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सत्यमेव जयते

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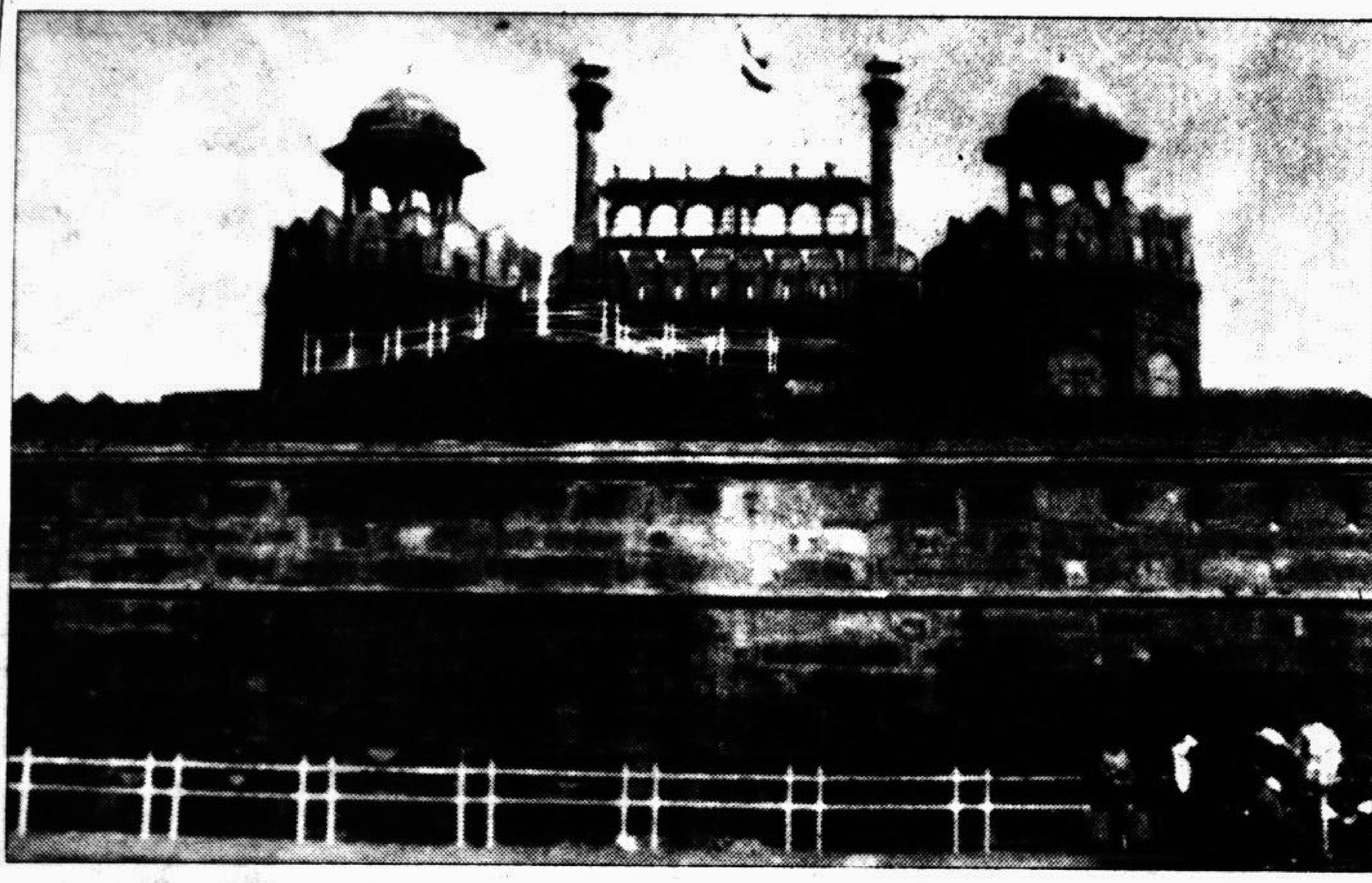

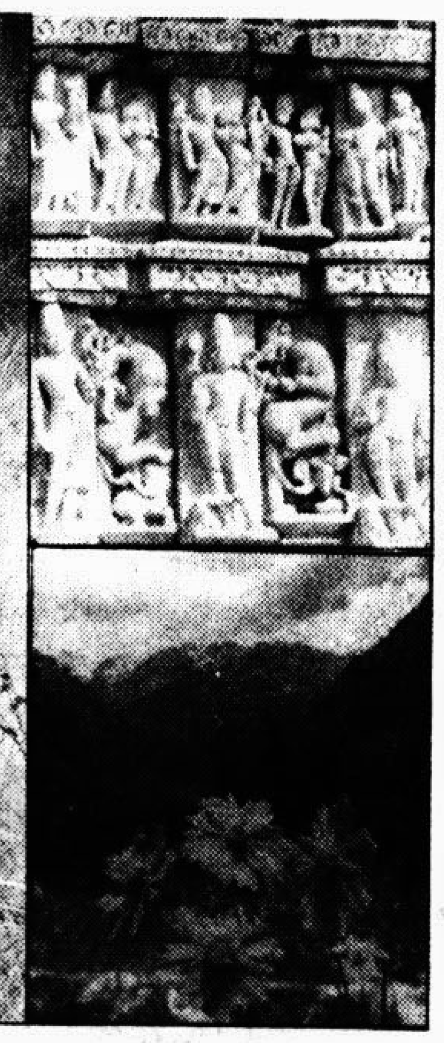

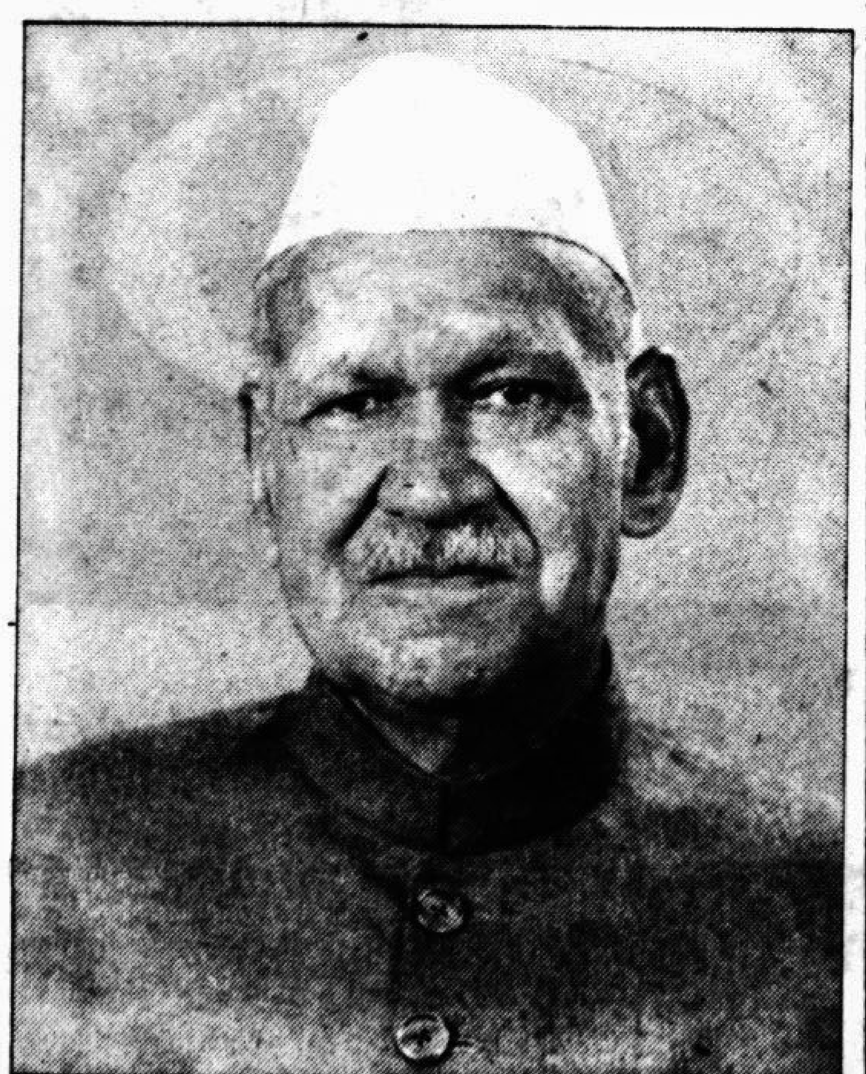

Dr Shankar Dayal Sharma
President of India

Indian Space Programme

THE Indian space programme began with the primary objective of achieving self-reliance in space technology required for national developmental goals, in terms of telecommunications, broadcasting, natural resource management and meteorology. The objectives pursued over the last few decades are gradually being realised. The development and successful launch of the Indian Remote Sensing Satellites (IRS) and the multipurpose telecom, broadcasting and meteorology satellites (INSAT), have established the fact that India has come of age in space technology.

The indigenously built multipurpose satellites, INSAT-2A launched in July 1992, INSAT-2B launched in July 1993 and INSAT-1D, the last of the INSAT-1 series launched in 1990, continue to perform well in orbit providing the vital services they were designed to render. The INSAT-2 system has a larger capacity compared to the INSAT-1 series, as it carries 18 C-band transponders as against 12 in INSAT-1, two high power S-band transponder, a data relay transponder, a higher resolution VHRR radiometer and also a geostationary search and rescue system to provide instantaneous emergency alert over the entire Indian Ocean area. INSAT-2C, which was launched recently incorporates additional features such as Ku-band transponders extended coverage C-band transponders and mobile satellite transponders.

INSAT-2C has been launched in December 1995 and INSAT-2D, will be launched next year. INSAT-2E scheduled for launch in 1997-98 will have meteorological payloads with an additional spectral channel and improved coverage. With the planned launches of the follow-on INSAT-2 series of satellites, it is anticipated that the space segment capacity of the INSAT system will be enhanced and improved to open up new vistas for the telecommunication and TV user community in the country as a whole.

Besides this, several experiments and demonstrations are continuing on exploring new applications of the powerful media of satellite communication for interactive education through television, business communication, news gathering and mobile communications.

Parallel developments with the state-of-the-art remote sensing satellites, namely IRS-1A and IRS-1B, have highlighted India's capability in all aspects of satellite technology. The achievements in the development and application of space-based remote sensing technology has already drawn cognizance the world over. Polar orbiting satellites, namely IRS-1A and 1B, provide multispectral imageries with a resolution of about 36 metres and a repetitivity of 11 days (together), vital information on forests, environment, agricultural crops, soil conditions, wasteland identification, flood and drought monitoring, oceans resource development, mineral exploration, land use and monitoring of underground and surface water resources, thus enabling a proper scientific methodology for achieving sustainable integrated development which can provide food security to the entire nation on a continuing basis.

IRS-P2, launched by India's own launch vehicle, PSLV, has joined the IRS constellation, enhancing the data availability. IRS-1C, scheduled to be launched within one month, incorporates advanced features such as the LISS-III camera, a panchromatic camera (PAN) and a wide field sensor (WIFS) enabling better spectral and spatial resolutions than their predecessors thereby enhancing the application potential of these satellites. It is expected that IRS-1C will be the best commercially available remote sensing satellite in the world, when it is launched.

Diverse applications particularly in the remote sensing area such as crop acreage and yield estimation, drought monitoring and assessment, flood mapping, land use and land cover mapping, wasteland mapping, ocean/marine resources survey, urban mapping, mineral prospecting, and forest resources survey have become an integral part of the resources management system in the country. The integrated Mission for Sustainable Development (IMSD), launched in June 1992, now covers 157 districts which have been identified for generation of action plans for locale-specific development using mainly IRS data. The implementation of the action plans generated for six districts has already been taken up and the initial results have been very encouraging. All these have gone a long way in enabling ISRO to leave its indelible mark in the space arena.

In addition, several major accomplishments have been achieved in the area of launch vehicles too. The fourth developmental flight of the Augmented Satellite Launch Vehicle (ASLV) also successfully achieved its mission of placing the 113 kg SROSS-C2 scientific satellite in a near earth orbit. Close on heels came the world class 44m tall four stage PSLV capable of launching 1000 kg IRS satellites into a 1000 km polar orbit. Technologically, the PSLV is a quantum leap over its predecessors and its successful launch has catapulted India into the select group of major rocket launching countries. The PSLV mission unequivocally demonstrated India's capability to launch endogenously built remote sensing satellites from within the country.

The mission has also proved, in flight, a number of systems which would be employed in the Geosynchronous Satellite Launch Vehicle (GSLV), thus hoping to bring the country closer to achieving the capability for launching INSAT class communication satellites. This is expected to be realised in another 3-4 years time frame, after which ISRO would have creditably established its mastery in the entire gamut of space activities.

Having successfully designed, developed, tested, and operated complete communication, remote sensing, metrological and scientific satellites for a variety of applications tuned to national development, ISRO has now established itself as a reliable source in providing end-to-end capability in the application space technology programmes for national and social development.

In the process of development and qualification, all the necessary test facilities have been established both within ISRO and at the respective industries, again with active support from Indian industry. The indigenous development proceeded successfully, resulting in India becoming one of the few countries having know how for some of the most crucial materials and products used in the launch vehicles and satellites, besides the total systems.

The successive indigenisation efforts and transfer of technology from ISRO have resulted in more and more materials such as solid and liquid propellants, chemicals and adhesives, rocket engines, sophisticated control components, rocket casings using high strength marking steel, ablative materials such as high silica cloth, carbon cloth, light alloy structures, electronics packaging, radars and a variety of ground equipment such as communication equipment, antenna, electro optical systems and computer processing systems, being manufactured and supplied by Indian industries, based on ISRO technology. Industries have contributed their mite in the development and installation of advanced facilities such as the large space simulation chamber for the testing of spacecraft, complex mobile structures for launching rockets and sophisticated liquid engine test stands.

New Products

With such a vast repository of sophisticated facilities and highly trained and skilled manpower, it was imminent that ISRO enter the global scene through the setting up of Antrix Corporation Limited. The company will concentrate on marketing the products drawing maximum support from the industries. The immediate objective would be to gain a foothold by

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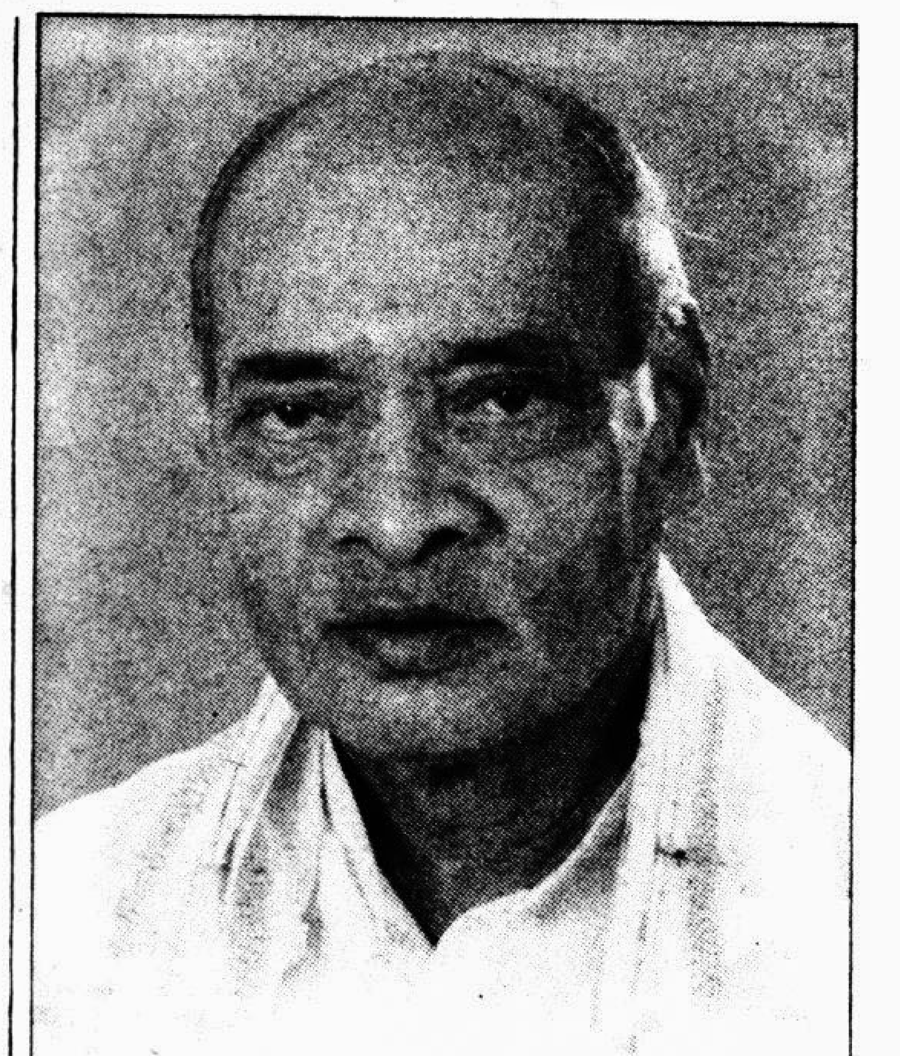

P V Narasimha Rao
Prime Minister of India

Insat-2C to Offer Wider Coverage

by N. Gopal Raj

INSAT-2C launched in early December, 1995 is to be the first Indian satellite to be co-located close to another satellite so that the two function as one large virtual satellite. Co-location becomes necessary when slots are not available in geostationary orbit.

In geostationary orbit, about 36,000 km above the equator, although the satellite is hurtling through space at over 11,000 kmph, its orbit matches the Earth's rotation so that the satellite appears stationary from the ground. Arthur C. Clarke was the first to point out, in an article in 1945, the possibilities of putting satellites in such an orbit to function as space-based relay stations of radio signals. With three satellites, 120 degrees apart, the world's requirements for communications, TV and radio relay could be met. That has not happened. Instead slots in geostationary orbit are registered with the Radio Regulation Bureau of the International Frequency Registration Board of the International Telecommunications Union (ITU) by the concerned country by technical discussions with other satellite system operators. India has at present three fully coordinated slots — at 74 degrees East, 83 degrees East and 93.5 degrees East — and is trying for more slots.

The Indian Space Research Organisation (ISRO) was one of the first to consider co-locating satellites for operational use. When the indigenous Insat-2 satellites were being configured in the early Eighties, the sizing of these satellites became an important issue. One possibility was to use large satellites which would provide the most efficient use of the orbital slots. But such large satellite would be beyond the indigenous launch capability being developed. It was decided, instead, that medium sized satellites would be used for the Insat-2 system, co-locating them when there were no free slots available. This option had the added advantage that satellites could be put into orbit to keep pace with the rate of utilisation. Also, the spare satellite which had to be kept in orbit in case any one satellite failed could be smaller and cheaper than if a large satellite was involved.

The Insat-ID, the last of the Insat-1 satellites bought from the Ford Aerospace of the US is occupying the 83 degrees slot. The Insat-2A and 2B are in the 74 degrees and 93.5 degrees slots respectively. The Insat-2C is to be co-located with Insat-2B at 93.5 degrees. The Insat-2D, when it is launched next year, will be placed alongside the 2A at 74 degrees.

Normally, satellites are kept at least 2 degrees apart in geostationary orbit. Since the largest earth stations in India — which would have the narrowest beam — have a beam-width of 0.3 degrees, the co-located Insat satellites are to be held within 0.1 degrees of each other so that they appear as one large virtual satellite. The ultimate aim is to keep them between 0.05 and 0.1 degrees apart, which translates into a distance of just 35-70 km apart.

In the C-band and extended C-band, the signals from the two co-located satellites are linearly polarised. The antennas of the satellite have been designed for high polarisation purity (a minimum of 30 dB). In addition, to provide greater operating margins, the transponder centre frequencies for the normal C band channels have been staggered.

Earth stations will need antennas with dual feeds, with separate low noise amplifiers and ports, to receive signals from both satellites. Receiving equipment available to cable TV operators already have such facilities. Alternatively, with a single feed, if signals from only one of the co-located satellites have to be received, the feed may have to be rotated by 90 degrees.

Atmospheric conditions, such as rain, can rotate the plane of polarisation and reduce the cross-polarisation isolation. Changes in the satellite's orientation (technically known as attitude), especially in the yaw axis, can also rotate the plane of polarisation. The cross-polarisation isolation provided by the antennas on the satellite has sufficient margin to

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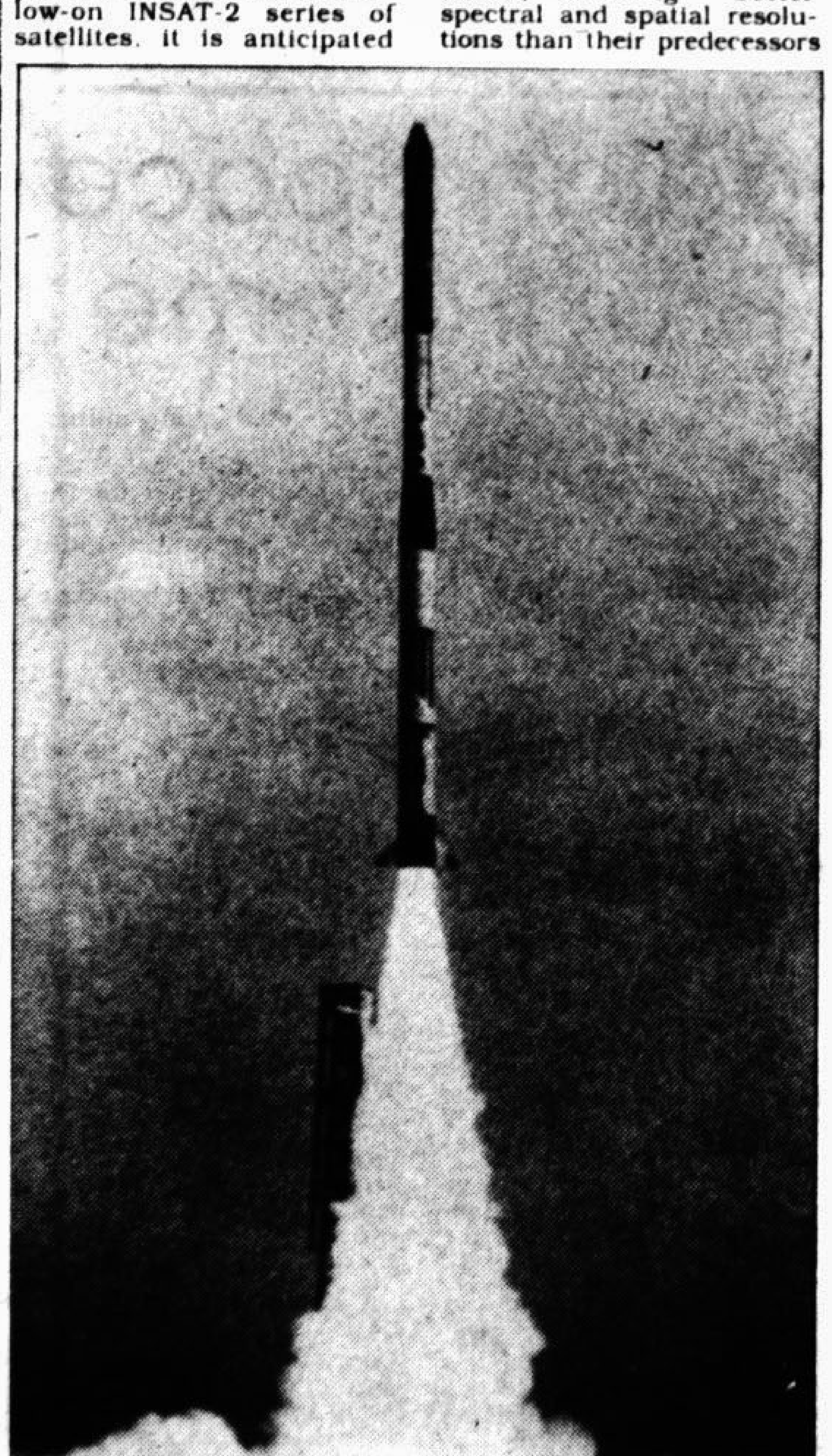

Augmented Satelite launch vehicle ASLV

Space Market Global Here

QUIETLY and efficiently, India is all set to expand its sphere of influence in the multi-million dollar global space market. In a landmark development, the Washington-based global satellite communications consortium INTELSAT, made up of 134-member countries, has entered into an agreement with the Indian Space Department for the leasing of eleven 36-Mhz units of C-band transponders on board INSAT-2E, a fully Indian designed and developed domestic spacecraft to be launched in 1997. Featuring several advanced technologies, INSAT2E will be one of the largest satellites in operation in the Asia-Pacific region. The agreement will fetch a net US $ 100-million to India over a period of ten years. Moreover, with the strategic alliance with Intelsat, INSAT system will play a key role in the fast changing satellite communications scenario of the region.

As it is, the flawless performance of the fully Indian made second generation INSAT spacecraft, INSAT-2A and INSAT-2B, launched by the Ariane vehicle of the European Space Agency (ESA) in 1992 and 1993 respectively, has boosted India's image as a world class builder of state-of-the-art commercial spacecrafts. A third satellite in the series, INSAT-2C, was launched recently in December 1995, and has started functioning very well.

This significant breakthrough for Indian space capability in the world space market was preceded by a lucrative deal that the EOSAT

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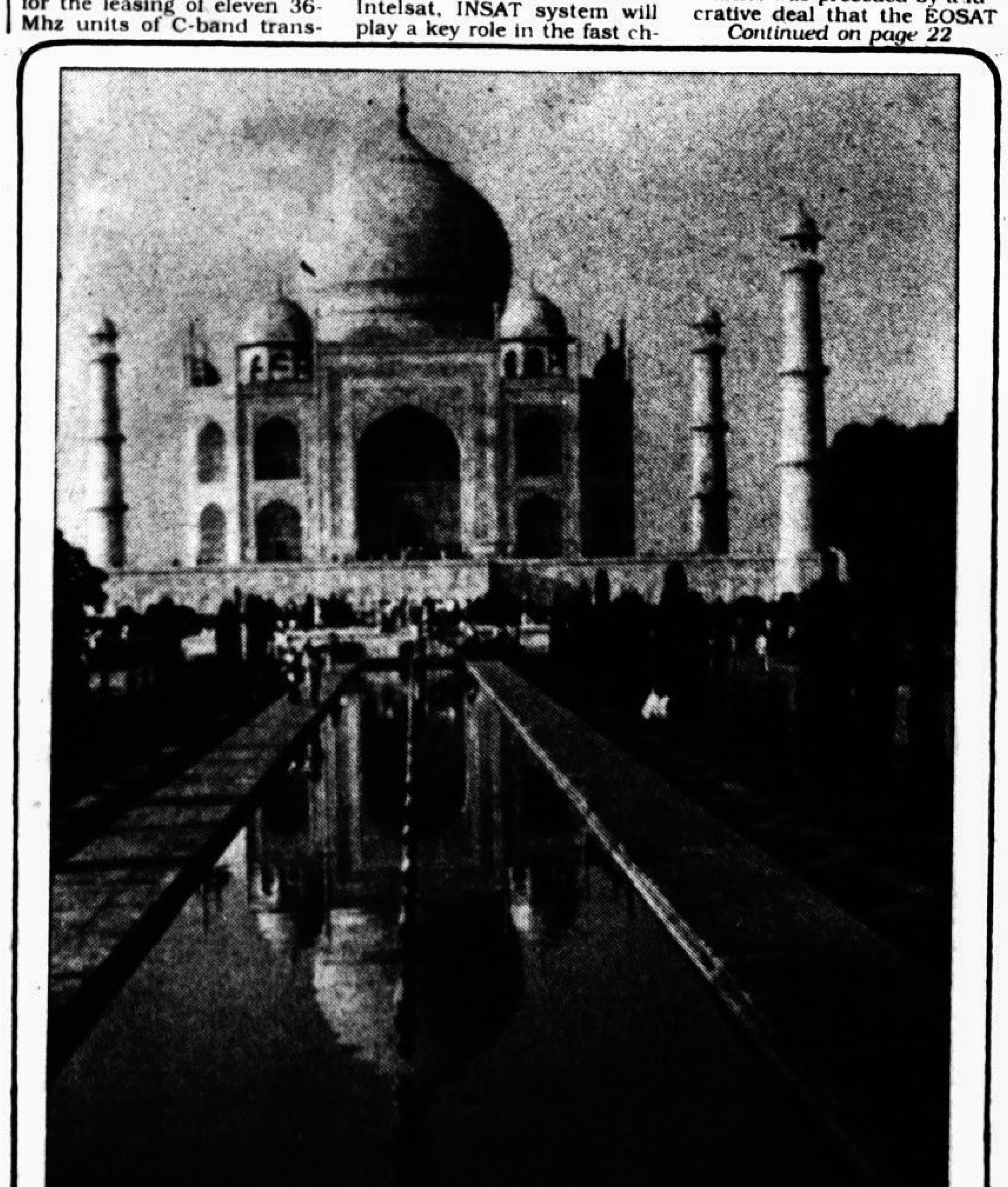

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