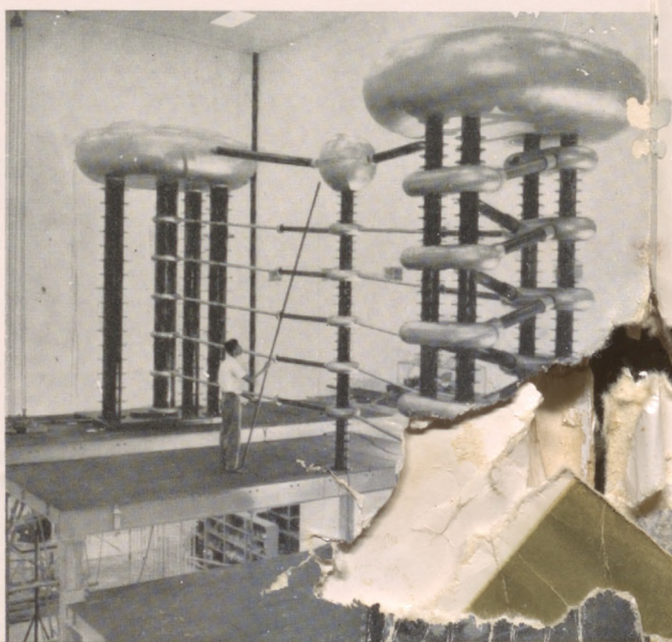




Digital Electronic Computer,
designed and built at the Institute

Plastic Balloon, 200 feet long, fabricated at the Institute for research upto altitudes of 1,10,000 feet

One Million Volt Particle Accelerator



feet

Sketches by Helmuth Bartsch
Photographs by R. R. Bharadwaj and B. D. Upadhyay

Kenilworth—the building where the Institute was first started in Bombay

The old buildings of the Royal Bombay Yacht Club

The Inauguration

Shri Sri Prakasa—*Governor of Maharashtra*

FRIENDS :

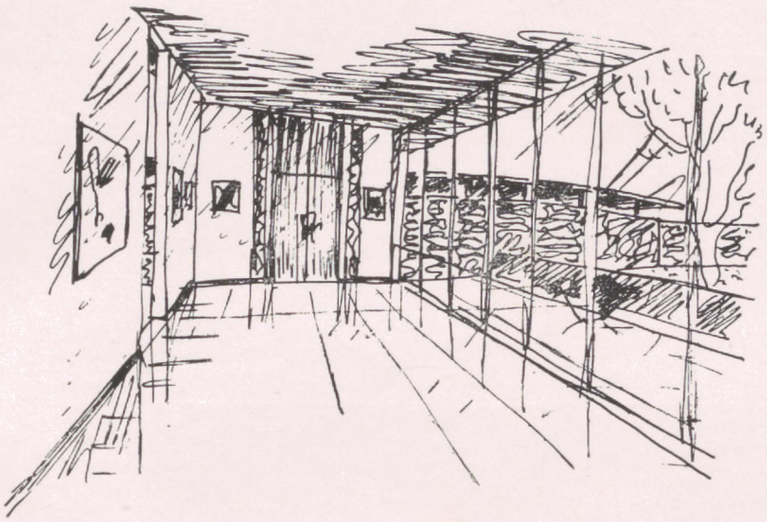
We are all assembled here to partake of the very pleasant opening ceremony of these new and magnificent buildings of the Tata Institute of Fundamental Research. We are happy that after eight years and fourteen days of hard work they are ready at last. Allow me to offer my felicitations to all concerned on their achievement. On behalf of us all I also extend our grateful thanks to our Prime Minister for the honour he has done us by coming in person to inaugurate them.

I must confess I feel I am a total misfit for the task that has been assigned to me. Eleven years ago, the Prime Minister invited me to take charge of the then newly created portfolio in the Central Government called the Ministry of Natural Resources and Scientific Research. Knowing nothing of either I naturally felt very nervous and confused. I remember that soon afterwards I was invited by Dr. Bhabha to preside over a seminar he was holding at Poona on various facets of scientific research. When I saw the array of great scientists in front of me, I was totally bewildered. My father had always told me that just as honesty was the best policy, frankness was the deepest diplomacy and so both for the expression of my sentiments and the edification of the assemblage, I recalled an old story. It was said that when Lord Goschen became the First Lord of the Admiralty of the British Government of the day, some wit remarked that "Goschen had no notion of the motion of the ocean" and still came to this high sounding office. I told my audience that so far as science was concerned, that was

exactly my position. I must say that Dr. Bhabha and other eminent scientists of the land were most kind and considerate and they thus enabled me to retain safely both my portfolio and my ignorance.

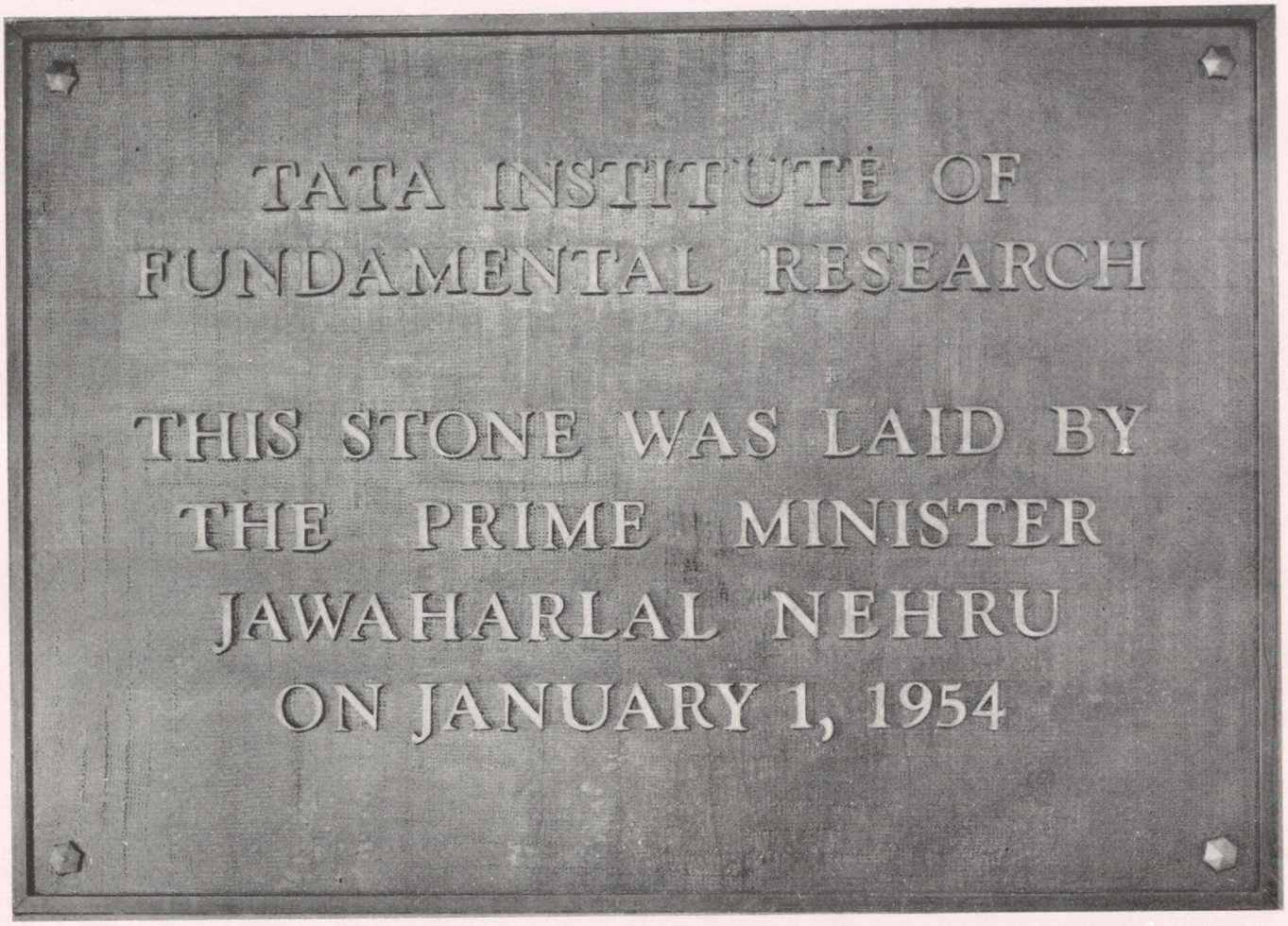
When again today the same Dr. Bhabha invites me to preside over this function, I am reminded of my old predicament. My task, however, has been rendered easy by my being asked to come here as what may be called a constitutional chairman. Knowing from fairly long experience what a constitutional Governor means I do not think I should fail even as a constitutional chairman. But before I give myself the pleasure of calling on the various speakers, I should like to pay my tribute of admiration and gratitude to the great House of Tatas for all that they have done during the last three generations for the progress and advancement of the country in diverse departments of its national life. They have been the great pioneers in the evolution of our industry and commerce, our science and technology and have given freely to all good causes. Many a medical, educational, social service and other public institution owes its existence and its development to their generous munificence. It will be long before the country will be able to pay the debt of gratitude that she owes to these her noble and patriotic sons. Even in distant Banaras, or Varanasi as it is now called—or Kashi as we love to know it—I had heard of the Tatas since early days. As a boy of 12 or 13, I recall the visit of the great scientist Sir William Ramsey to the Central Hindu School and College where I was studying. He came at the invitation of our Principal, Dr. Arthur Richardson, who had been his pupil before, and gave a lecture on something that I did not understand. But I believe Banaras saw the coming wonders of electricity for the first time on this occasion. I was then told that Sir William Ramsey had come to India at the invitation of the great Jamsetjee Tata to look round and suggest the best place for an institute for scientific research. This was later established in Bangalore, I understand on the advice of the great scientist, and is known to the world as the Indian Institute of Science. The successors of Jamsetjee Tata, generation after generation, are maintaining his great traditions, and we have all reason to be grateful to them for doing so. The story of this institution is a simple one, and can be soon told.

In 1943, when Dr. Bhabha was a professor at the Bangalore Institute—and our Prime Minister curiously enough was passing his days and nights in the Ahmednagar Fort not too far away, laying the foundations of freedom that was to follow within four years—the idea came to



Dr. Bhabha that it would be good to have a top-rate institute for research in the most advanced branches of physics, and when Mr. J. R. D. Tata, the worthy scion of the great House, heard of this he felt that the famous Sir Dorab Tata Trust and Sir Ratan Tata Trust would surely help in implementing the suggestion ; and thus this Tata Institute of Fundamental Research came into existence with the ready assistance of the then Government of Bombay. The Government of India then came prominently into the picture, and this is now our national centre for nuclear science and mathematics. It enjoys an international reputation and has won such recognition that outstanding scientists from other lands come to us to work here. It is a matter of great gratification to us that we have present here with us today scientists and mathematicians from Australia, France, the United Kingdom, the United States of America and the Union of Soviet Socialist Republics who have all come to assist at this ceremony and later to deliver lectures to us on their own very special and important subjects. I extend to them on your behalf and my own a most warm and cordial welcome.

May I now request Mr. J. R. D. Tata, the Chairman of the Council of the Institute to address us, and tell us more of the Institute than I can be expected to do?



Shri J. R. D. Tata – *Chairman of the Council*

MR. PRIME MINISTER, SHRI SRI PRAKASA, SHRI CHAVAN, LADIES AND GENTLEMEN:

As Chairman of the Council of this Institute, it is my privilege and deep pleasure to welcome you all here today and to thank you for responding to our invitation. I am particularly happy to welcome the Prime Minister, the Governor and the Chief Minister of our State and to thank them for their participation in this function. I am also happy to welcome Mr. Krishna Menon, to whose Ministry we are indebted for the release of this fine plot of land which used to be in their possession. Many of those present were on this very site, eight years and fourteen days ago, when you, Mr. Prime Minister, were good enough to lay the foundation stone of this set of buildings and laboratories which are to be inaugurated and, so to

speak, consecrated this afternoon. We are grateful for your presence then; we are even more grateful and happy for it today, for in the intervening years you have given constantly renewed proof of your sustained interest and that of your Government in the work done here; an interest without which the Institute could never have grown to its present stature of one of the world's leading centres of fundamental research.

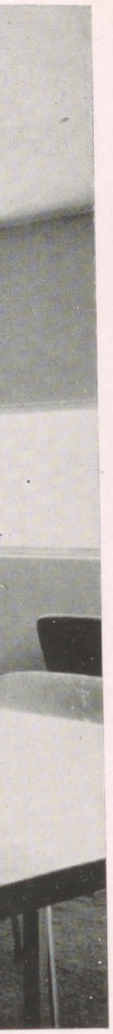
Tall oaks do not from all little acorns grow, but if this acorn planted some seventeen years ago, is now such a tall and sturdy oak, it is mainly because of the encouragement and generous financial support it has received from the Government of India, thanks to you, Sir. For that we are deeply grateful, as we are also to the Government of Maharashtra and its predecessor, the Government of Bombay, who joined Tatas from the very beginning as co-sponsors of the Institute and have borne their share of the burden ever since.

While this Institute has benefited much from the generous support it has received and from the large funds placed at its disposal by the Central Government over the years, I venture to claim, on its behalf, that the services it has rendered to Indian science, and to the country as a whole, have been fully commensurate with the effort and funds lavished on it. In thanking, therefore, the Government of India, the Government of Maharashtra and the Tata Trusts for their sponsorship and support of this Institute, I hope I may, at the same time, congratulate them on the excellence of their judgement in making such a sound and rewarding national investment!

I shall leave it to Dr. Bhabha to describe or evaluate the scientific work done in this Institute. To most of us the world of pure science, and particularly that of higher mathematics and theoretical physics, is a totally alien one—far beyond our ken or comprehension; but, although some may deplore it, we do vaguely realise that our present civilisation is being increasingly moulded by the headlong advance of science and technology; that abstract scientific theories of today may well become practical realities of tomorrow, and that in our own country the vast programme of development on which we have embarked under the Prime Minister's leadership cannot succeed if we do not keep pace with the march of science and technology in other countries.

It is, in passing, of interest to note that, as far back as a century ago, at a time when most of today's scientific knowledge did not exist, Jamsetjee Tata, almost prophetically, saw clearly the need for Indians to become

The Council Roon



science and technology minded as a prerequisite to their achieving political freedom and economic progress. There has been, happily, a striking thread of continuity linking Jamsetjee's dream of yesterday to the reality of today, for it was Jamsetjee who founded the Institute of Science in Bangalore. It was there that Dr. Bhabha undertook his first scientific work in India, and it was to continue and expand this valuable work that the Tata Trusts and the Government of Bombay jointly formed this Institute.

We are all aware of the immense progress India has made in science and technology since the days of Jamsetjee Tata, and particularly since independence, thanks again to our Prime Minister's vision and understanding. Only a few amongst us, however, realise that in the specialised fields of mathematics and theoretical physics, on which are being laid the foundations of the new atomic age in which we shall soon all live happily—unless we are all blown up before that—the major part of the work done in India has been centred in this Institute. While the Institute has contributed substantially to the world's pool of knowledge in the fields of high energy physics and mathematics, in my view its greatest value to India has lain in the training, the opportunities for further study and experimentation, and the inspiration it has provided to a host of promising and enthusiastic young scientists, most of whom are today playing a vital part in the development in India of the use of nuclear energy for peaceful purposes.

Before I make way for the more important speakers on the programme, I would be failing in my duty as well as depriving myself of much pleasure if I omitted to take this opportunity to say something about the part Dr. Homi Bhabha has played in the establishment and development not only of this Institute but of India's progress in the field of nuclear science and atomic energy.

Scientist, engineer, artist, builder and organiser extraordinary, Dr. Bhabha is perhaps still too young to be referred to as the father of Indian atomics, but whether he likes it or not, there is no doubt whatever that that is how he will be known in the future, for, to the best of my knowledge, every single programme of research and development in the field of nuclear science and atomic energy undertaken up to now in India, has in some way or another been his personal baby.

Like almost all great mathematicians and theoretical physicists, Dr. Bhabha achieved international recognition at an early age. If he had chosen to

remain in foreign lands and continued to devote his creative genius to pure science, he might well have become known as one of the greatest scientific minds of the century. He chose instead to return to serve India and to apply his formidable mental powers and capacity for creative work to the task of giving India the specialised and highly rarefied disciplines and techniques necessary to harness nuclear energy for peaceful purposes. Beginning with this Institute, which he founded in a very small way in 1945 with the help of the Tata Trusts and the then Government of Bombay, Dr. Bhabha, on behalf of the Government of India, went on to create and direct the Atomic Energy Establishment at Trombay and the national atomic programme as Secretary to Government in the Department of Atomic Energy and Chairman of the Atomic Energy Commission. To him goes the major credit for the almost incredible progress that India has, in a very few years, made in the field of atomics and the stature she has acquired in the world. I do not wish to embarrass Dr. Bhabha any further, but it is right that, on this occasion, we should pay tribute to him and recognise the immense contribution he has made and still continues to make to India's scientific and industrial progress.

Before I conclude, and as memories are sometimes short, I should like to mention one other man who did much in his time for the development of Indian scientific resources in general and for this Institute in particular. I refer to the late Dr. Shanti Swarup Bhatnagar. Just as Dr. Bhabha has been primarily responsible for all developments in India in nuclear science and atomic energy, Dr. Bhatnagar was the moving spirit in the establishment of the great chain of national laboratories set up by the Council of Scientific and Industrial Research under the leadership, again, of our Prime Minister. Dr. Bhatnagar, as Director of the Council of Scientific and Industrial Research and Secretary to Government in the Ministry of Natural Resources and Scientific Research, was a staunch supporter of the work of Dr. Bhabha in this Institute, and we honour his memory for the part he played in our development.

Before I sit down I would like, with your permission Mr. Chairman, to read a very fine message which has been sent to us from Professor Niels Bohr, perhaps the greatest name in physics in the world today. We had hoped that Professor Niels Bohr might have been present today and in fact we know that he had made a very special effort to free himself from previous engagements to come all the way to Bombay. Not being able to do so, he sent us a message, which I shall read:

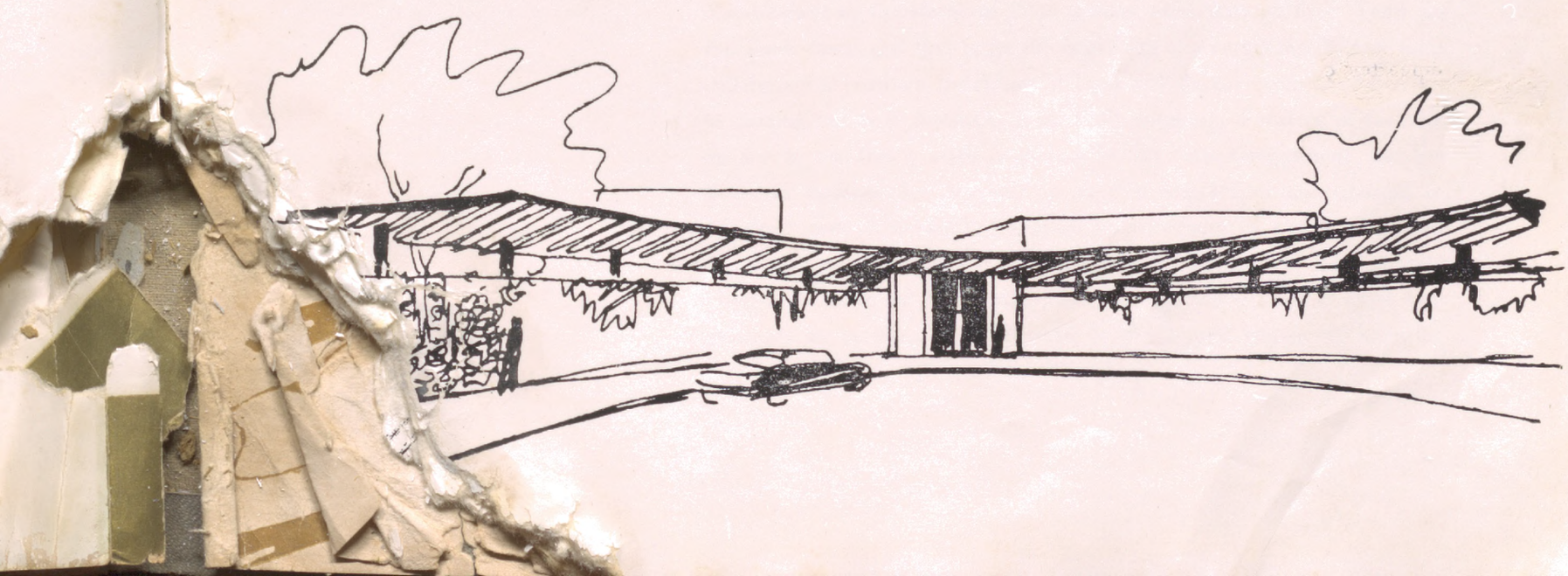
"To my deep regret urgent obligations in Copenhagen have made it impossible for me to accept the invitation to attend the inauguration of the new buildings of the Tata Institute of Fundamental Research. I welcome, however, the opportunity of conveying through Dr. Peters the heartiest felicitations from the whole group of physicists working in Copenhagen.

"For long times we have here in Denmark benefited from co-operation with Indian scientists and especially enjoyed the close personal connection with Dr. Bhabha, to whose foresight and initiative the creation and success of the Tata Institute is primarily indebted, and in whom we equally admire the physicist contributing to the elucidation of fundamental features of the constitution of matter and the artist so deeply interested in all aspects of human cultures.

"I wish to express the warmest wishes that the work at the Tata Institute and other similar institutions growing up in your great country will contribute to the welfare of the Indian people and stimulate that world-wide co-operation in science which holds out such great promises for promotion of understanding and confidence between all nations.

Niels Bohr"

May I welcome you all once again and thank you very much for your presence and encouragement!



Shri Y. B. Chavan – *Chief Minister of Maharashtra*

MR. CHAIRMAN, MR. PRIME MINISTER, MR. TATA, DR. BHABHA AND FRIENDS:

Seventeen years ago, a joint effort between the House of Tatas and the then Government of Bombay started some very new work of very great significance in the city of Bombay. The then Government of Bombay was thinking of developing an institute of higher studies in the newly advanced science of physics and it called upon Dr. Bhabha to take the chair. But the Government of Bombay found that Dr. Bhabha had already made a commitment to the House of Tatas to start work through their Trust on the same lines, and thus came the beginning of a very fine effort of joint collaboration between the House of Tatas and the Government of Bombay in starting this new Institute. It is, truly speaking, a matter of pleasure for me to see that a small beginning by the State Government and the Trust in Bombay has resulted in such a magnificent contribution to advanced study in the field of science. It is because of the beginning of this Institute in Bombay, I think, that we have the location of the Atomic Energy Establishment at Trombay, and through the location of these two institutes in Bombay, Bombay today is the biggest centre of scientific

activity in the country. I am told hundreds of scientists—when I say hundreds, I literally mean hundreds—hundreds of scientists are functioning in the city of Bombay in these two establishments, thus making Bombay, which is popularly known only as an industrial centre in the country, a great centre of learning in the scientific field. Mr. Tata just now referred to the advance of technical and scientific developments in the world, but the great thing that has happened in the last ten to twelve years for our country is that our own participation in this great effort has created a new sense of confidence in our people. These new researches, discoveries and inventions sometimes succeed in creating only awe in the minds of the people who do not participate in them. But the important post-independence era of our country has succeeded in changing the face of the country in different directions. And this is a very fundamental change that our country has experienced, which has succeeded in changing the outlook of people by participation in this new work of pursuing higher studies in advanced branches of science, and of doing research.

The East Canteen and the Central Workshop. The high building at the back houses the cascade generator

The Building from the south, with the power house and the air-conditioning plant on the right

Sir, by your presence today, you have certainly recognised the services of the Tata Institute of Fundamental Research, and particularly, as Mr. Tata has stated, the contribution made by Dr. Bhabha in this particular field. As a matter of fact, we all feel here that there are not only two institutions functioning here—the Tata Institute of Fundamental Research and the Atomic Energy Establishment—but that Dr. Bhabha himself is an institution. We feel that we have got three institutions functioning in Bombay and we are very proud of the whole thing. As a matter of fact, the State Government, though it has made a very humble contribution to this effort, is certainly proud of having taken a decision at a very proper time because this Institute started functioning before the chain of national laboratories in the country started. Thus, we have a little satisfaction at having made a pioneering effort in the right direction. I welcome you, Sir, on behalf of the Government of Maharashtra to this very significant function and request you to address the gathering.

The lobby

Dr. H. J. Bhabha – *Director of the Institute*

MR. CHAIRMAN, MR. PRIME MINISTER, MR. CHIEF MINISTER, MR. TATA, LADIES AND GENTLEMEN:

The Tata Institute of Fundamental Research started its work in June 1945. It is therefore the oldest of our post-war national laboratories. And yet it is only today, 16½ years later, that its own buildings are being inaugurated by the Prime Minister. This fact alone shows that the manner in which this Institute has been built up is different from that of the other national laboratories, where attention was first directed towards providing them with a building. There are, however, a number of other differences in approach also. I would therefore like to take a few minutes to recapitulate the history of this Institute and the manner in which it has grown.

While I was still working as a professor at the Indian Institute of Science in Bangalore during the Second World War, I noted that there was no scientific institution in India devoted solely to fundamental research, especially in the newest branches of physics, namely, nuclear physics and high energy physics. By fundamental research I mean basic investigations into the behaviour and structure of the physical world without any consideration of their utility or whether the knowledge so acquired would ever be of any practical value. Nevertheless, the support of such research, and of an institution where such research can be carried out effectively, is of great importance to society for two reasons. First of all, and paradoxically, it has an immediate use in that it helps to train and develop, in a manner in which no other mental discipline can, young men of the highest intellectual calibre in a society into people who can think about and analyse problems with a freshness of outlook and originality which is not generally found. Such men are of the greatest value to society, as experience in the last war showed, for many of the applications of

science, which were crucial to the outcome of the war, were developed by men who, before the war, were devoting their time to the pursuit of scientific knowledge for its own sake. Radar and atomic energy are two examples of fields in which a vast body of established basic knowledge was developed into technology of immense practical importance, largely through the application in war time of the efforts of those who might be called 'pure' scientists.

Secondly, the history of science has shown that "there is no genuine knowledge of the universe that is not potentially useful for man, not merely in the sense that action may one day be taken on it, but also in the fact that every new knowledge necessarily affects the way in which we hold all the rest of our stock".

Accordingly, in a letter dated the 19th August 1943 to Shri J. R. D. Tata, I pointed out that "the lack of proper conditions and intelligent financial support hampers the development of science in India at the pace which the talent in the country would warrant", and suggested that the Tata Trusts might consider taking the initiative in setting up an institute for fundamental research. In his reply of the 2nd September 1943 to me, Shri J. R. D. Tata wrote: "from what you say in your letter, it is evident that there is scope for rendering valuable service to the country and to the cause of scientific research in India ..... After all, the advance of science is one of the fundamental objects for which most of the Tata Trusts were founded, ... If they are shown that they can give still more valuable help in a new way, I am quite sure that they will give it their most serious consideration". The Trustees of the Sir Dorabji Tata Trust decided to accept financial responsibility for supporting the Institute at a meeting held on the 14th April 1944. I think it should be recalled on this occasion that this decision was taken more than a year before the explosion of the first atomic bomb over Hiroshima and before nuclear physics had become what might be called "the band-wagon" of science.

The location of the Institute in Bombay was decided largely because of the interest of the then Government of Bombay, which was anxious to build up a strong department of physics at the Institute of Science, and which had invited me to undertake this task. As I was already committed to starting an institute of fundamental research I suggested that the Bombay Government might co-operate with the Tata Trust in the founding of this Institute. Thus it came about that the Institute was founded as a joint endeavour of the Sir Dorabji Tata Trust and the then Government of Bombay in 1945.

Next year the Council of Scientific and Industrial Research of the Government of India, under the presidentship of Sir Ardeshir Dalal, and with the enthusiastic support of its Secretary, my distinguished colleague, the late Dr. S. S. Bhatnagar, decided to give a grant to the Institute for the year 1946-47. The subsequent development of the Institute to its present proportions is due to the great interest and powerful support of the Government of India.

The Atomic Energy Commission of the Government of India was first established in 1948, and one of its immediate problems was the shortage of trained scientific personnel in its field. It was therefore natural that the Commission should turn to the Institute for training personnel for its work, and for carrying out some of its own major projects. These early projects were carried out by joint teams belonging to the Institute and to the Physics Division of the Atomic Energy Commission, which was then housed in the Institute's premises and looked after administratively by the Institute. The Commission, on its part, gave substantial help to the Institute by providing funds for increasing its activities and for specialised equipment for nuclear research.

One of the first activities undertaken by the Institute for the Commission was the setting up of a small electronics group to design and build the electronic instruments without which atomic energy work is impossible. This group was the nucleus from which grew the present Electronics Division of the Atomic Energy Establishment at Trombay with a staff of over 560 people, and which is now producing not only most of the electronics instrumentation used at Trombay, including the control systems of reactors, but also that which will be used all over the country in agricultural, biological, industrial, and medical work with radioactive materials. The Institute has given some 46 members of its scientific staff to man various divisions of the Atomic Energy Establishment at Trombay, to mention only two, Shri A. S. Rao, Head of the Electronics and Health Physics Group, and Dr. R. Ramanna, Head of the Physics Group. There was a time when no less than 175 members of the staff of the Trombay Establishment were looked after by the Institute. It is also appropriate to recall on this occasion that the control system of Apsara, the first reactor in Asia, was built under the auspices of this Institute in a war time hutment on this very site, and many parts of the reactor in the Institute's workshop. It is not an exaggeration to say that this Institute was the cradle of our atomic energy programme, and if the Atomic Energy

Establishment at Trombay has been able to develop so fast, it is due to the assisted take-off which was given to it by the Institute in the early stages of its development. It is equally true to say that the Institute could not have developed to its present size and importance, but for the support it has received from the Government of India.

By 1955 it had become clear that the Government of India's interest in the work of the Institute was of a permanent nature. Considering it "to be in the interests of the country to maintain a high level academic institution where study, search for knowledge and scientific research shall be pursued for the purpose of increasing man's knowledge of nature without considerations of practical utility", the Government of India signed a new Tripartite Agreement with the Government of Bombay and the Sir Dorabji Tata Trust, as a result of which the Institute came to be recognised as the National Centre of the Government of India for advanced study and fundamental research in nuclear science and mathematics. Thanks to the steady support which the Institute has always received from the Prime Minister at various important stages of its development, it has now become one of the largest and most important of our national laboratories.

The Institute started in a modest way during war time in half a hired house called Kenilworth, at 53 Pedder Road, with a total floor space of 6,000 square feet. By the end of 1949 its activities had grown to such an extent that an area of some 35,000 square feet was leased in the premises formerly occupied by the Royal Bombay Yacht Club. Our new building has an area of some 256,000 square feet, and the only elbow room left for future expansion is a little space on the top floor.

In planning the buildings of the Institute, the Council took the view that the latest and the best ideas in laboratory design should be incorporated, and accordingly a noted American firm of architects with considerable experience of tropical building, namely, Messrs. Holabird & Root of Chicago, were commissioned to design these buildings. I would like to say on this occasion how happy we are with the result, and to express our appreciation of the personal interest taken in it by the principal architect, Mr. Helmuth Bartsch. They have done a truly fine piece of work, as you can judge for yourselves. A building of this complexity and quality is due to the combined effort of many people, and on behalf of the Institute I would like to thank all of them. I must, however, mention particularly the principal contractors, Messrs Shapoorji Pallonji & Co. Pvt. Ltd., who have done a magnificent job. I would also mention the Building Project Officer,

The entrance, with the stairs leading to the Reading Room

The lounge

Shri S. A. Kikkeri, for the devoted and hard work he has put in. The Foundation Stone of the building was laid by the Prime Minister on the 1st of January 1954, and a plaque at the entrance in the corner of the building commemorates the event. It is only appropriate that the building should be inaugurated by the Prime Minister today. For it is thanks to his personal interest and strong support of science in India, and of this Institute in particular, that we have such an ideal place to work in. This building has taken so long to construct because we had to do a lot of pioneering in the course of it, pioneering which has resulted in permanent benefit to the country. For example, the aluminium companies in India were induced to extrude special sections for windows and doors in a rustless alloy resistant to corrosion by the warm sea air. The well-known firm, Messrs Godrej & Boyce, imported a costly machine in order to weld and fabricate these windows. There is a whole list of other items now readily available in the Indian market which were produced for the first time.

I have spoken so far only about the supporting frame work of the Institute's activities. The building itself is only a shell to make possible the work that is done inside it. It is by the quality and volume of its scientific work that an Institute like this must be judged, by the extent to which it has helped to explore and push back the frontiers of knowledge, to open up new fields

The Library

e Library

The Reading Room

The West Canteen

of knowledge, to provide the country with men highly trained in the newest fields of scientific endeavour and able to make their own contribution to the increase of scientific knowledge, and by its general impact on the scientific life of the country as a whole. I would like to devote the rest of my speech to the scientific work of the Institute.

From its very inception the work of the Institute has been in the fields of high energy physics, cosmic rays, and mathematics. Work done since the war in many parts of the world has revealed that the ultimate structure of the physical world is not as simple as had once been thought. While matter, as we find it in normal conditions and at low energies, may be built up of two or three types of building bricks known as the elementary particles, this is no longer so at higher energies. The simple picture had already been shown to be too simple just before the beginning of the war by the discovery of a new elementary particle, the meson. Since the war the process has gone much further and a number of new elementary particles have been discovered—more than one type of meson and a number of other entities known as strange particles. The number of these basic building bricks is now about thirty. It is to some extent a matter of taste as to what one calls a different type of particle and what one considers as a different state of the same entity. The very concept of an elementary particle is something about which different views are held. There is no doubt that we have penetrated down to a deeper level of nature, which is accessible to us only through the study of the interactions of matter at very high energies. In cosmic radiation nature has given us a source of particles of the very highest energies we know, extending certainly far beyond 10^{15}, and even upto 10^{18} electron volts, i.e. upto a million billion volts and beyond. How high this energy is can be gauged from the fact that the largest accelerators at present in operation in the world, namely the one in Geneva belonging to the European Centre of Nuclear Research and the one at Brookhaven National Laboratory, provide particles of energies barely upto 30 billion volts. Particles in cosmic ray, therefore, have energies many thousands to many millions of times higher than those produced by the most powerful accelerator, and this is one of the primary reasons for the great interest in the study of cosmic rays. Indeed, most of the new elementary particles known today have been discovered through an analysis of cosmic ray phenomena, and in this line, the Institute has made significant contributions.

A method for studying phenomena at these high energies is by the use of special photographic emulsions. The technique of using stripped emulsions,

i.e. emulsions without glass backing, was developed for the first time in the world in this Institute in 1951-52. The use of these stripped emulsions directly resulted in the discovery in 1953 by the Emulsion Group of this Institute, under Professor Peters, of the K^- meson, a negatively charged particle of a mass approximately a thousand times that of the electron. It also yielded some of the first known examples of the associated production of K^- mesons and hyperons. Since then large sandwich stacks consisting of alternative layers of emulsion and tungsten sheets have been used, and one of the largest stacks in the world, consisting of plates 4 feet by 2 feet in size, was flown by the Institute here last year in collaboration with the University of Bristol. We have in this building a facility for developing the largest nuclear emulsion stacks, and there is perhaps only one other comparable facility in the world today, namely, in the University of Chicago.

To fly these large stacks and other equipment at high altitudes special techniques had to be developed. The Institute's group which has concentrated on the development of plastic balloons, after a large amount of research and development spread over a period of several years, has now perfected the manufacture of plastic balloons of a million cubic feet in volume, which are capable of carrying loads of up to 250 lbs. to altitudes of some 110,000 feet and above. The radius of the largest balloons flown so far is about 60 feet and their length about 200 feet. We are now proceeding to make still larger balloons, which will go still higher. Originally, these balloons were made of commercial polyethylene sheets, but these did not perform satisfactorily. It is generally known that the temperature of the air falls as we go up in the atmosphere. It is not so generally known, however, that the minimum temperatures reached in the tropics at an altitude of some 55,000 feet are $-85°C$ to $-95°C$, whereas the minimum temperature at any point in the atmosphere in the temperate climates is in fact higher, being $-60°C$ at a height of some 40,000 feet. The normal plastic from which our original balloons were made, while passing through these levels became brittle and splintered like glass. To meet this difficulty American balloon manufacturers have used special fabrics developed for the purpose, but till recently these were not sold outside the United States. We had, therefore, to tackle the problem ourselves and special plastic was extruded in Bombay with fine carbon powder mixed in it, so that the carbon would absorb the heat from the sun's rays and stop the plastic from freezing. At first too much carbon was mixed, and although the balloons

did not freeze, they became too hot at the highest altitudes and the plastic began to melt. It is only after a lot of experimentation that the correct technique was developed, and we now have balloons which perform with a 100% success, and are as well as, if not better than, some of the American balloons which were flown recently in collaboration with us in this country. The credit for this considerable achievement goes to Professor M. G. K. Menon and the Balloon Flight Group under him, which is one of the two largest in the world engaged in flying high altitude equipment. Balloons made here were used last year in flights made from Italy by the Bristol University in a joint European programme of cosmic ray research financed by NATO.

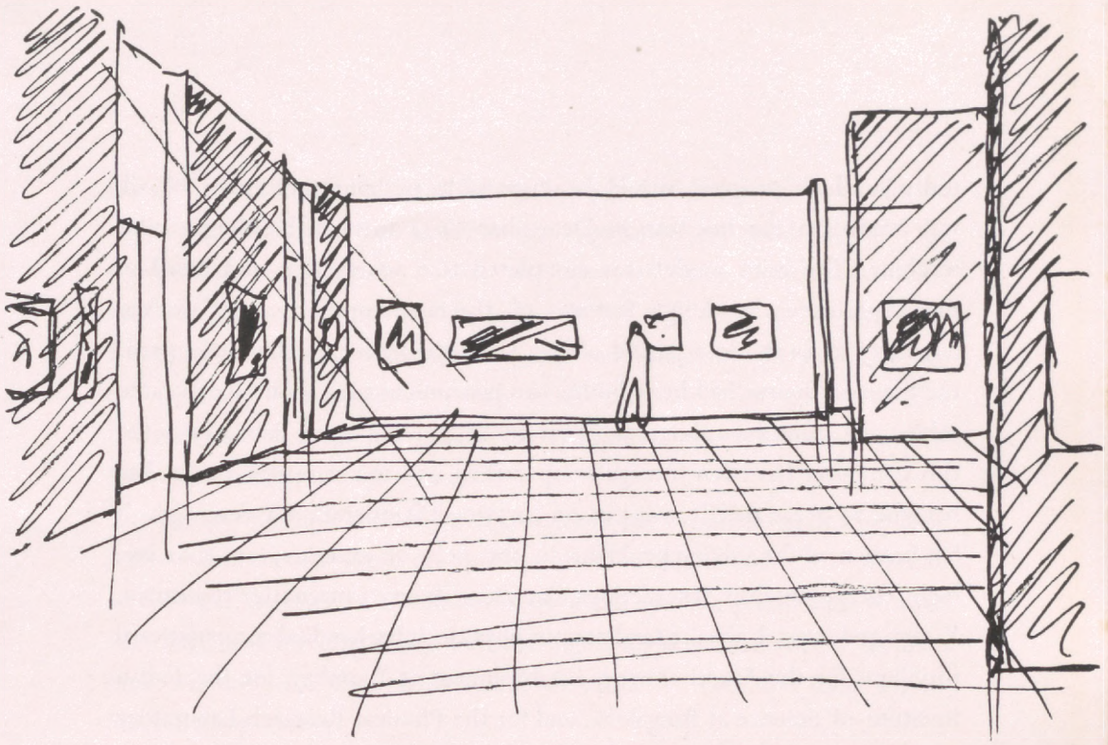
An instrument which has been of great importance in studying cosmic ray phenomena is the cloud chamber, and we have designed and have under construction a cloud chamber, which will be 2 metres wide, 1.5 metres high, and a meter in depth. This cloud chamber, weighing some $4\frac{1}{2}$ tons, will be the largest in the world. It will be operated with a device called a total absorption spectrometer, which will measure the energy of particles upto 10^{14} (hundred thousand billion) electron volts, with an accuracy of about 10%. This device, the only one of its kind in the world, has already given some important results. It has permitted the correlation of the multiplicity of very high energy collisions with the effective target mass in the collision.

A group at the Institute is engaged in the study of extensive air showers which are produced by extremely high energy cosmic rays. The equipment for measuring these events has been set up by the Institute at Ootacamund on the grounds of the Government House, through the courtesy of the then Governor of Madras who is happily with us today as the Governor of Maharashtra. In this equipment scintillation counters, each 1 square metre in area, are spread over an area of 100 metres square for sampling the electronic densities over the area. There are three mu-meson detectors, nine units for detecting nuclear interacting particles, a total absorption spectrometer of the type I have just mentioned, fifteen units for studying the cores of local showers, and finally electronic circuitry which can measure the difference in the time of arrival of different parts of the shower within time intervals of the order of a thousand millionth part of a second. This impressive array of equipment was built by Dr. Sreekantan and his group and has recently yielded a result which may have far reaching consequences in cosmology. There is an indication of a north-south

asymmetry in the arrival of primary cosmic rays with energies greater than 10^{15} (million billion electron volts), two to four times as many of these high energy cosmic rays entering the earth's atmosphere from the northern than from the southern hemisphere.

Our work in cosmic rays has led us into the field of geophysics. High energy cosmic rays entering the top of the atmosphere collide with atoms there and produce radioactive forms or isotopes of known chemical elements in very small quantities. Thus, while natural carbon is not radioactive, a variety of it, called carbon 14 and produced by cosmic rays, is radioactive and decays with a half-life of 5,600 years. In this way are produced about a dozen radioactive isotopes of known elements. In 1954, when the Geophysics Research Group at the Institute was formed, only three isotopes produced by cosmic rays in the atmosphere were known. In the following five years eight other isotopes were detected, and out of them five were discovered as a result of investigations carried out by members of the Institute, especially Professor Lal.

The life times of these cosmic ray produced isotopes vary from a few minutes to several million years. Phosphorus 33, for example, has a half-life of 25 days; sulphur 35 a half-life of 87 days; silicon 32 a half-life of 700 years; and beryllium 10 a half-life of 2.7 million years. These different isotopes can therefore be used to study geophysical phenomena, such as the nature and amount of atmospheric circulation and circulation of water in the oceans, in studies of sediments from the ocean floor and of certain regions on the ocean floor where their deposition continues undisturbed, providing a record of the occurrence of a variety of geological and oceanic phenomena in the past, such as volcanic activity, climatic conditions, the ocean's biological activity and the influx of extra-terrestrial material. Since the amount of these cosmic ray-produced isotopes is extremely small, and practically all material contains some radioactive atoms, extremely fine techniques have to be developed in order to exclude spurious effects due to the surrounding matter. The techniques developed at the Institute now permit the counting of one atom in 10^{24} atoms, i.e. one in a million billion billion. Chemical techniques had also to be developed, capable of removing quantities of a particular element as small as a millionth part of a gram to a thousand-millionth part of a gram. It is a matter of some satisfaction that the Geophysics Group at the Institute has made some pioneering contributions at the frontiers of knowledge.



Carbon 14, the radioactive isotope of carbon produced by cosmic rays, is found in all living matter. It decays with a half-life of 5,600 years, and the amount of it contained in any remains of any living matter allows one to date the day when the organism ceased to live in time periods extending from 500 to 40,000 years. Due to the existence of an outstanding Geophysical Group, the Institute has set up a Carbon Dating Laboratory, which will be available to the whole country to assist in the scientific dating of archaeological specimens and human antiquity.

Another radioisotope produced by cosmic rays is tritium, the radioactive equivalent of hydrogen, with a half-life of 12.3 years. This isotope finds its way into all hydrogen containing material, like water. It can be used as a tracer in studying the circulation of water and in obtaining information about underground water, such as the source of water, the size of the underground reservoir, and the rate of its charging from water deposited on the surface. A Tritium Laboratory has also been set up recently at the Institute as a general facility for the country, and the Department of Atomic Energy has appointed a Tritium Committee to build up a library of water samples from all over the country and to select those samples which should be analysed for their tritium content.

I would like to mention one other activity, because of its pioneering nature in this country. Electronic digital computers are becoming more and more important in modern scientific research and there are many fields

today in which progress would be impossible without their help. Work was started in the Institute in December 1954 towards building a pilot machine. The pilot model was completed two years later, and based on this experience the design features of the main computer were worked out early in 1957. In a period of two years thereafter, i.e. by early 1959, the main computer had been built. The instrument uses about 3,000 radio valves and consumes about 20 kilowatts of power. Since February 1960, this computer has been in regular operation, and the demands on it had become so great that it was put on to two-shift operation a year ago. It has been used for solving problems in the field of extensive air showers, high energy nuclear interactions, cascade theory, magnetic resonance, X-rays and crystal physics, and reactor physics. It has handled computational problems for the Atomic Energy Establishment at Trombay, for the Indian Institute of Science at Bangalore, and for the Physical Research Laboratory at Ahmedabad. It is available as a national facility for the whole country. It is now proposed to develop this computer work at the Institute along two parallel lines. In order to develop the art of designing and building computers in this country to the level it has reached elsewhere, the group which built the present computer proposes to take up the design and development of a computer which will be comparable with the most powerful and versatile computer available some 4 or 5 years hence. On the other hand, as the practical demand for a computer in the next five years is going to be very great, and the Institute's projected computer will not be ready for another four or five years, it is proposed to acquire one of the latest and most powerful standard computers available today and to operate this as a service not only for the Institute, but for the Atomic Energy Establishment and other scientific institutions throughout the country.

There are several other fields of physics in which very good work is being done in the Institute, but lack of time does not permit me to touch on them.

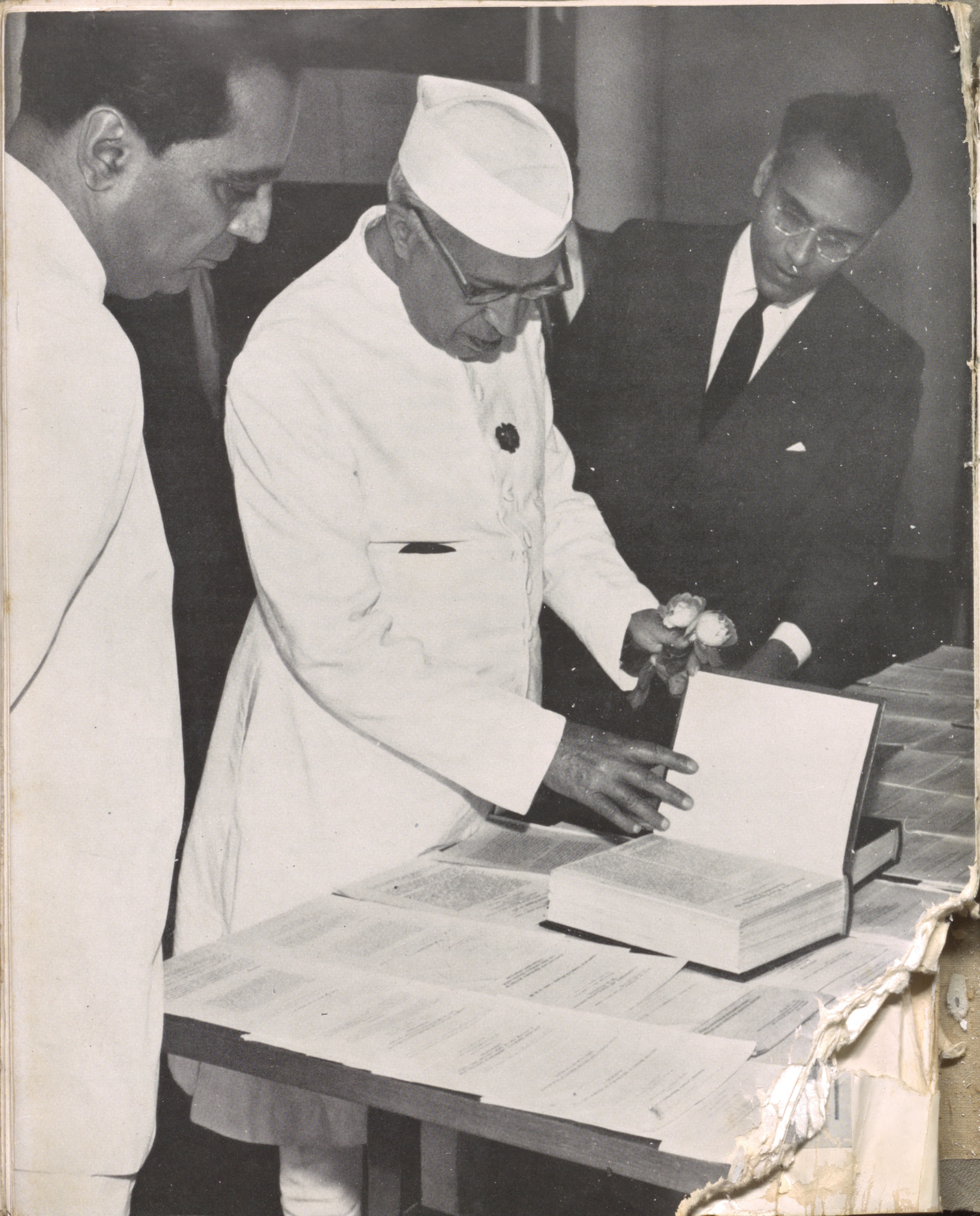
I said at the beginning that this Institute is the National Centre of the Government of India for advanced study and fundamental research in mathematics. I have tried to give in popular language some idea of the work that is done here in physics, I do not know with what success. To do the same for the mathematical research done at the Institute would take at least as long and might well be even less successful. I do not wish to tax your patience much longer. My talk would however be incomplete

if I did not refer to the work of the School of Mathematics and mention that it has established an international reputation for itself through the outstanding contributions which its members have made to various branches of modern mathematics. Credit for this must go to Professor K. Chandrasekharan, who has carefully and painstakingly built up an exceptionally fine group of young mathematicians over the years. The Government of India has reason to be proud of the achievements of its National Centre for Mathematics.

The completion of a building of this size and the organization of a function such as this needs a great deal of attention to detail and effort from all concerned. Members of the administrative and workshop staff have worked very hard and for long hours into the night, and I wish to thank them all most sincerely for their enthusiasm, devotion to duty and their whole-hearted cooperation.

Now that the building has been completed and the myriads of chores connected with moving to a new place of work, organising new laboratories and making new arrangements have been more or less dealt with, I hope the academic staff of the Institute will be able to concentrate without distraction on the aims for which this Institute was established, namely, the furthering of scientific knowledge. I trust that the scientific achievements in the years ahead will justify the confidence which the Prime Minister and the Government of India have placed in us.

The Prime Minister examining a publication of the Institute →



The Prime Minister

Shri Jawaharlal Nehru

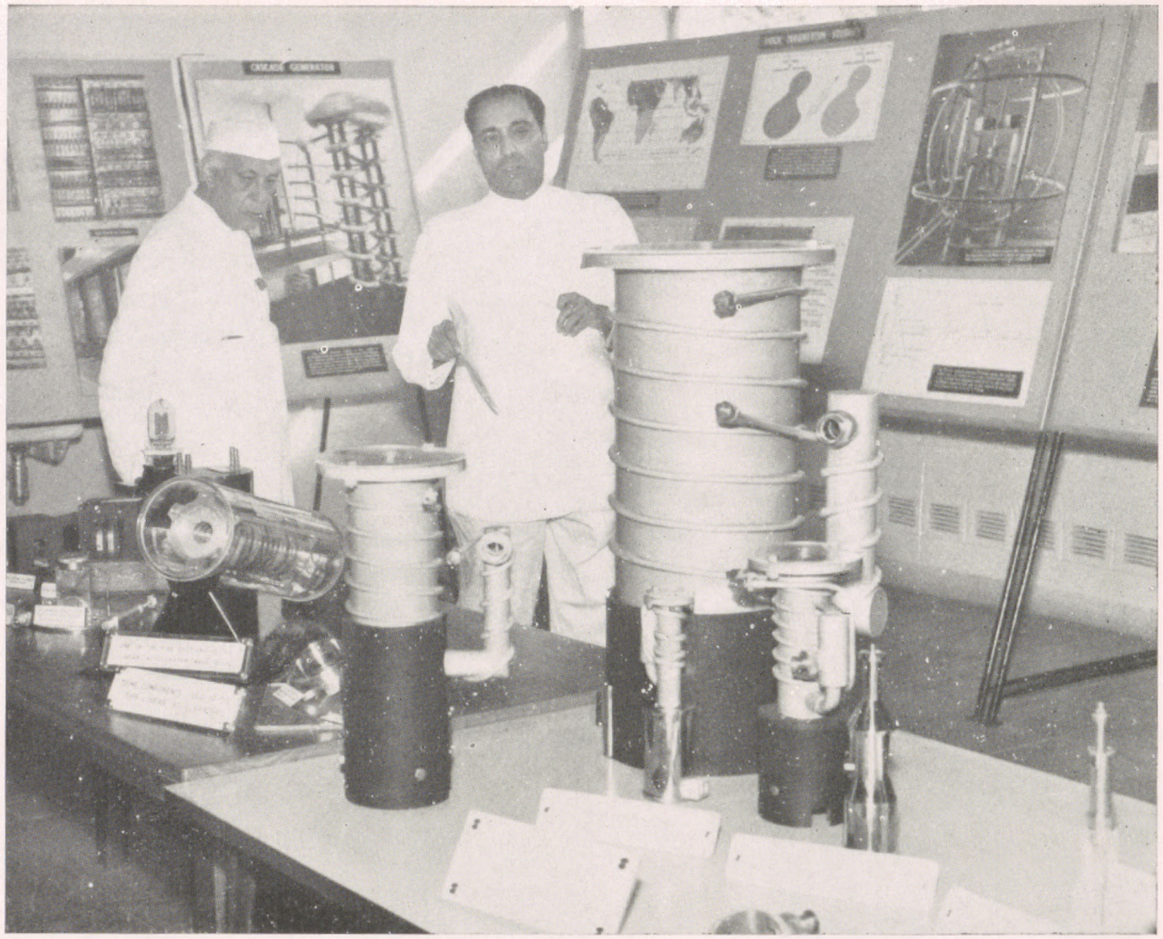
MR. CHAIRMAN, MR. CHIEF MINISTER, MR. TATA, DR. BHABHA, FRIENDS: You have been told that a little more than 8 years ago I was invited here to lay the foundation stone or the corner stone of this structure. It is so long ago that I have almost forgotten that I did it, and I began to think of another instance which happened in Delhi, when a foundation stone was laid and after a few months people discovered that somebody had stolen it! Normally speaking, a delay of eight years in completing a structure seems rather excessive, but coming here once in between and partly going around this building today and seeing what it contains, my original

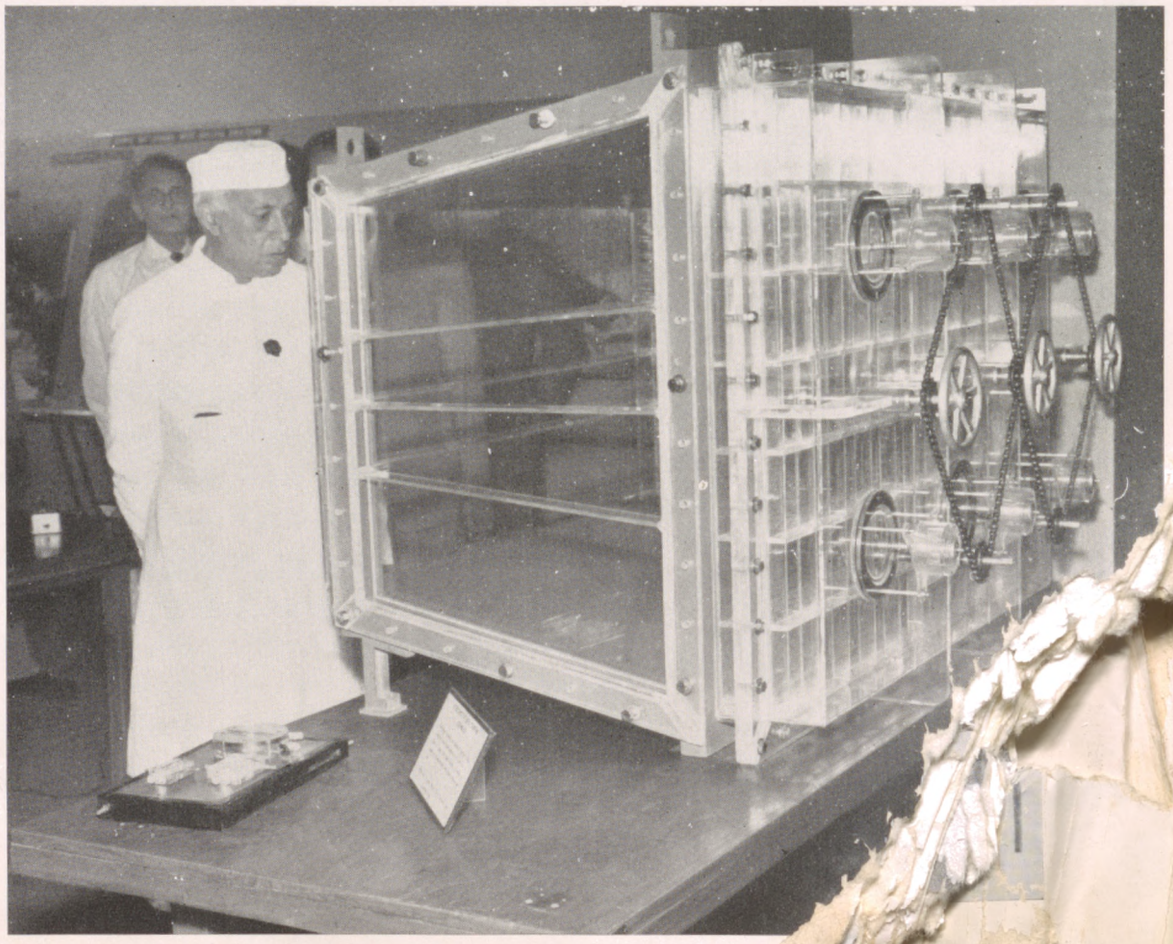
impulse to criticise the delay was considerably modified, because it has required a great effort to put this up in the way in which it has been done; there have been difficulties and anyhow the result achieved is something very much worthwhile. So I am happy to be here today to associate myself again with this Institute in this function.

Previous speakers have referred to the growth of scientific work in India in the last few years, have referred to that pioneer Jamsetjee Tata, who, at a time when few people, certainly in India, thought about it, encouraged this kind of work both in science and technology and heavy industry. He was a man who could look ahead, and whose traditions have been followed by those who have followed him, who have come after him; and, therefore, this Institute is appropriately named after the House of Tatas.

Now in these years much has happened and many big laboratories have been put up in India, and I believe they are doing good work. But there is one aspect which is sometimes not as good, perhaps as it might be, although so far as this aspect is concerned, here in Bombay under Dr. Bhabha's guidance we do not suffer from that particular disability. I have found, going about and generally keeping in touch with these developments, that we really have a very fine lot of young scientists in India, but I am not quite sure that in many places in India they get all the opportunities that they might have to do their work and to develop. Now this does not apply either to this Institute or to the Atomic Energy Establishment at Trombay, because among the many virtues and qualities that Dr. Bhabha possesses, of which we have heard praise a little while ago, one is that he not only encourages people to do their best work, but he builds up young people. He has built up very fine groups of able and brilliant young scientists in these two establishments. It is really meeting these young people, who have already distinguished themselves and who I am quite sure will distinguish themselves still more in future, it is in meeting them and finding out what they have been doing, that I have felt so hopeful, so optimistic about the future of science in India. I would like this example of Dr. Bhabha—that of building up groups of young scientists wherever there is an opportunity in India to give them worthwhile work—to be followed all over this country. It is true that previously the opportunities were perhaps not adequate. Now with these magnificent well equipped structures, opportunities are there, and therefore it is easier to find young people to do good work. I am quite sure that in the future

The Prime Minister looking at the photographs of equipment used for research on cosmic rays





The Prime Minister being taken round the Scientific Exhibition of work done at the Institute

of the largest multi-plate the world, built at the

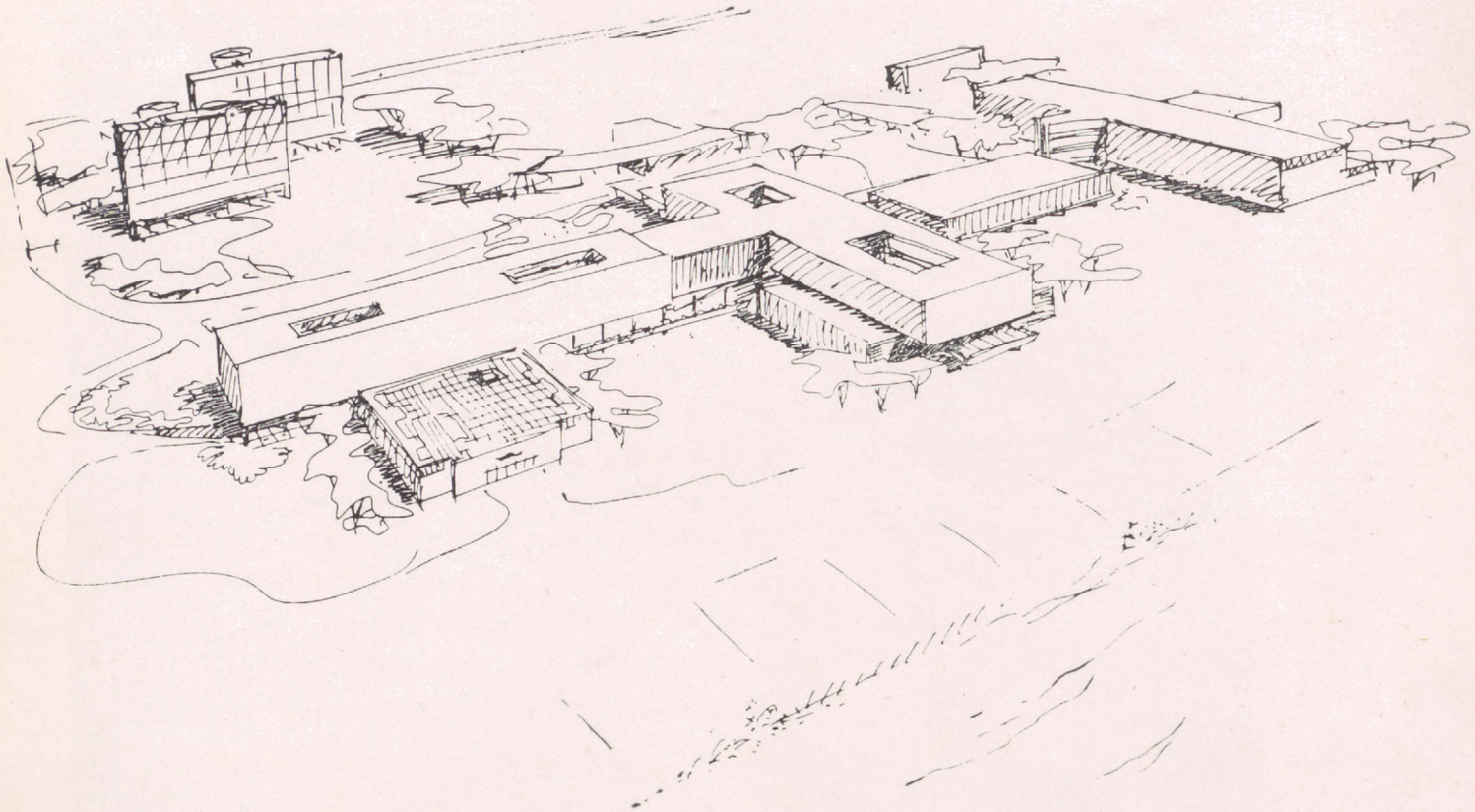
good work will be done by young scientists who, as I have just said, have quite unusual capacity.

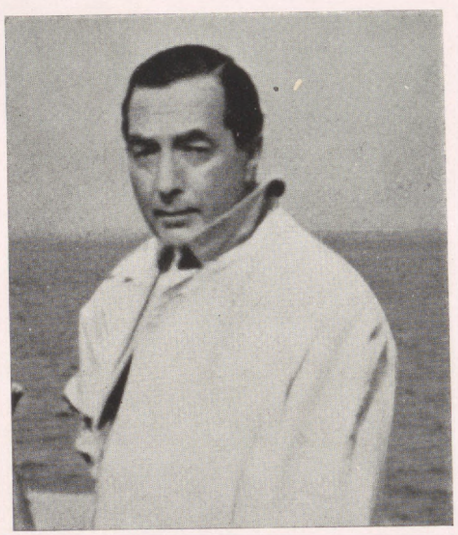
Just before we started this meeting, Dr. Bhabha was good enough to take me round this building and show me some of the work that is being done here, because this building has been functioning for some time and it is not quite correct to say that I have come to inaugurate it. So, I went over this building and met the young scientists, and I looked wise and understanding; but the fact of the matter is that I could not understand much of the things that I saw. We are now entering into an age when scientists begin to function like the high priests of old, who looked after the sacred mysteries; we all bow down to them in reverence and awe, and sometimes, with a little fear, as to what they might be up to. Anyhow, one cannot escape science and scientists in this age. Perhaps the scientist might—and I say "might"—make a better job of it, if he has a chance in the future, than the politician. I am not sure, of course, but I put it to you that it might be possible. So I am prepared to take the risk, because anyhow it is a risk living in these days and dealing with politicians of my own tribe. in any case, the scientist has got a very important part to play, and it is Important, I think, that we should encourage him to play that part. Therefore the growth of science in India is very welcome to me, and, in so far as I am concerned, the Government of India will encourage the growth of science in the future as it has done in the past.

A number of eminent scientists have come here from abroad. I am happy they have come, because it has been a pleasure and privilege of the Atomic Energy Department to co-operate with other governments and eminent scientists in various countries. Their coming here today is very welcome, so that we might strengthen the bonds that tie us to scientific developments elsewhere.

I need not take your time any more. It has been a great pleasure to me, and something like an exhilarating experience, to come here from time to time and to see the growth in our scientific work, whether on the other side at Trombay or here. This takes me out of the normal rut in which I live, which is often rather depressing. So I am grateful to Dr. Bhabha for this opportunity given to me to come here to associate myself with this ceremony and to meet many eminent people. Now, as I am expected to inaugurate this building formally, I do so with great pleasure.

Tea on the West Lawn after the Inauguration





Notes by

Helmuth Bartsch

Designer of the New Buildings

The complexity of the problem combined with the limited area available for the project posed a challenge to a creative mind. The location of the property along the Arabian Sea could not have been more ideal.

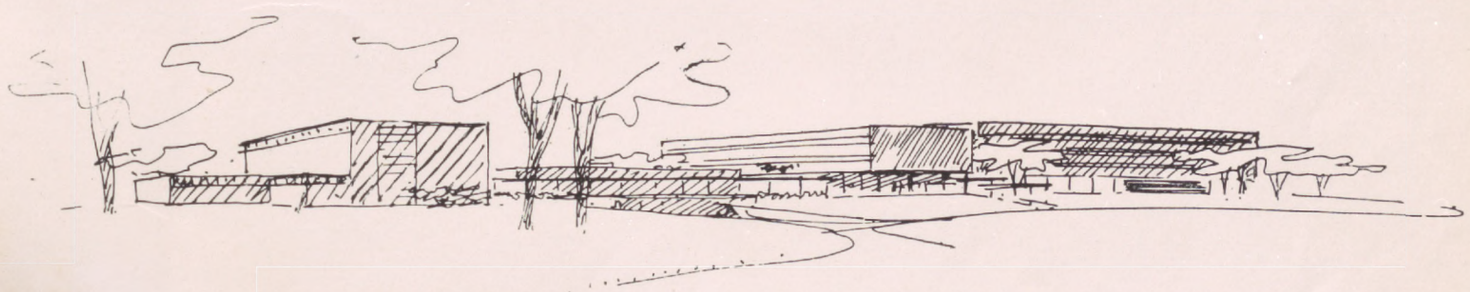
Expression has been given to each function or separate department by accenting the important individual building masses in an otherwise completely unified development. Only those units which by the nature of their use required isolation have been set apart from the principal group.

This arrangement has produced an integrated group of buildings which reflects the intensity of the plan.

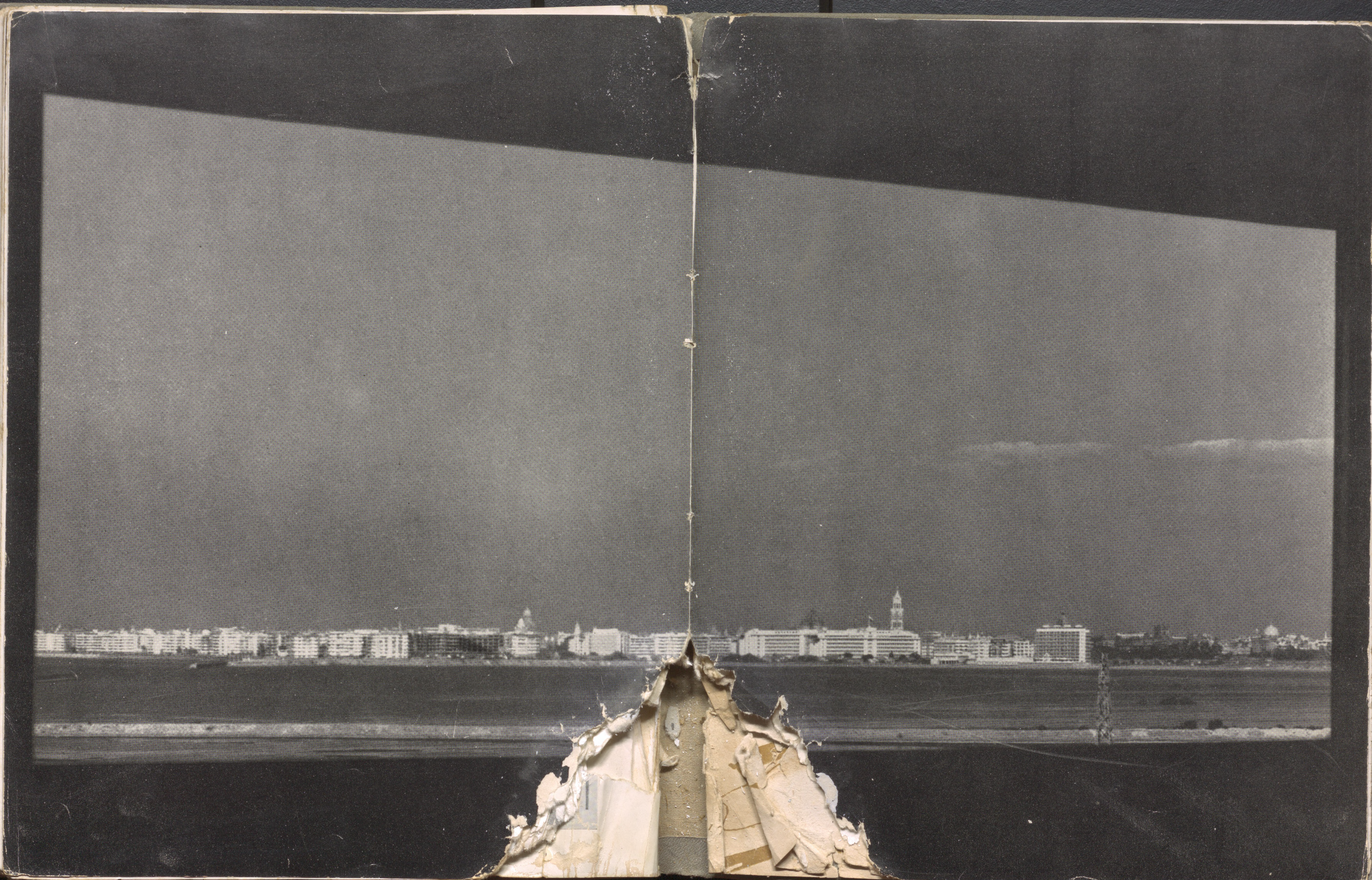
The architect has attempted to combine an impression of lightness and elegance in the type of architecture selected as these characteristics seem eminently suited to the country.

A certain playfulness has been confined to the ground floor of the main building. The exterior open gallery presents magnificent views of the nearby sea as it appears through various architectural frames. The entrance lobby is accented by a free standing cantilever staircase which rises to a mezzanine library and opens by means of a wide corridor to dining and recreational facilities and to various class and lecture rooms on either side. Here rooms which interlock with each other create pleasant vistas which are made more effective by free standing walls of glass or masonry placed inside or outside the supporting columns.

In this development the architect worked with a client rather than for a client. This client displayed unending interest and encouragement and constantly added intelligent suggestions and advice. The result, it is hoped, is a building which will not only fulfil its function but should afford a great deal of enjoyment.



The significance of this building group to the new India should not be left unmentioned. Every item was manufactured in India with the exception of large aluminium sections on the ground floor. This was accomplished against all odds through the client's persistence.



The Building at night from the West Lawn