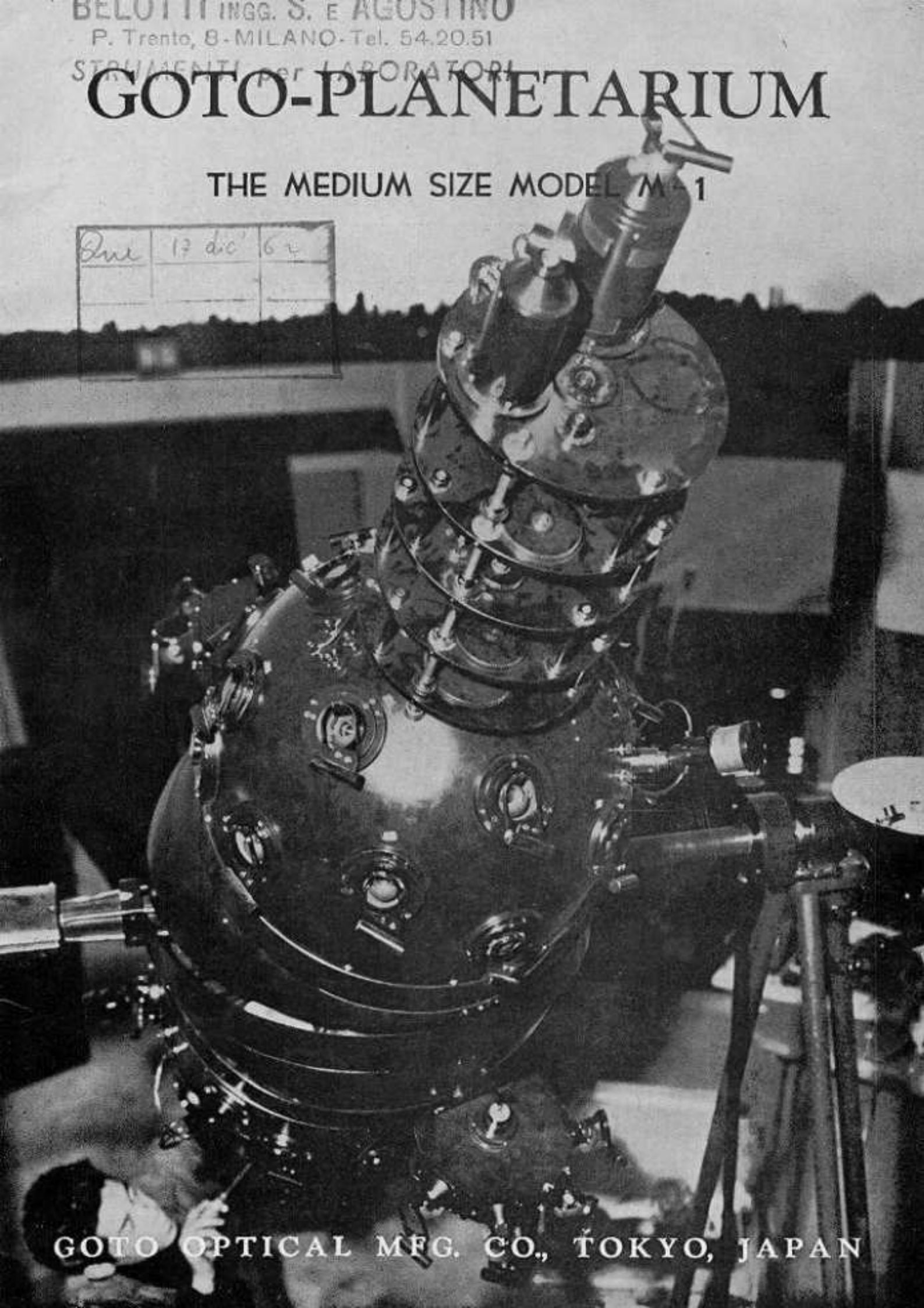
GOTO-PLANETARIUM

THE MEDIUM SIZE MODEL M-1



GOTO OPTICAL MFG. CO., TOKYO, JAPAN

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M-1 Planetarium at the Fourth World Trade Fair, New York, in 1960.

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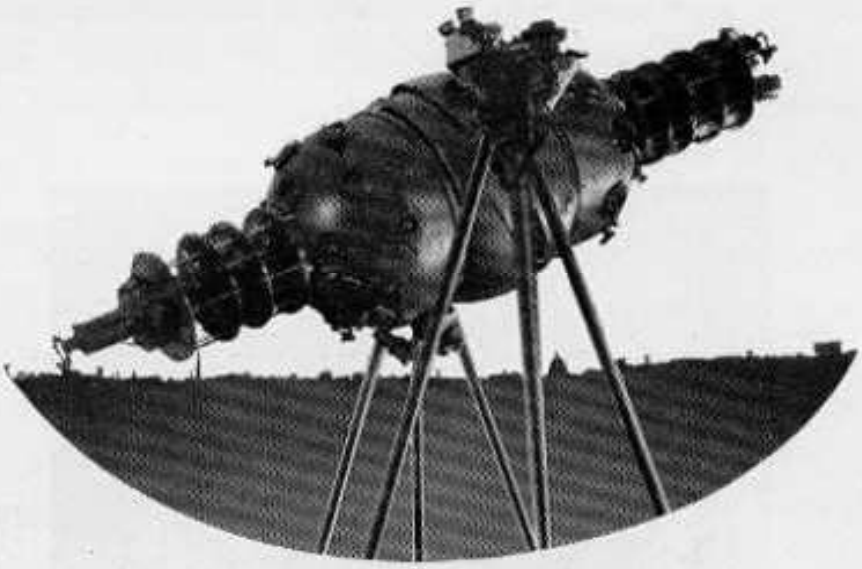
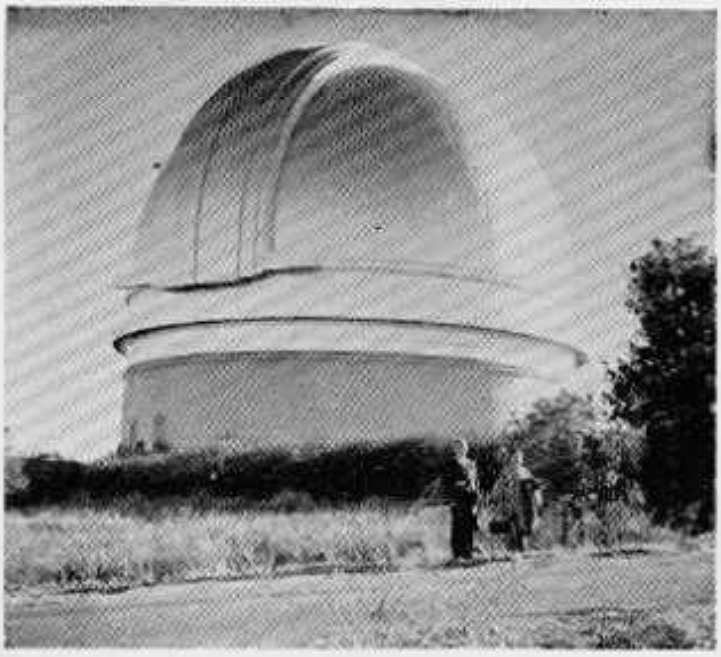


GOTO OPTICAL MFG. CO.

TOKYO JAPAN

"Why did not somebody teach me the constellations, and make me at home in the starry heavens which I don't half know to this day?"

— Carlyle —



President Goto in front of the large dome of the Palomar Observatory, largest in the world.

1. Up-to-date in Space

It has been several thousand years since the dawn of civilization. The people tilled the soil and sowed seed for a living. For this purpose it was necessary to count time and to make a calendar. Then early people watching the celestial sky, accumulated knowledge about the harmonious movements of the heavenly bodies, and the positions of the Sun and the Moon.

All of this was done by the naked eye.

It was only about 350 years ago, that Galileo Galilei, the great Italian Astronomer, discovered Sun-spots, mountains on the Moon, the satellites of Jupiter and other new astronomical phenomena, using a telescope of his own invention.

Science made rapid strides after that Large telescopes were made one after the other, and new discoveries followed. Thus mankind's view of space underwent great changes.

In 1948, a 200 inch Reflector called the giant's eye was completed at the top of Mt. Palomar in the U. S. A.. Mankind's present view ot space is owed entirely to the effects of this large telescope.

When we look at the starry sky, the Moon is the most familiar object. As a matter of fact, it is the nearest heavenly body to the Earth. From olden times, many races had their own traditions about the Moon. There are many interesting stories, such as angels coming down to the world from the Moon, or men flying out from the Earth to the Moon by various methods.

If we could go to the Moon easily, people would feel tempted to travel tc the Moon.

Since we entered the latter half of the 20th century, mankind has been making desperate efforts to reach the Moon.

When the above undertaking succeeds, this will be a base for following plans toward Mars and Venus.

Knowledge of Astronomy is necessary not only for the pilots of ships or airplanes.

The route to space travel is now open. Knowledge of the new cosmic science is in demand among all people.

Planetarium facilities can give this knowledge to the public with interesting performances.

That is why the planetarium is a worthy device.

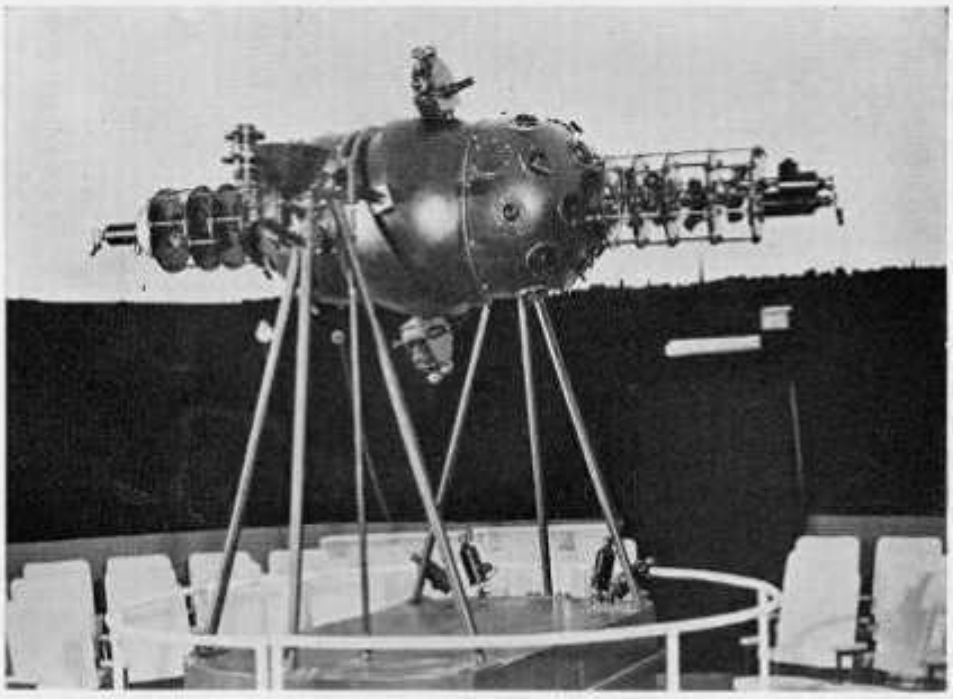
2. What is a Planetarium?

After the success of the artificial satellites, the world had entered the space age. The flying artificial satellites, leaving a light trace of orange colour in the morning and evening twilights, made a shocking impression on the human mind. Even people who have never been interested in the heavens until now, are obecoming curious about the stars, twinkling brilliantly, to the end of space. People wonder about the construction of the universe and what is there.

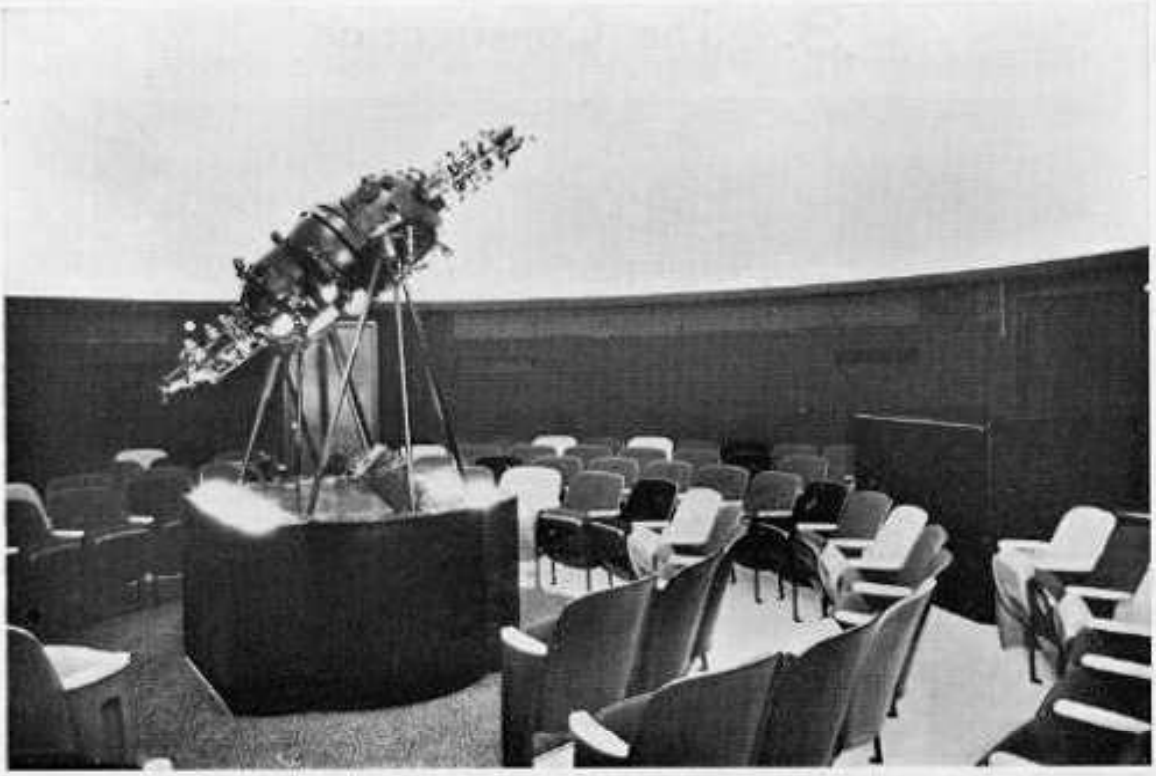
These many people wish to know more about the mystery of space and the celestial sky.

Many scientists have studied methods of making devices to reproduce all the heavenly phenomena in the huge celestial globe of nature, artificially by human hands. About 2,000 years ago an orrery had already been made in China. In recent times a large orrery was made by Cambridge University in England. It was used for 120 years. In 1911, Clark University in the U. S. A. improved on that of England. This orrery can be driven by electric power. One of these foundations, the Carl Zeiss Co. of Germany made the first planetarium in 1923, and opened the route to modern planetariums.

A planetarium is an instrument which reproduces all phenomena of the heavens as naturally as possible. Therefore it consists of precise and complicated mechanisms,



The Medium Size GOTO-PLANETARIUM Model M-1



Planetarium Chamber of Museum of Art, Science & Industry, Bridgeport, Conn., U.S.A.

and optical projection apparatuses which have many features, and a remote control console which is made using the highest electrical techniques. It is a projector.

Therefore, it needs a large dome as an artificial sky upon which to project the astronomical images, as if they were in the actual sky.

The Goto Optical Mfg. Co. has completed a medium size planetarium that was displayed at the Tokyo International Trade Fair held in May, 1959.

This instrument has a superior mechanism which will fill the demands for nearly all performance effects.

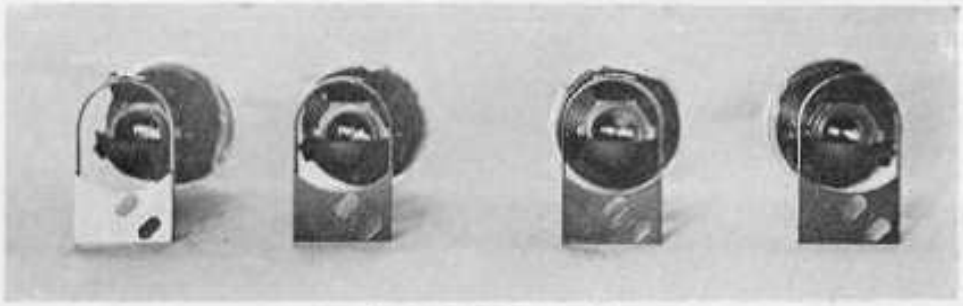
This is the first of its type made in Japan. It has many special features not before included in a planetarium of medium size. It can project the entire celestial sphere from northern to southern hemispheres.

The change of the Moon's phase can be accomplished automatically. Also, using this instrument, the annual motions of the Moon, the Sun, the 5 planets, the precessional motion and alteration of latitude can be easily performed.

This planetarium must almost equal the large ones, in points such as rigid calculative precision and complexity of the mechanisms and special parts.

Nearly the same effects can be obtained as with the large projectors, but at much less cost. In fact the medium size planetarium is about one-tenth the cost of the larger instruments, and so we believe it to be most suitable for use in cities and tourist resorts as a moderately priced cultural facility.

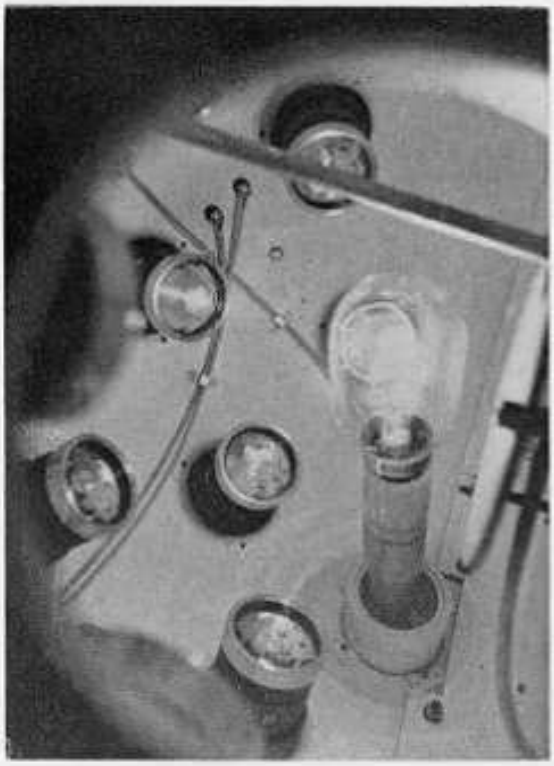
3. The Construction



Fixed Star Projectors.

The medium size Goto-Planetarium consists of a stand, two supporting tripods and a main body.

The central part of the main body is the three axis motions part, such as the diurnal, the annual and the precessional motions. There are two parts of fixed star projectors for the northern and southern hemispheres, symmetrically placed about the three axis motion component. This arrangement ensures that the entire heavens can be projected by the instrument.



Inner Side of Fixed Star Projectors Globe.
(Projector Lamp and Condensers.)

Daylight Lamps.

The Medium Size GOTO-PLANETARIUM Model M-1

The projectors of the Sun, the Moon and the 5 planets are mounted on the top of each of the fixed star projector parts and move in connection with each other.

Each projector projects the images through special optical projection lenses.

To project the fixed stars, we divide the whole sky into 32 divisions, and use 32 projector units.

These projectors are separated in two groups: the northern sky and the southern sky. And each group of 16 projector units uses the one common light source consisting of a 400 watt lamp to project the star images on the ceiling of the dome.

Each projector has a shutter, therefore images projected under the horizontal line are cut off automatically.

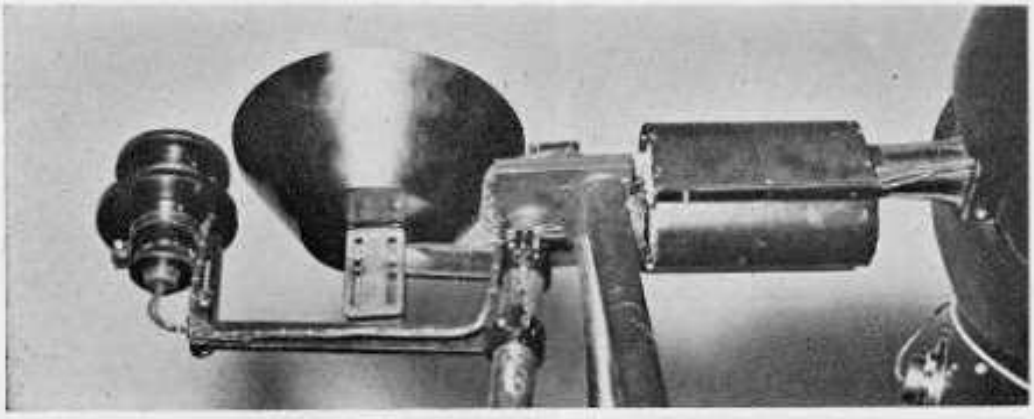
We selected up to 6th magnitude stars (about 5,000) from Norton's Star Atlas and made original star charts for our own purposes. It was necessary to allow for the distortion of spherical projection caused by the mechanical construction, as well as the parallax caused by moving the projection point from the center of the dome itself.

After this, photographs of the various star fields were prepared.

We separated the projecting apparatuses of the solar system into two groups. The projectors of the Moon, the Sun and Mars are mounted on the southern hemisphere side.

The projecting apparatus of the Moon is a most complicated and delicate mechanism. The projector tube revolves round the main axis with a 27 odd days period of the sidereal month. The basic gear which inclines 5° 8′ to the ecliptic, revolves with 18.6 year periods passing through the nods of the ecliptic and the moon's path. The wax and wane of the Moon can be shown, and there changes can be made successively and automatically.

The Sun image can be projected with the annual motion exactly the same as

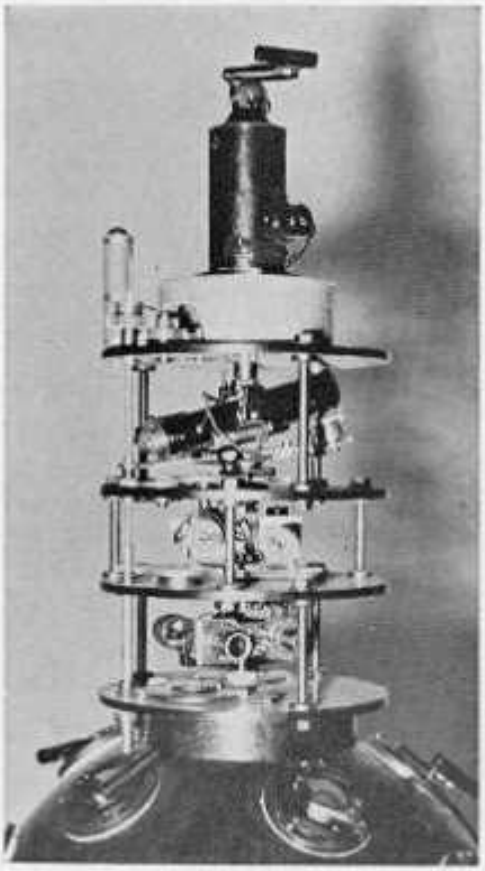


Daylight Lamp and Twilight Projector.

seen in the sky from the Earth.

On the northern hemisphere side of the projector, the projectors of Mercury, Venus, Saturn and Jupiter are mounted. The revolving movement of the projector for each planet is transmitted frnm the common main axis by gears each with reduction ratio. The annual motion of each planet can be reproduced on the dome as if they were seen in the actual sky, showing the phenomena cf progressive motion, retrogressive motion, and the stationary point. A mercury switch operates constantly on each projector, therefore the projector image under the horizontal line is cut off automatically.

The milky way projector is made of cylindrical double glass. The printed film milky way chart is inserted on the outer surface, and at the center, a light source lamp is set. To cut the image under the horizontal line a proper quantity of mercury is put in this projector. We divided the milky way into two, and mounted two projectors on each of the fixed star projectors for the northern and southern hemisphere, thus the beautiful cloudlike milky way can be projected without a gap. The



Moon, Sun, and Planet Projectors Mechanism.

Planet Projectors Mechanism.

projection apparatuses for the equator and ecliptic are built-into both sides of the diurnal motion part, separated for the southern and northern skies. This one consists of four projection tubes, and projects the scale lines.

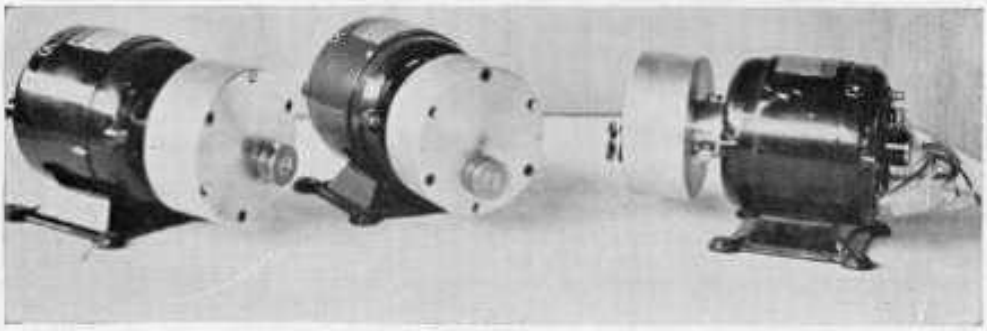
As standard equipment, the daylight lamp and morning glow lamp are mounted on both sides of the tripod heads and we can perform the impressive scene of twilight and the evening glow very effectively. The meridian projector is also mounted on the stand and can project the meridian with angle scale.

By the use of this projection together with that of the equator and ecliptic, we can explain the ideas of spherical astronomy easily. In addition to the above, various performance effects and the interesting projections can be obtained by using various standard and auxiliary projection apparatuses, as follows : -

1. We can project up to 6 th magnitude fixed stars (about 5,000).
2. We can perform the annual motion of the Sun.
3. We can project the wax and wane of the Moon by changing its phases successively, together with its complicated motion.
4. We can show the annual motion of each planet and project the phenomena of progressive and retrogressive motions, and the stationary.
5. We can project the milky way, the nebulae and the clusters.
6. We can project the polar point, and the scale of precession.
7. We can represent the equator, the ecliptic, the meridian, and the vernal and autumnal equinox.
8. We can show the twilights and glows of morning and evening.
9. We can present auroras, meteors, comets, rainbow, thunder and lightning.
10. We can show solar and lunar eclipses, solar system and constellation pictures.

Three Axis motions Part.

4. The Mechanisms of Motion



Motors with vari-speeder.

The movement of this planetarium is driven by 3 small D. C. motors and 1 small A. C. 100V motor. The three D. C. motors are involved in the center part of the main body and transmit the motions of the diurnal, the annual and the precession to each mechanism. The A. C. motor in the stand drives the latitude alteration movement. The speed for one revolution of each movement except latitude alteration can be changed freely by a vari-speeder attached to each motor. Each motor can be operated either singly or simultaneously, therefore, interesting and complicated performances are possible.

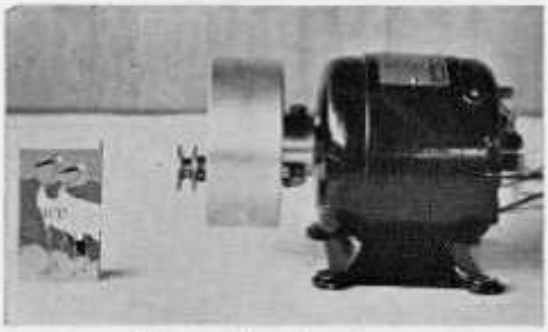
Diurnal Motion:

When we are on the ground, and look at the sky, each constellation moves from east to west, using the connecting line between both heavenly poles as an axis. This is a result of the Earth's rotation. The period of the Earth's rotation is called a sidereal day, which is divided into 24 hours. That is the diurnal motion, by which the sun-rise, the sun-set, the alteration of day and night, and the rise and fall of the all heavenly bodies are done in the natural world.

The planetarium is able to reproduce this diunal motion of 24 hours length on the dome within only a few minuter, and project very beautiful and impressive star images with soft music.

Annual Motion:

The position of the Sun in the heavens changes from day to day, and returns to the original point within a period of about 365 days. This simply means that the Earth revolves round the Sun within a period of one year, which is called the Earth's annual motion. The route on which the Sun moves in the heavens, is called the ecliptic. As the equator of the Earth inclines 23°.4 to the ecliptic, these two lines intersect each other at two points, which are the vernal equinox and the autumnal eqninox.



Motor with vari-speeder.

Our planetarium can project these points. Mercury, Venus, Mars, Jupiter and

Saturn also revolve annually around the Sun. Our planetarium can perform the long time variations of these motions within only a few minutes.

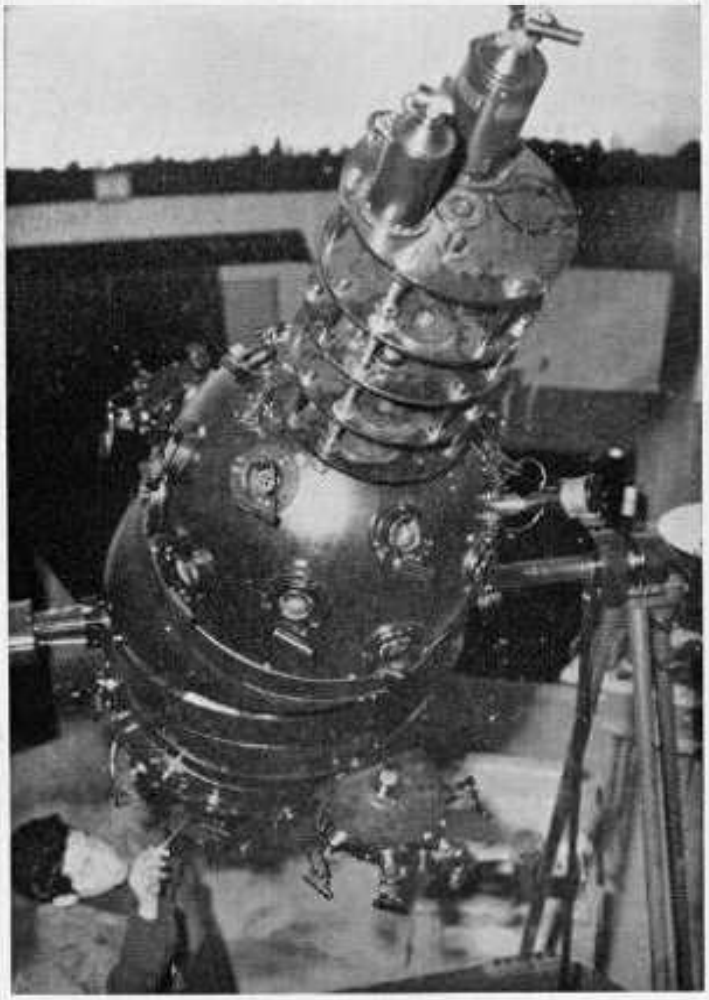
Latitude alteration :

The movements of the heavenly bodies, and the positions of the constellations seen in the sky, vary according to the latitude on the Earth. At the equatorial zone all the stars rise from the east and set in the west. At the north pole, the pole star twinkles overhead, and each constellation goes round the pole star as center, in parallel with the horizontal line. Therefore at the north polar zone can be seen the Sun which does not set at night. The same phenomena appear at the south polar zone.

Our planetarium enables us to project the sky anywhere in the world by alterating the latitude axis. It can invite the spectators to a world trip among the constellations at one sitting.

Precessional motion :

If we observe the position of the constellations through the ages, the point of due North revolves within a period of 25,800 years. Accordingly all stars change their positions along the ecliptic within this period. This phenomenon is called precession, and is due to the slow rotation of the Earth's axis in a manner not unlike the wobble seen in a child's spinning top. For this reason the starry heavens of about 5,000 or 10,000 years ahead will have a different diurnal and annual motion from that seen in present times.



Main Body.

Our planetarium can easily show these phenomena in a moment.

All of the above mentioned movements by our planetarium can be performed right and reverse, so it can follow all the movements and the changes of the heavenly phenomena, in spite of the time, both the past and the future.

Thus, our planetarium does every performance beyond the limit of time and space, and gives everybody the strong dream-like impression that they are engaged in space travel or at the end of the far milky way.

5. Conducting Apparatus

The operation of this instrument is conducted by the control console containing the remote control system.

If operation is done by a lecturer near the instrument, he will disturb the performance, and will disrupt the creation of a natural impression.

The arrangement of switches and meters etc. on the control console is very convenient for use in dark places. A clock, meters and microphone are mounted on the center of the console, and there is a space on the desk to place papers, so it is very convenient for the lecturer. Daylight, moonlight, dawn and twilight can be illuminated separately and can be ontrolled in brightness optionally.

By this, the beautiful atmosphere of the morning and evening glows can be shown.

If the silhouette of the horizontal line is solid, we can illuminate midget-lamps just like the actual lights of a city, by using the reserved socket. This will double the effect of the performance.

Whether or not the points of the projection images of the Sun, the Moon and each planet are correct, is examined in advance.

In this instrument, the right points of the reciprocal relations of each projector can be easily adjusted in accordance with the data from the astronomical calendar.

Control Console.

Each light source of the planetary system, fixed stars and the milky way can be illuminated separately or simultaneously. The equator, the ecliptic, the north and south poles, and the precessional scale can also each be illuminated by separate switches. These projection methods are necessary for the astronomical lecture. Each motion of the diurnal, the annual, the precessisn. and the alteration of the latitude can be driven separately by each motor. But these motions can be conducted simultaneously. The speed of each motor can be changed

optionally by the action of vari-speeder, except for the latitude alteration motor.

We have a pointer as equipment, which projects an arrow mark.

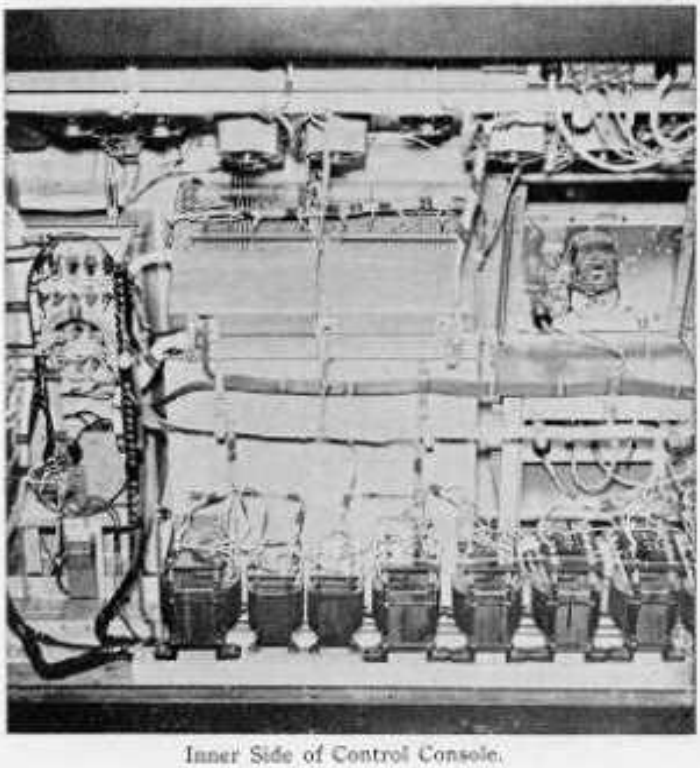
If the lecturer explains the astronomical phenomena in the dome using this pointer, the best effects can be expected.

Pointer.

In addition to the above, it is possible to use with our instument tape-redorders, and record players, to obtain various performance effects.

We attach a tape-recorder as standerd equipment. It is in the drawer of the console.

It is also possible to attach an auxiliary stand to the console. By use of this auxiliary stand, projectors for artificial satellites, meteors, the solar eclipse, the lunar eclipse and the other auxiliary projecting apparatuses can be attached to our planetarium to project various interesting phenomena.

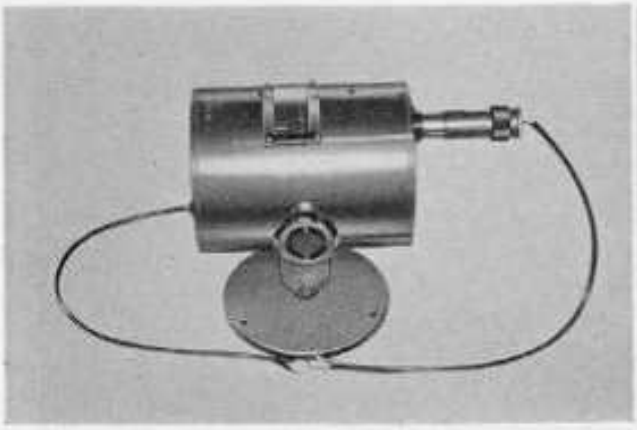


Inner Side of Control Console.

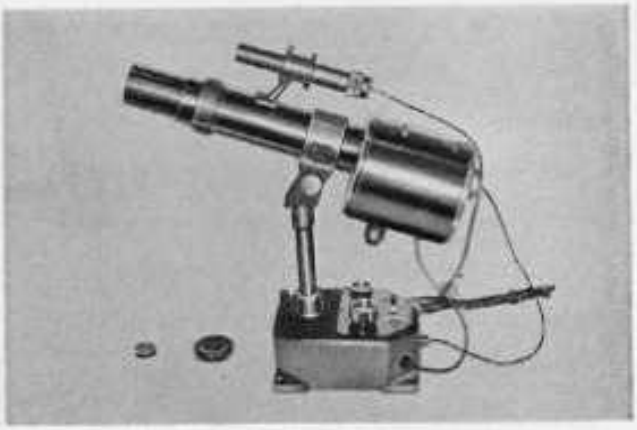
We have the following main auxiliary projection apparatuses as special equipment.

1. The projector of the constellation pictures can project the 26 famous traditional pictures of constellations.
2. The projector of the flash and lightning can reproduce the actual effect with the sound of thunder.
3. The projector of the solar system can project the condition of the movement of each of the planets

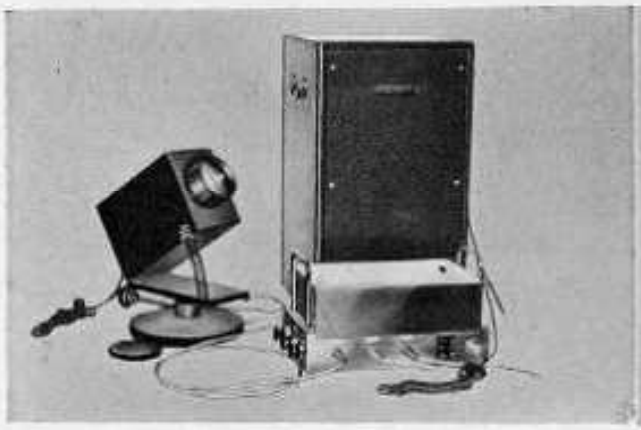
The Medium Size GOTO-PLANETARIUM Model M-1



Artificial Satellite Projector.



Solar and Lunar Eclipse Projector.



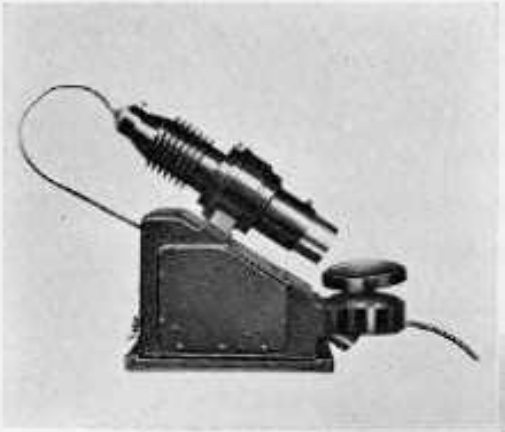
Flash and Lightning Projector.

Revolving Projector of Constellation Pictures.

revolving around the Sun.

4. The projectors of the solar eclipse and the lunar eclipse can project the artificial eclipses of the Sun and the Moon mechanically.
5. The projector of the meteors:
   Not only can show the individual meteors, but the beautiful sight of the famous meteor groups can be projected.
6. The aurora projector:
   Can reproduce the grand sight of the aurora, which can be seen only at the polar zone.
7. In addition to the above, projectors of the artificial satellites, the rainbow and comets, can also be mounted on this instrument.

The Medium Size
GOTO-PLANETARIUM
Model M-1



Comet Projector.

Rainbow Projector.

Aurora Projector.

Solar System Projector.

Meteors Projector.

6. Specifications

★ The medium size model M-1 planetarium is complete with a control console as standard equipment.

★ Planetarium ..... 1 set

Construction : Main body 1

Three axis motions part
Fixed star projector for northern sky
Fixed star projector for southern sky
Planets projector part (Moon, Sun and Mars)
Planets projector part (Mercury, Venus, Saturn and Jupiter)

Stand 1
Supporting Tripods 2

Motors : For diurnal motion; 47 W D. C. 1
For annual motion; 47 W D. C. 1
For precessional motion; 47 W D. C. 1
For latitude alteration; 47 W D. C. 1

Featuros : Distinguishing features of this planetarium as compared with others of this type.

(a) It is provided with optical lenses for each projector.
(b) It reproduces the entire celestial sphere from northern to southern hemispheres.
(c) It performs the annual motion of the Sun, Moon and 5 planets.
(d) It represents the precessional motion.
(e) It represents the automatic change of the Moon's phase.
(f) It has a remote control system from the control console.

The instrument is equipped with the special features above mentioned which have never been found, except in much larger planetariums, so that it will fulfil all the conditions necessary for the study of astronomy.

The Medium Size
GOTO-PLANETARIUM
Model M-1

Standard equipment :

Equator and ecliptic projectors	2
Polar point projectors	2
Meridian projector	1
Precession scale projector	1
Daylight lamps	2
Twilight projectors	2
Morning glow lamp	1
Evening glow lamp	1
Milky way projectors	2

★ Control console ..... 1 set

Construction : Main body 1

- Operation switch board
- Electric source switch board
- Transformers
- Volt meters, Ampere meters
- Illumination lamp

Specification : In-put power ; 3 KVA A. C. 100 V
50 ∞ 60

Standard equipment :

Tape recorder	1
Microphone	1
Speaker	1
Pointer	1
Clock	1
Illumination lamp	1

★ ★ ★ ★ ★

★ Auxiliary projectors :

(a) Artificial satellite projector

(b) Solar and lunar eclipse projector

(c) Comet projector

(d) Meteors projector

(e) Solar system projector

(f) Revolving projector of constellation pictures

(g) Flash and lightning projector

(h) Aurora projector

(i) Rainbow projector

★ Power requirement :

The source of current power supply required for the instrument is 100 volt A. C. 60 cycles. A transformer to change the standard current in any country into 100 volt A. C. suitable for the instrument is supplied upon request without extra charge. The capacity of input power is 3 kilo-VA.

★ Planetary motions :

The planetary motions are geared to the motion of the Sun, so that the position of the Sun on the ecliptic defines the date, and the instrument can be set at any position of the Sun on the ecliptic. Accordingly in compliance with the ephemeris the planetarium can be set to correspond to the planetary positions for any date, past or future.

★ Spare parts of the instrument :

Various kinds of light source lamps.

Various kinds of slipring brushes.

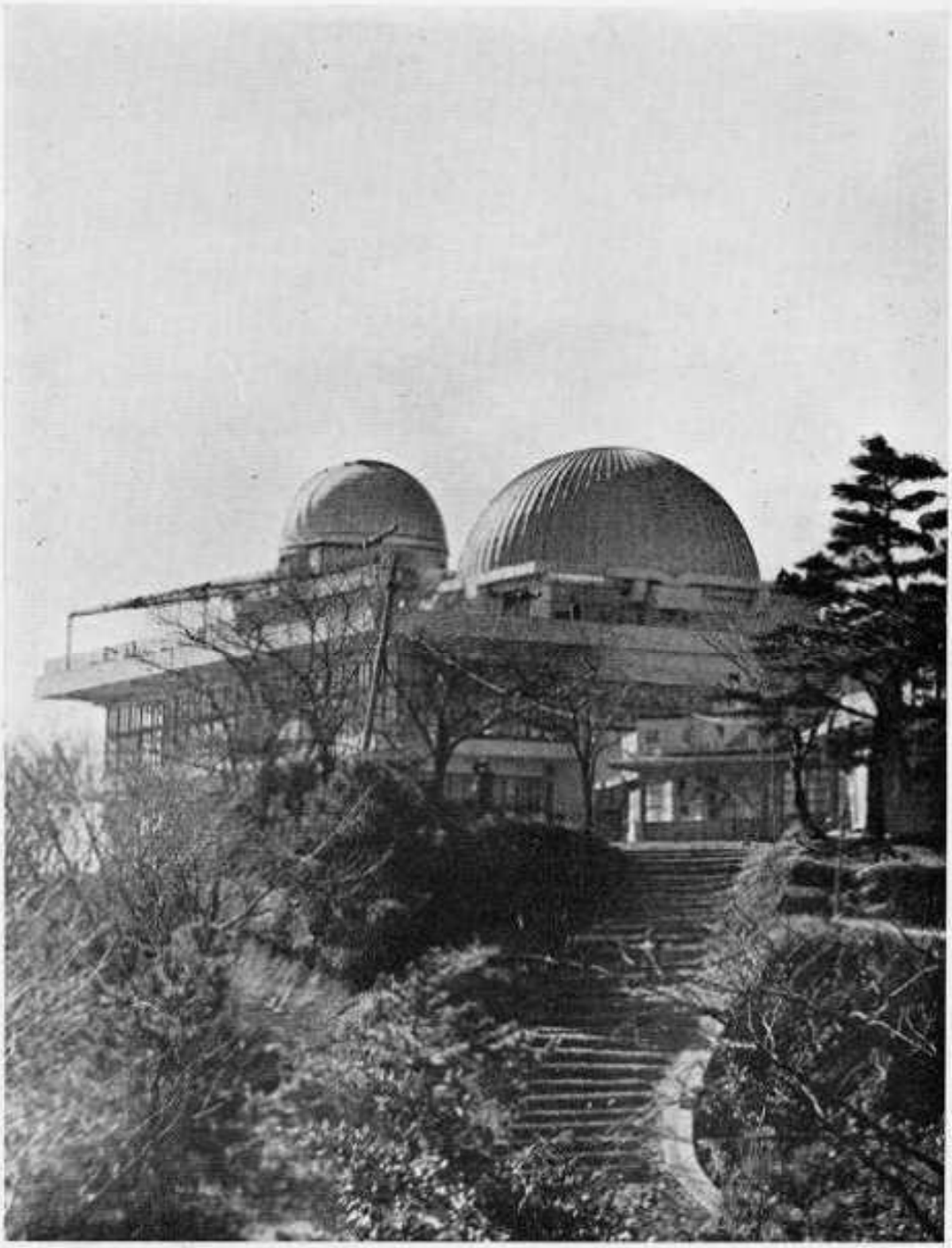
Sockets, Switches, Resistance boxes, Shutters.

A quantity of the above mentioned spare parts are furnished with the instrument.

7. Dimensions

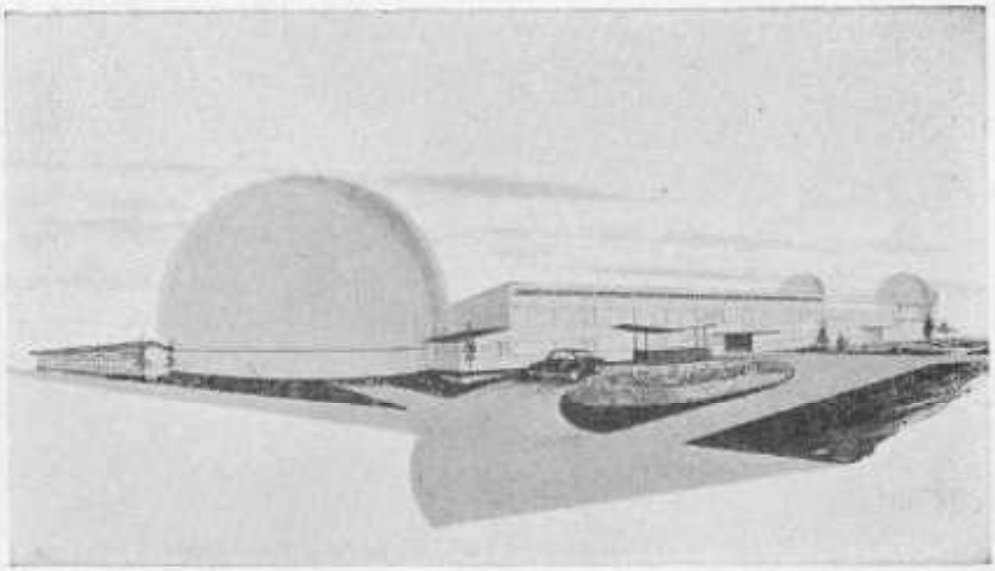
★ Main body :	Height	:	220 cm	7 ′ 2½ ″
	Width	:	140 cm	4 ′ 7 ″
	Weight	:	about 180 Kgs.	400 Lbs.
★ Stand :	Length	:	180 cm	5 ′ 11 ″
	Width	:	90 cm	2 ′ 11 ″
	Height	:	220 cm (From floor to top of the tripod head.)	7 ′ 2½ ″
	Weight	:	140 Kgs.	300 Lbs.
★ Remote Control Console :	Length	:	140 cm	4 ′ 7 ″
	Width	:	70 cm	2 ′ 4 ″
	Height	:	120 cm	3 ′ 11 ″
	Weight	:	350 Kgs.	770 Lbs.
★ Dome :	Height of horizontal line	:	220 cm	7 ′ 2½ ″
	Standard Diameter (inside)	:	10 m	33 ′
	Seating	:	100 ~ 120 seats	
	Capacity	:	150 persons	
★ Export Packing :	Total 1 set	:	6 Cases	
	Measurement	:	390 CFt.	
	Gross Weight	:	1,600 Kgs.	3,530 Lbs.

The standard diameter of the dome, to be satisfactorily illuminated, is 10 meters. It can be considered that the height of the horizontal line in the dome will differ with the circumstances, in this case if the difference is not too much, we can adjust the height of the stand.



Nihondaira Planetarium, Shimizu, Japan.

Shinsekai Planetarium, Tokyo, Japan.



Printed in Japan.