ELECTRIC WATER HEATING

NEWNES

PRACTICAL MECHANICS

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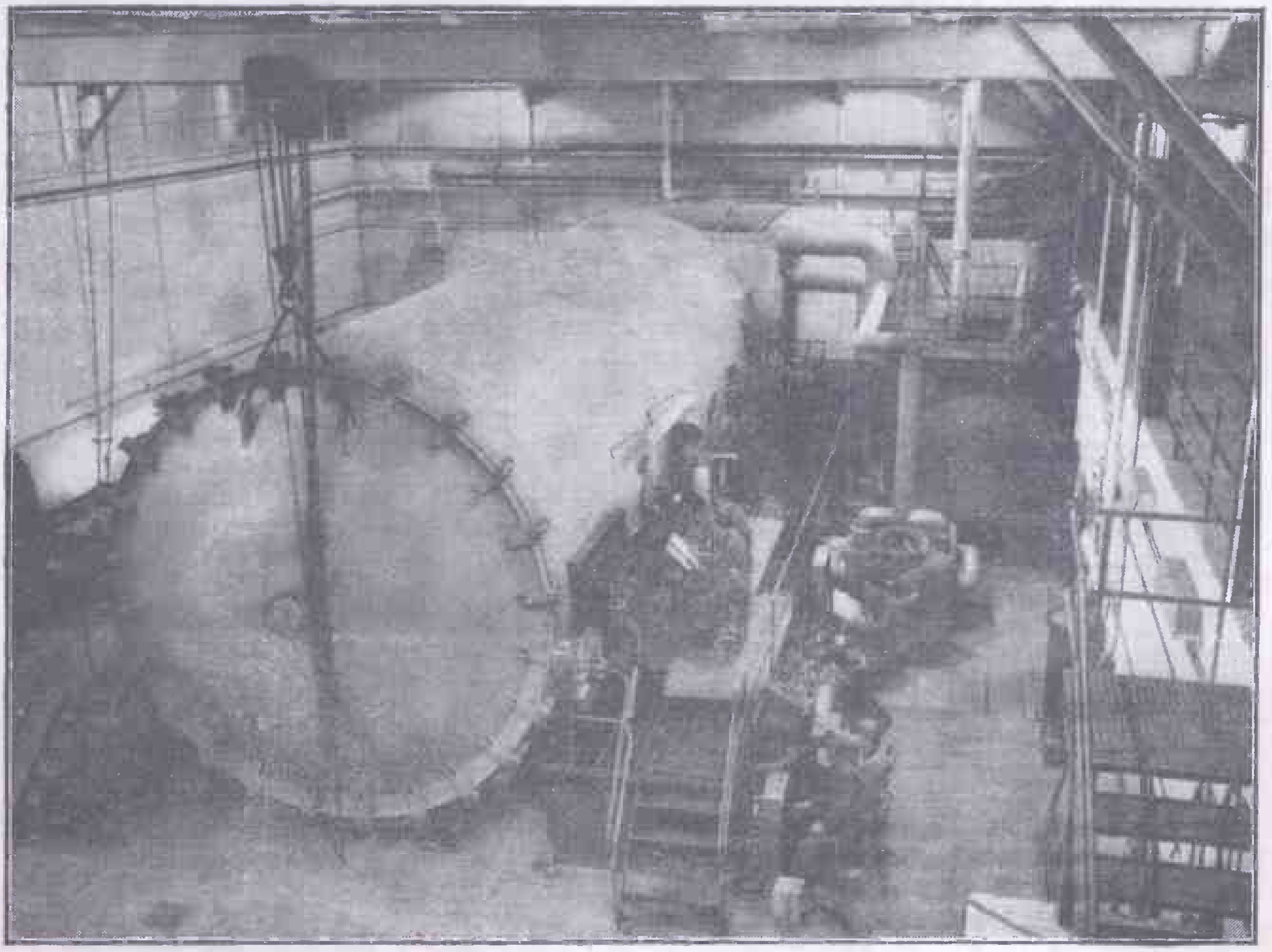


THE NEW ALTITUDE CHAMBER TO BE USED FOR RESEARCH WORK (*See page 129*)

PRINCIPAL CONTENTS

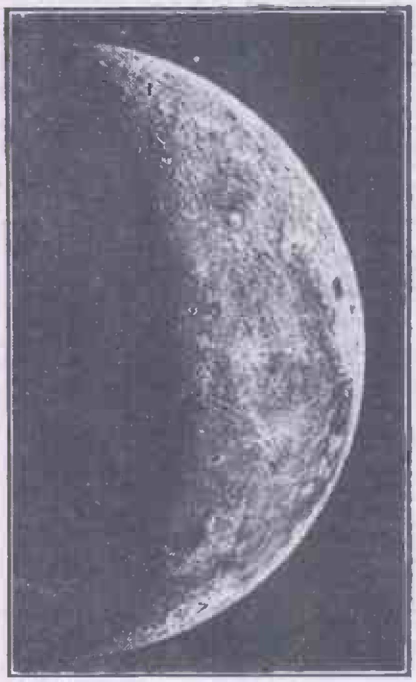
Planetary Atmospheres

Important Considerations for Future Pioneers of Interplanetary Travel

By J. F. STIRLING, M.Sc.

DURING the last half-century, astronomical science has tended to move the main focus of its interest outwards from our own system of sun and planets to considerations centreing around the stellar universe as a whole; but there are signs nowadays that astronomy is again returning to detailed planetary investigations and research. For example, the increasing interest which has been aroused within very recent years in the subject of the various atmospheres which may and, indeed, undoubtedly do, envelop many of the planets of our solar system.

It is a strange fact that up to the present time very little technical consideration has been given to the elucidaticn of the nature and composition of planetary atmospheres. Yet the whole question is inseparably bound up with all considerations of interplanetary explorations. Before any future interplanetary travel projector can seriously plan even the most straightforward voyage within the confines of our sun's system of revolving planets, he must necessarily be possessed of accurate and detailed information regarding the precise type and the extent of the atmosphere which he is likely to encounter when descending on to the surface of any particular planet.



A photograph of the crescent moon. Had the moon any atmosphere a star passing behind it would fade away in intensity and not be instantly extinguished as is actually the case.

The main tool in the astronomical investigation of planetary atmospheres is the spectroscope, the instrument which simply yet almost miraculously is able to split up the light proceeding from a planet and give definite information regarding the chemical composition of any gas which may surround it.

To the indispensable spectroscope must also be added the infra-red camera, for infra-red rays are, in some instances, able to penetrate deep down into the atmospheres of planets in a way which other light rays are unable to do. During the process, some of the infra-red rays are absorbed by the planetary atmosphere, and it is in consequence of this partial absorption that a good deal of exact information concerning the composition and amount of atmosphere surrounding the planet can be obtained.

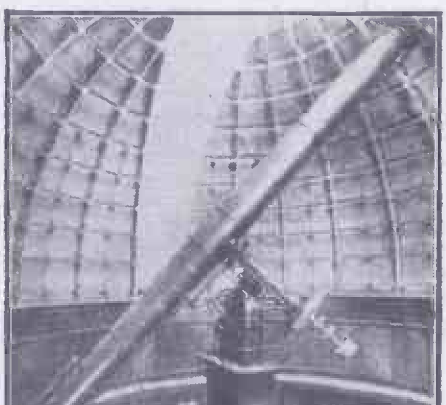
Moon Travel

The nearest body to our earth is, of course, the moon; and the moon will, without much doubt, constitute the first extra-terrestrial body on which the scientific space travellers of the future will land.

Now, the moon is, to all practical intents and purposes, atmosphereless. True it is that there may lurk, among the depths of its steep valleys, a few lingering traces of gaseous emanation, but the existence of such atmospheric remains has never been proved. In addition, despite statements to the contrary, the existence of any traces of water vapour on our satellite has never been demonstrated.

If the moon had an atmosphere, the spectroscope and the infra-red camera would reveal it. Furthermore, when a star passes behind the moon it would not, to us, appear as if it had been extinguished instantly, like an electric lamp being switched out. Had the moon an atmosphere the star in question would gradually fade out, the moon's atmosphere dimming the light of the star before the body of the moon obscured it altogether.

Hydrogen gas glowing in a gigantic nebula far out in space.



A spectroscopic telescope erected in Lick Observatory, U.S.A. It has been used for observations on planetary atmospheres.

Hence, it is certain that no atmosphere exists on the moon. Our satellite is a perfectly dead world in every respect. Space travellers to Luna Land will have, in view of the moon's lack of atmosphere, to equip themselves not only with very efficient breathing apparatus, but they will also have to devise some type of pressure suits enabling them to maintain the pressure on their bodies at approximately 15lb. per square inch, this being the earth's atmospheric pressure under which our bodies are designed to operate. Any violation of this strict requirement during an exploration of the moon or of any of the planets would rapidly have a fatal termination.

Quite apart from the evidences of the spectroscope and the infra-red camera, it is possible to deduce mathematically the existence of atmospheres of one type or another, surrounding the planets.

An atmosphere consists merely of innumerable gaseous particles which are held down to a planet by the attraction of gravitation. Now, the natural tendency for any collection of gaseous particles is to place themselves as far as possible apart from one another. Hence, the tendency of a gas is always to diffuse into space. Ordinarily, however, an atmosphere cannot diffuse away from its planet in consequence of the holding-down or gravitational effect of the planet. For any particle of atmosphere to escape from the planet it must acquire a velocity which is greater than a certain minimum velocity, the latter value being determined by the mass and the radius of the planet.

Velocity of Escape

The minimum speed at which a particle of gas can diffuse into space from a planetary atmosphere is known as the "escape velocity." This varies from planet to planet.

It is well known that the constituent particles of any gas are in a state of perpetual motion, the speed of the particles increasing with increase in the temperature of the gas and vice versa; but not all the particles in a mass of gas move at an identical speed. Hence, calculations have to be effected by assuming an average or mean velocity of the gaseous particles. If, therefore, the mean velocity of these particles should happen to coincide with the gaseous escape velocity of a planet, the planet would lose its atmosphere very quickly, and if the escape velocity is very much higher than the mean velocity of the atmospheric particles the atmosphere will be retained by the planet almost indefinitely. It has, for example, been calculated that if the escape velocity of a planetary atmosphere is five times as great as the mean velocity of hydrogen particles, the said atmosphere will be almost completely immune from loss.

Now, the escape velocity of a gas from the moon is not much greater than the mean velocity of hydrogen. Hence, any light gas surrounding the moon would escape almost instantly. The same applies to any oxygen, nitrogen or water vapour which might at one time have surrounded the moon. If there are any traces of gas left on the moon such a gas will probably be carbon dioxide, although we have no direct evidence of this.

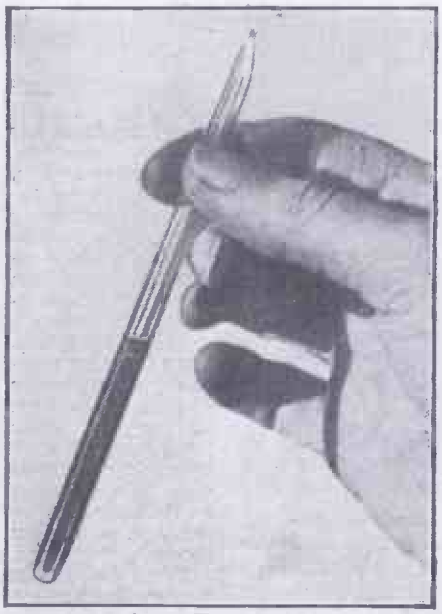
Practically the same conclusions apply to Mercury, the planet nearest to the sun. Hence, if any space-traveller in the distant future should ever succeed in landing on this diminutive planet his breathing and pressure equipment would have to be planned on the same lines as those necessary for a journey to the moon.

Astronomers do not affirm that Mercury is entirely without an atmosphere, but a conclusive proof of such an atmosphere has not been directly reached. In any case, if this planet does possess an atmosphere it must be one of the most tenuous kind, the terrific heat of the sun having long ago boiled off the more volatile gases.

Coming now to Venus, the bright planet which encircles the sun between Mercury and the earth, we have a planet whose atmosphere is something akin to our own.

Comparable Atmosphere

The escape velocity of an atmospheric particle from our earth is 11.2 kilometres per second, whilst the atmospheric escape velocity of Venus is 10.2 km/sec. For this reason, it may be concluded on theoretical grounds alone that Venus and the earth have atmospheres which are roughly comparable in density and in extent.



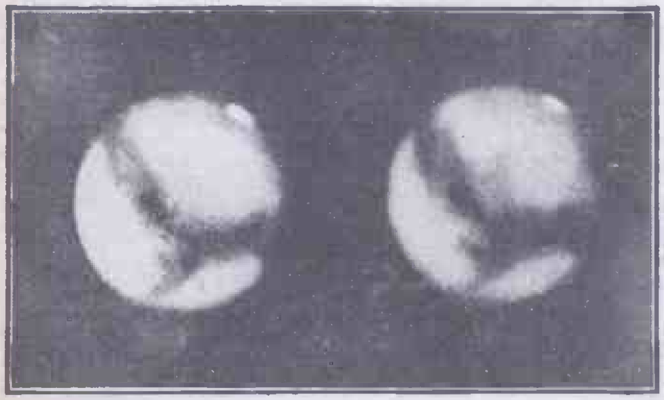
A tube of liquified gas (chlorine) existing under pressure. Liquifaction of atmospheric gas must exist on many of the planets under the influence of cold and pressure.

By photographing the planet Venus in ultra-violet light, cloud markings, which are continually changing their form, are recorded. This indicates the presence of winds or of some other type of atmospheric currents.

The surprising fact about Venus is the failure to detect water-vapour on its surface. Indeed, the presence of oxygen on Venus has never been satisfactorily demonstrated. If any oxygen is present around Venus, it must be not more than a thousandth of the oxygen content of the earth's atmosphere.

Although Venus may be lacking in oxygen, it possesses an abundant amount of carbon dioxide gas. Astronomers have estimated that the amount of carbon dioxide surrounding Venus is equivalent to a layer two miles thick, whereas the amount of this gas in the earth's atmosphere works out roughly equivalent to a layer of only about 30ft. thickness.

Because of the great amount of carbon dioxide gas surrounding Venus, the temperature at the surface of the planet will be greater than it otherwise would be, the huge blanket of carbon dioxide slowing down radiation of heat from the planet. The surface temperature on this planet has been estimated as being about 100 degrees C. (the temperature of boiling water) or even a little higher. Because of this temperature and in view of the apparent oxygen deficiency of the planet's atmosphere, there is probably little (if any) vegetation on Venus. Space travel to this neighbouring planet of ours would, therefore, entail innumerable technical considerations in respect of breathing apparatus and protective suits.



Two photographs of the planet Mars, our neighbour in space. Note the polar ice caps and also the surface markings of the planet.

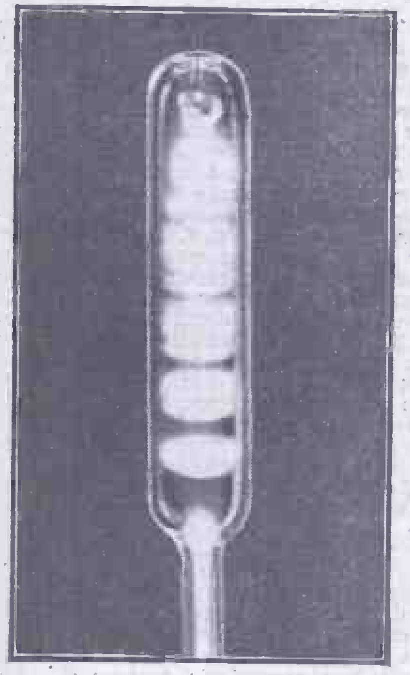
The Atmosphere of Mars

Our other planetary neighbour, more distant than we are from the sun, is Mars, perhaps the most generally popular of all the planets on account of the suggestion that some form of life may exist on it. The atmospheric escape velocity from Mars is only 5.0 km/sec. Consequently, Mars must have a much thinner atmosphere than that of Venus. Yet water vapour can be detected in the Martian atmosphere, although oxygen and carbon dioxide have not been directly noted. It has been suggested that the characteristic red colour of the planet Mars is due to the almost complete oxidation of its rocky surface, the amount of free oxygen surrounding the planet being very little.

If this suggestion has any truth in it, Mars must be a planet which has gone rusty, the majority of its gaseous oxygen having combined itself with the ingredients of the Martian rocks.

Although direct evidence of carbon dioxide in the Martian atmosphere is as yet lacking, the presence of this gas is at least generally inferred, since there is fairly satisfactory evidence of the growth of vegetation on Mars, and, so far as we know, carbon dioxide is essential to the organic life of the vegetable world.

Perhaps, to the future space traveller, conditions on Mars will turn out to be the most favourable of all the planets (the moon included), always, of course, provided that adequate oxygen supplies are taken by the planetary traveller when taking off from the earth.

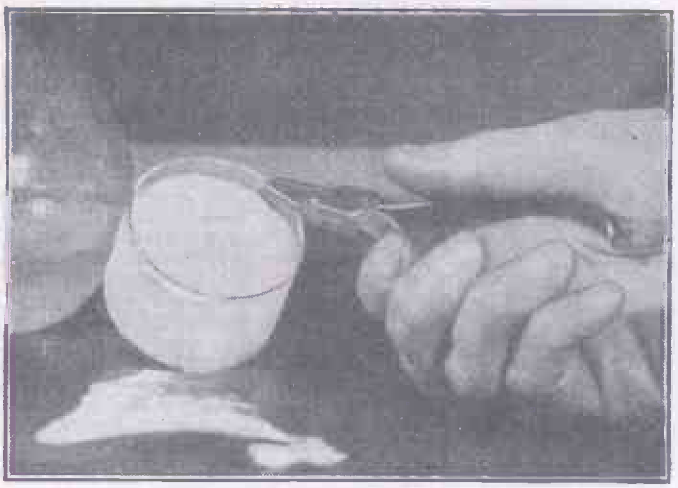


Hydrogen gas glowing under electric potential in a vacuum tube.

Omitting the amazing host of miniature planets existing between the orbits of Mars and the giant planet Jupiter, let us now consider the atmospheric conditions prevailing on the four major planets, Jupiter, Saturn, Uranus and Neptune—to name them in order, as we proceed outwards from the sun. To this list we might add the newly-discovered planet Pluto, which ploughs its lonely trail around the sun beyond the orbit or path of Neptune, and which, so far as we are yet aware, is the most distant of all our sun's family of planets. Pluto is so distant, however, that we know little about it as yet and we have certainly no knowledge of any atmospheric conditions which may possibly prevail on it.

The Prince of Planets

Jupiter is the well-known giant of our planetary system. It is a veritable prince of



Frozen carbon dioxide gas. Many of the atmospheric constituents of the more distant planets must be approaching this condition of low-temperature solidification.

planets, being about eleven times the diameter of the earth and taking nearly twelve years to complete its journey round the sun.

Jupiter only receives about 1/27th of the amount of heat which our earth takes from the sun, for which reason it must constitute an entirely frozen world. At one period astronomical opinion was that Jupiter was immensely hot, so much so as to be faintly self-luminous. More advanced opinion, however, has concluded that the surface of Jupiter has an ice coating of some 16,000 miles in thickness. That the planet has an extensive atmosphere is apparent from its telescopic appearance and from various features associated with this. Calculations indicate that the atmosphere of Jupiter is very dense, and that it may be about 6,000 miles high. For this reason alone, any possible descent by a space projectile through an atmosphere would have to be well controlled in speed, in view of the great hazard of the projectile's rapid and complete destruction by atmospheric friction. The same, too, applies in the case of the three other major planets—Saturn, Uranus and Neptune.

The problem of ever descending through Jupiter's atmosphere to the ice-bound surface of the planet is, however, almost impossibly formidable, for the atmosphere surrounding this planet is so dense that, at the planet's surface, an atmospheric pressure of about a million times that of the earth's atmosphere my be expected. Any possible means of resisting such a terrific pressure is certainly unknown to present-day science.

The same applies, also, to the atmospheres surrounding Saturn, the ringed planet (which, incidentally, has the densest of all planetary atmospheres), Uranus and Neptune. Thus the mere problem of gigantic atmospheric pressure of any of these planets would seem to preclude any possible human descent on their surfaces in the light of modern scientific knowledge.

Since the gaseous escape velocities from all these planets is exceedingly high, it is almost certain that even the lightest of all gases—hydrogen—cannot have diffused away in any substantial amount from these planetary bodies. Hydrogen must, therefore, be present extensively in the atmospheres of all these planets. And not only hydrogen must abound in these atmospheres but helium also. Nitrogen and carbon dioxide are there, it is thought, only in traces, and there is almost certainly no free oxygen.

Atmosphere of Ammonia

It is surprising to find in the atmospheres of Jupiter and Saturn a quantity of ammonia gas, NH_3, and also methane, CH_4, the simplest of all the hydrocarbon gases which is well-known on earth (or, rather, under earth) in the guise of the deadly "fire-damp."

There is less ammonia in the atmosphere of Saturn than there is in Jupiter's atmosphere. The temperature of these planets must, however, be so low that the ammonia vapour must be perpetually on the point of condensation. No doubt, indeed, the ammonia exists not as a true gas but as a whirling blizzard of minute particles of the frozen ammonia.

Ammonia has not been detected in the atmospheres of Uranus and Neptune. No doubt it does exist on these planets, but because their temperatures are even lower than those of Jupiter and Saturn, any ammonia present on Uranus and Neptune must be frozen solid on the surface of the planets.

Methane gas exists abundantly on all the four planets. It seems to be present in much larger quantities on Uranus and Neptune than it does on Jupiter and Saturn. One or two recent astronomical observers have essayed an estimate that there may be a 25-mile depth of pure methane gas on the planet Neptune; but at the mean surface temperature of this planet (more than minus 200 degrees C.) even the methane must be ready to condense to a liquid.

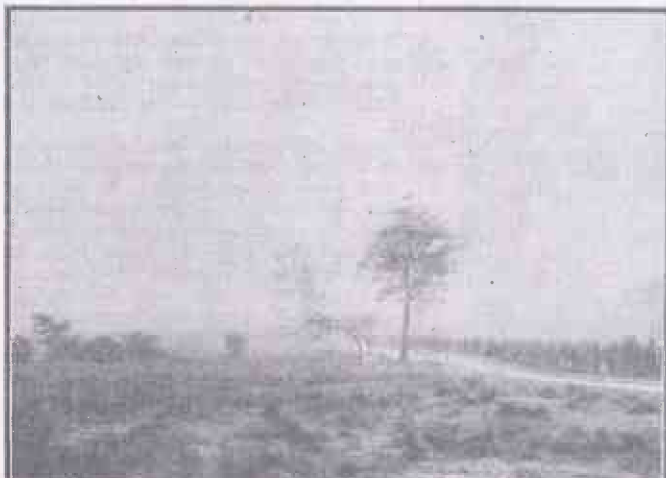
More complex hydrogen carbon gases than methane have been looked for in vain in the atmospheres of the above four planets. It seems as if hydrogen, helium, ammonia and methane make up the main constituents of these planetary atmospheres.

New Forms of Life?

Under such conditions any form of life known to us could not possibly exist. Reflecting on such a statement, however, we must realise the fact that what we may term "earth life" may not comprise the only variety of physical existence. Our forefathers were wont to conceive of a race of beings which lived and had their entire being in fire and flame. It may also be possible for some type of physical life (at present totally unknown to us) to live at a temperature nearing absolute zero, to exist by some as yet unknown solar radiations and to flourish exceedingly on a mixed atmosphere of hydrogen, ammonia and methane.

So far as we know at present, planets may be assigned to three groups in relation to their atmospheric characteristics, viz.—the smaller bodies such as the moon and Mercury (and, most likely, all the other planetary satellites) which are almost completely devoid of atmospheres, the medium-size planets, such as Earth, Venus and Mars, which have medium-density atmospheres consisting of oxygen and/or its compounds together with carbon dioxide gas, and, finally, the larger planets which have very dense atmospheres comprising hydrogen, helium, ammonia and methane gases but which are lacking in oxygen and its compounds.

A rough separation of planetary atmospheres, no doubt. Nevertheless, it gives us something to work on, and it suffices at the present time to furnish us with a rough idea of the intricate and highly formidable problems which must necessarily face any planetary voyager of the future who may hope to plan a journey outwards from the earth to any other member of our solar system.



Showing the effect of atmospheric penetration by infra-red rays. This landscape photograph was taken by ordinary light rays.

The same landscape photographed by infra-red light, after screening out all other rays. Note the greater penetration of distance. The same infra-red technique is employed for penetrating through planetary atmospheres in order to obtain information as to their constituents.