Living amongst the Stars

at the Johannesburg Observatory

Dirk J Vermeulen

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Dirk J Vermeulen

The author received a BSc degree in Electrical Engineering from the University of the Witwatersrand in 1953. Following early retirement from the electronics industry he has been able to indulge in his interests including archaeology and the history of science and technology.

For the past 20 years much of his life has been devoted to the development of the South African Institute of Electrical Engineers (SAIEE) Historical Section. The SAIEE have their headquarters in Innes House and this being very much a part of the Johannesburg Observatory the author and many of its members have had a natural interest in the history of the site. When Rosemary Falcon, Chairperson of the Associated Scientific and Technical Societies (AS & TS), suggested that a history of the observatory was badly needed the author was easily persuaded to take on the task.

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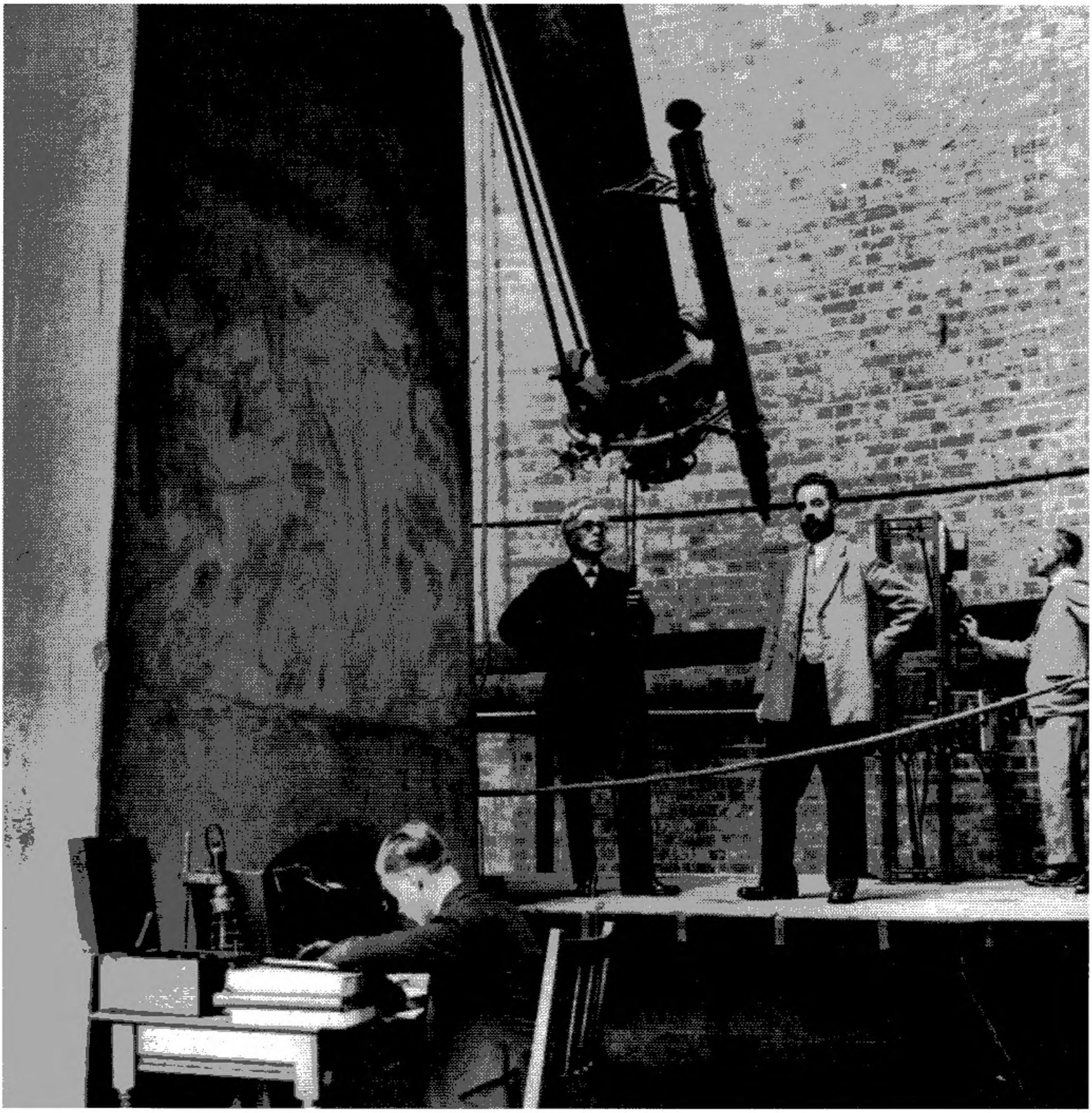
at the Johannesburg Observatory



The four Union Astronomers from left to right: WS Finsen (seated), RTA Innes, Dr WH van den Bos, HE Wood

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Acknowledgements

This book started when the president of the Associated Scientific and Technical Societies, Rosemary Falcon, proposed opening the Johannesburg Observatory to a wider public. She felt the need for a booklet on the history of the site and I undertook to produce such a document. It soon became clear that the subject deserved a more comprehensive coverage and this book was born.

I have had to depend heavily on expert help and therefore wish to express my gratitude to the following without whom this book could not have been written.

I want to thank Jan Hers, the acting director of the Observatory until it was closed in 1971. He has provided me with copious details about the Observatory generally and particularly on the time service. Jan had accumulated a great deal of information on the Observatory intending, I believe, to write the full story himself – he graciously shared this information with me and this book owes a great deal to him. Fortunately he had kept copies of the annual reports of the Observatory submitted to the Royal Astronomical Society and provided me with copies of these invaluable documents.

At the beginning of my search Ferdinand Potgieter, previously Information Officer of NITR, offered me the material he had put together (much of it from Hers) whilst he was working at the site and several illustrations showing the work of the NITR at the Observatory site. Thank you also to Ferdie for the Union Observatory sun compass which you donated to the SAIEE Museum.

Thank you to the late Danie Overbeek who spent many hours explaining astronomical technicalities to me and showed me where the main telescopes were located at the observatory. He also told me of his experiences as an amateur astronomer at the Observatory and read a draft of the story making several helpful suggestions.

More recently Brian Fraser, chairman of the South African Amateur Astronomical Association, and Atze Herder have contributed significantly by sharing their information on Franklin-Adams, minor planet discoveries and the association of the observatory with its counterpart in Leiden. They also read the draft manuscript and suggested several improvements.

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I am particularly grateful to Hazel Cunnington who by a remarkable series of coincidences put me in touch with Robert Innes's daughter, Winifred Gracie. Thank you Winifred for describing your

Acknowledgements

memories of Robert Innes and his family. Winifred provided me with several important photographs and other material which have enriched the story considerably.

Descendants of people who worked at the Observatory have been generous in allowing me to copy their records and for sharing their recollections to me. I would particularly like to thank Pamela Sorgentini (née Johnson), Elisabeth Lockwood (née van den Bos), Peter and Eyvind Finsen for allowing me to benefit from their family records and for their first-hand reminiscences.

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Most of all I want to thank my wife, Irene, for her constant interest in this book, for repeatedly editing the text and for her valuable suggestions. Without her constant support I would not have been able to complete this task.

Thank you SAASTA and especially Beverley Damonse for your support, encouragement and financial contribution which will make it possible to distribute this book to selected libraries that might not be able to purchase copies.

Last but not least I would like to thank my publisher, Chris van Rensburg, for taking on this book and his staff for their ever-friendly assistance. I particularly want to thank Beverley Lawrence for her meticulous attention to detail and for finding ways to make this publication work. I also wish to thank Alastair Pyper of Huegrey Graphics for his patience and perseverance during the proof-reading stages.

Dedication

To my wife, Irene, who lovingly coached me in the art of writing and provided the encouragement and helpful suggestions that were essential for survival on the long road to publication.

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Foreword

Beverley Damonse
Executive Director: South African Agency for Science and Technology Advancement (SAASTA)
SAASTA is a business unit of the National Research Foundation

South Africa's rich astronomical history dates from the early 19th Century. When management of the Johannesburg Observatory was transferred to the South African Agency for Science and Technology Advancement (SAASTA) in 2003, I began to uncover, for the first time, the rich history of this unique site which is perched on a koppie, overlooking the City of Gold. I was intrigued by the fascinating personalities and stories linked to science activities at the Observatory over the past century. We at SAASTA became excited at the possibilities it offered for enhancing our mandate and vision. The results of our investigations are plans for a vibrant science and education hub on this historical site. It is therefore an opportune moment for us to support the effort to record the enchanting story of this unique Observatory and make it available through a number of public libraries.

This book provides a historic perspective of the site, from its establishment over a hundred years ago on a bare koppie far from the centre of the city – where one could still encounter a leopard! – to the present day, when SAASTA has provided the site with a new vision as a thriving hub of science activity. This vision still conforms to the wishes of the original owners of the farm to use the site for astronomy and related science activities.

The story of the Observatory, like the tracking of the stars, proves to be a fascinating one. The book offers insight into the dedication of the astronomers of the previous century and their important and unique discoveries which added to the pool of scientific knowledge. One such example is Robert Innes's discovery in 1915 of the star he called Proxima Centauri, our Sun's nearest neighbour in the sky. Another I thoroughly enjoyed was the leading position taken by the Observatory staff in determining the orbits of the first Russian and American artificial satellites. The book does the history of the Observatory justice by capturing stories like these for all to enjoy.

As an important part of the National System of Innovation, the National Research Foundation is fortunate to lead and manage, through its business units SAASTA and SAAO, both the redevelopment of an astronomy site over 100 years old (Observatory Site and the latest, world-class Southern African Large Telescope (SALT), which marks the start of a new era in the region's astronomy. South Africa's astronomy vision is to remain world class and the countries facilities and observatories in addition to their primary research function, are wonderful catalysts for outreach programmes that aim to build a cohort of African astronomers and other science skills for the future.

I hope that this book on the history of the Observatory will inform and delight readers and also provide some insight into future plans to turn the site into an integrated, vibrant centre that will provide a unique, interactive science and education experience for its visitors for generations to come.

Introduction

Chapter 1

In the aftermath of the South African War the Transvaal Colonial Government was faced with many pressing claims on its resources. Under these circumstances it is surprising that they chose to open a meteorological station in Johannesburg knowing that it could not be expected to show immediate benefits. This account is largely concerned with what followed but to learn about the beginnings one must look back to see what was happening in the Cape.

The first Europeans to reach South Africa had to find their way by following the coastline and in bad weather it was easy to get lost. Bartholomew Dias encountered this problem when he rounded the Cape in 1488 and named it the Cape of Storms. Not only was there a pressing need for geographical and sky maps but also for a better understanding of the weather.

Several early visiting astronomers did much to improve the situation. At the start of the 19th century the British, who had just taken over the Cape, decided to build a permanent observatory. On 20 October 1820 an Order in Council called for the establishment of His Majesty's Observatory at the Cape of Good Hope with the cost being borne by the Navy. The first astronomer, the Rev Fearon Fallows, arrived in 1821 to establish the facility. He started by opening a school for the children of neighbouring farmers and succeeded in having the site levelled by charging a load of earth for each lesson given.

By 1841 regular meteorological observations were being made at the Observatory and a further nine weather stations had been established in the Colony by 1860.

During its remarkably successful existence the Cape observatory was home to many important astronomical measurements and discoveries. A number of first rate directors were appointed including David Gill (fig 1) who arrived in 1879 to continue the work of mapping the southern stars and who made some important measurements of the size and shape of the earth. He also improved the meteorological service by introducing better instruments and by arranging for regular inspections of weather stations to see that they were using their equipment correctly.

Before leaving Europe Gill had made a tour of European observatories and established contact with their astronomers including Prof JC Kapteyn at the Astronomical Laboratory of Groningen University in the Netherlands.

1.1 Gill's development of Astrophotography.

As an amateur astronomer Gill had successfully photographed the moon in 1869[44]. At that time most photographers were using the Collodion wet-plate process in which the light sensitive glass plates were coated with an emulsion just before use and had to remain wet throughout the exposure. With the exception of photographs of the sun[28] and the moon the long times required for astronomical work must have discouraged anyone from attempting to record star images with this

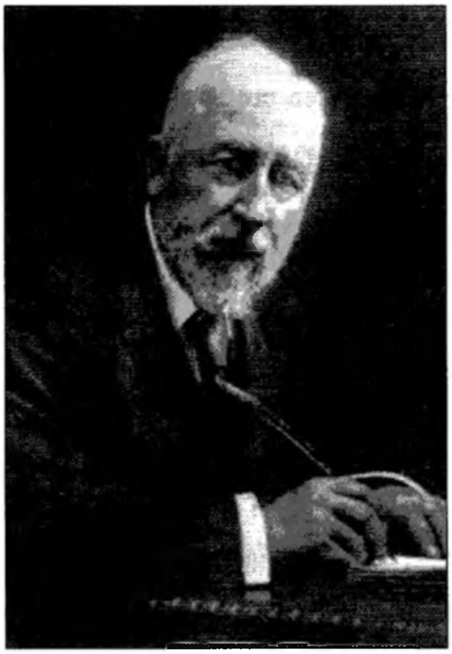


Fig. 1: *Sir David Gill (1843-1914), Her Majesty's Astronomer at the Cape of Good Hope from 1879-1906 (knighted in 1900)*

technique. When it arrived in the late 1870s the dry-plate process not only freed photographers from this restriction but also brought with it a significant increase in speed[67].

In 1882 the 'Great Comet' was successfully photographed several times in Cape Town. Gill also wished to record this important astronomical event and he persuaded AH Allis, a Mowbray photographer to assist him. They mounted Allis' standard camera fitted with a 2½-inch Dallmeyer lens with an 11 inch focal length on the Grubb 6-inch equatorial telescope to track the rotation of the earth and thus permit longer exposures. The new dry-plate technique[60] produced some good images of the comet and Gill was delighted to see that the background stars were also recorded faithfully. Paper copies of these records were sent to several astronomers and the negatives were deposited with the Royal Astronomical Society. This experience prompted Gill to explore the technique thoroughly and he obtained lenses of 33 and 54 inch focal length (6 inch diameter) from Dallmeyer for this purpose. The Royal Society made a special grant of £300 to Gill to continue the work and in 1885 a suitably qualified photographic assistant, C Ray Woods, reached Cape Town to assist Gill with a systematic survey of the skies[2].

The first application of his new technique was the mapping of the sky from the South Pole to -18° declination including all stars with magnitude greater than 9,2. Gill began this work in 1885 and the photographic records were completed by 1890. Gill persuaded Prof JC Kapteyn to undertake the arduous task of measuring and cataloguing the stars he had recorded photographically. This was fortunate as the Cape Observatory did not have the resources to cope with this work.

Kapteyn had been appointed to the chair of Astronomy and Applied Mathematics at Groningen University in the north of the Netherlands in 1878. This newly established department lacked equipment and Kapteyn needed something significant to engage his talents.

Kapteyn was aware of the paucity of data on the southern sky and realised that although this task was, to use his own words, 'the curse of astronomers' it was an important job that needed to be done[3]. It took Kapteyn seven years to measure and catalogue the 454 875 stars. The survey was completed in 1896 and was known as the Cape Photographic Durchmusterung (CPD). To quote Gill 'probably the most valuable result of the CPD to science is the fact that it first directed Kapteyn's mind to the study of the problems of cosmical astronomy and thus led him to the brilliant researches and discoveries with which his name is now and ever will be associated[9].'

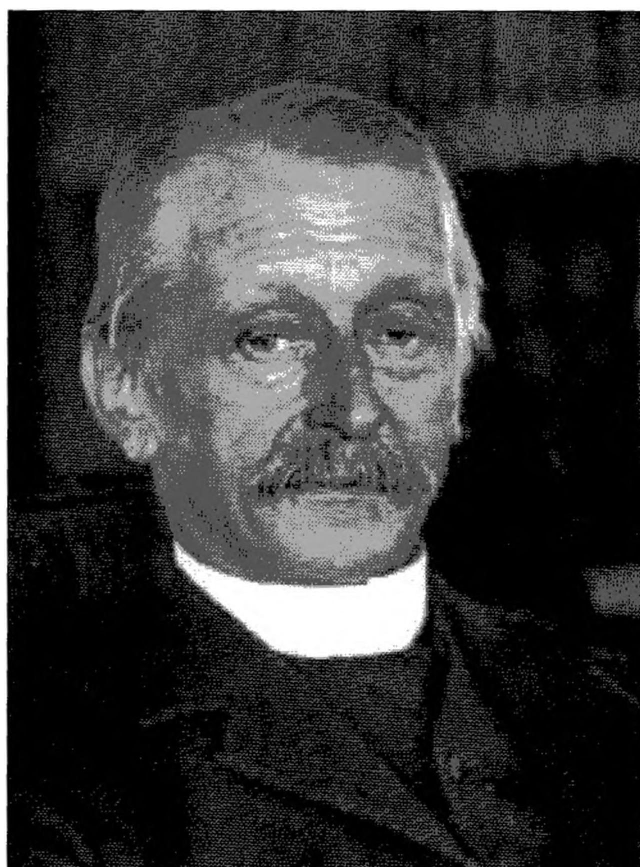


Fig. 2: *Prof JC Kapteyn (1851-1922) of Groningen University in the Netherlands*

The Transvaal Meteorological Department [21, 22, 26]

Chapter 2

By 1899, when the South African war started, basic meteorological observing stations had been set up in Kimberley, Pietermaritzburg, Bloemfontein, Pilgrim's Rest, Barberton, Pretoria and Johannesburg.

In 1902 Theodore Reunert (figs 3, 10, 118 and appendix 1), secretary of the Johannesburg branch of the South African Association for the Advancement of Science (S_2A_3), petitioned the Transvaal Government to establish an astronomical and meteorological observatory in Johannesburg. To their credit the Colonial Government responded positively and the project was started without delay.

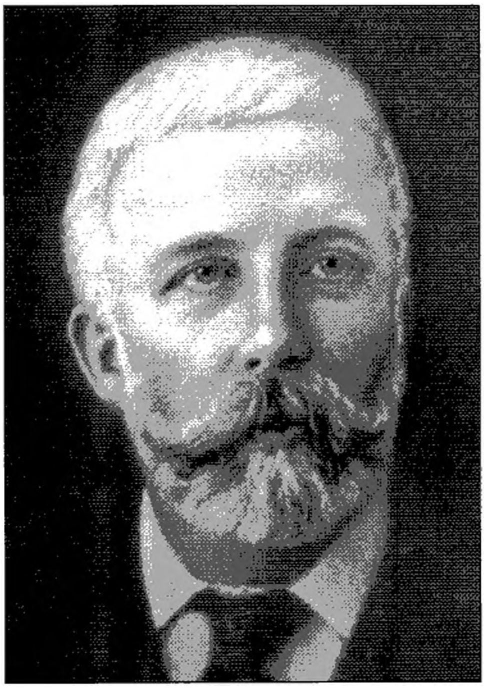


Fig. 3: *Theodore Reunert (1856-1943) was instrumental in starting the Transvaal Meteorological Department in Johannesburg*

The author could find no record reflecting the official point of view but the following, based on the information available, is a possible explanation for the priority given to this project: One of the foremost post-war objectives of the Governor of the Transvaal, Viscount Milner, was to re-kindle the economy. He naturally saw the goldmines as a prime target but he also believed that scientific agriculture was the key to long term success[6 40 43] and would thus have viewed meteorology as an important supporting service. As part of his determination to Anglicise the country Milner would also have seen this as an opportunity to promote Johannesburg with its largely English speaking population.

At some stage Gill probably experienced the remarkably clear night skies of the Highveld and realised that the future of astronomy in South Africa lay inland. He was known to have been friendly with Milner and at the same time he had a reputation for being successful in gaining official support for his projects[14]. Put these conditions together and it is not difficult to imagine that Gill might have persuaded Milner to build an observatory in Johannes-burg even before the Reunert petition appeared. It is possible that Gill prompted Reunert to initiate the S_2A_3 petition so that the request could be seen to have broad support.

The Transvaal Government decided to establish a Meteorological Department with headquarters in Johannesburg in November 1902 and ordered the required meteorological equipment by cable from London[68] but no provision was made for astronomical instruments. The original estimate of costs for the meteorological items for the first year of operation was £1 350 but this amount, rather surprisingly, was increased to £5 629 so that better instrumentation could be provided[26]. The Colonial Secretary invited Sir David Gill (knighted in 1900) to nominate a suitable director for the Transvaal Meteorological Station.

Gill recommended Robert Thorburn Ayton Innes (fig 4) who had occupied an administrative position at the Cape Observatory since 1896. Innes had actually been functioning on a far broader front than pure administration and had not only proved himself as an enthusiastic and effective astronomer but he had also taken an interest in the meteorological work done at the Cape. Gill knew that Innes would not rest until he had established an astronomical observatory on the Highveld.

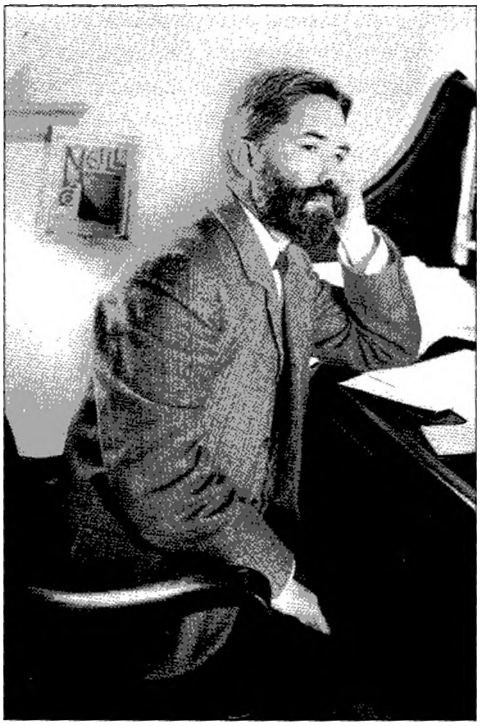


Fig. 4: *Robert Thorburn Ayton Innes (1861-1933) director of the Transvaal Meteorological Department (ca 1905) (SAAO)*

The Transvaal Meteorological Department was formally established on 1 April 1903 with Innes in charge. His first task was to find a suitable site for an observatory. He wrote to the Town Clerk of Johannesburg asking for his help and added the following comments:

> As you are no doubt aware, an observatory should be so situated that it has a free horizon in all directions, and cannot be closely built in by manufactories of smoky works. The actual ground required for the buildings is not large, but the observatory should be surrounded by grounds which could be made ornamental, and available to the public under easy restrictions.

Even at this stage it was clear that Innes was preparing for an astronomical observatory as well as a meteorological station.

2.1 Site of the Meteorological Department

In May 1903 Innes reported that the Bezuidenhout family had offered a suitable venue for the Government Observatory on their farm Doornfontein. The site ran northwards from the top of a koppie close to the northern boundary of the farm and to the west of the monument erected to commemorate the Indian soldiers who died in the South African war (figs 5 and 41). Eight acres were offered free of charge subject to the making and maintaining of a hard road from Bellevue East to the Bezuidenhout's homestead. When the road was eventually built it was named Observatory Avenue and still runs past the residence in what is now known as Bezuidenhout Park. The family also laid down the condition that the ground be used for purposes of science as carried out in an observatory for meteorological, astronomical, or strictly allied subjects. An additional 2 acres were offered for £500 making a total of 10,4 acres (4,2 Hectares)[86].

On 14 May the proposed site was inspected by:

Sir David Gill	representing the Government
Mr C Donnelley	representing the Public Works Department
Mr Burt Andrews	representing the Johannesburg Town Council
Mr Reunert	representing S_2A_3
Mr Dumat	representing S_2A_3
Mr Innes	

After viewing the site Gill described it as follows:

> I have little hesitation in saying that this is one of the finest in the world for an observatory. It is nearly 6 000 feet above sea level, the atmospheric conditions seem to be most favourable, and on my recommendation the site, 10 acres in extent, has been secured by the Government.

Gill recommended that the Government make a contribution of £2 000 towards the construction of the required 2 km stretch of road and that the extra 2 acres should be included in the transaction. In July 1903 Gill showed Herbert Baker (knighted in 1912) the site and asked him to prepare plans for a director's house and for the meteorological observatory.

The site was first occupied in May 1904 when Innes moved in to prepare it for the forthcoming

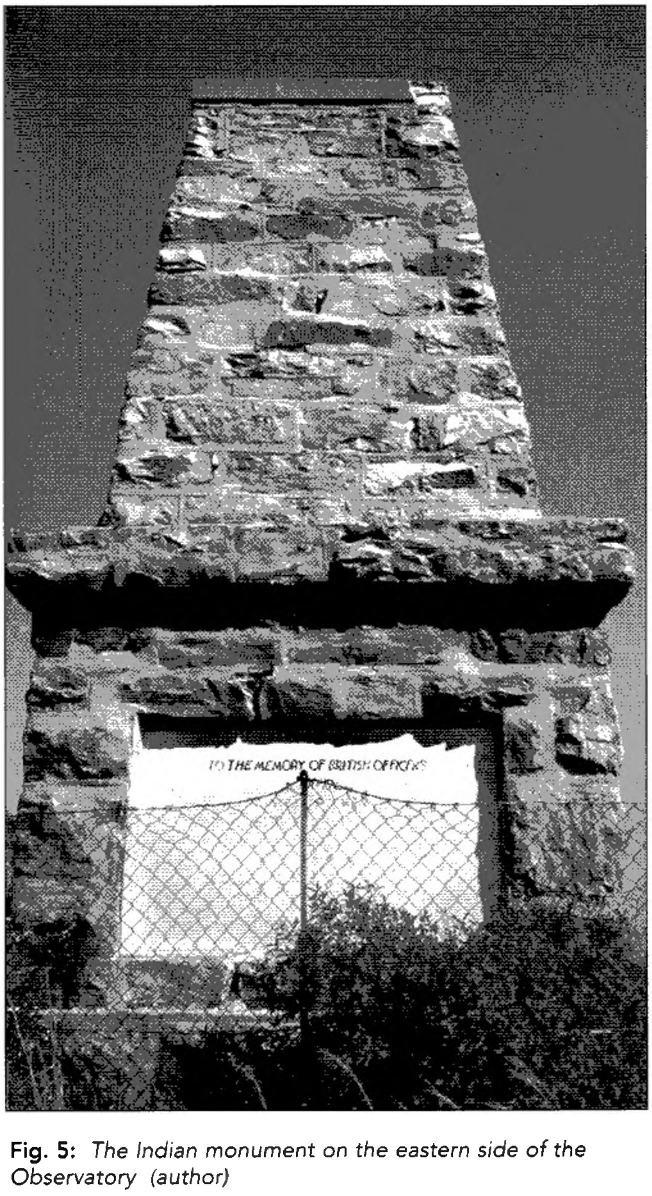


Fig. 5: *The Indian monument on the eastern side of the Observatory (author)*

Observatory. The wood and iron prefabricated house shown on the right hand side of (fig 20) was erected to house Innes and his family.

Today it is not easy to imagine just how far out of town this spot was and it is interesting to hear the comments made by the astronomer Willem de Sitter when he visited the Observatory in 1905 with members of the British Association. Late one evening he tried to find a cab to take him to the Observatory but was told that they were not willing to venture so far into the country after sunset[7].

2.2 The opening

The Baker building at the top of the hill (the lintel above the west entrance is inscribed Library) was officially opened by the Governor, Viscount Milner, at 4 pm on Tuesday 17 January 1905. Figs 7-10 show that this was a gala occasion. A full list of the distinguished guests is given in appendix 2 and some of these can be seen in the group photograph (fig 10). The Band of the South African Constabulary entertained the guests as they inspected the many instruments in use at the observatory[78,88].

Innes made the first speech in which he summarised the meteorological work that had previously been done in the Transvaal. He also reported that in addition to the measurements then being taken at the observatory 350 voluntary observers reported rainfall in the Transvaal.

Sir David Gill followed stating that the establishment of the observatory marked an epoch in the

Fig. 6: *The official invitation to attend the opening of the Transvaal Meteorological Department. On the reverse side attendees were invited to take advantage of the half fare offered by the railways to anyone wishing to attend the ceremony (Museum Africa)*

development of the country. He expressed the view that the first stage of development of a community was to find something to eat followed by the second stage which was to avoid being eaten. In spite of the unusually high intellectual level of many of the inhabitants of Johannesburg he believed that the community had not yet advanced much beyond those early stages.

He pointed out that due to insufficient personnel the meteorological work being done at the observatory was restricted to the mundane. Whilst admitting that, for several geographical reasons, the Cape Town observatory was not making weather predictions he believed that given a suitably trained assistant Innes could initiate a successful weather forecasting service in the Transvaal.

Gill then urged for a start to be made on the intended astronomical section and suggested that with inexpensive equipment they could start by providing a time service, which would have been invaluable in view of the frequent interruptions to the telegraphic time signals coming from the Cape.

Fig. 7: *Viscount Milner opening the Transvaal Meteorological Department on 17 January 1905 (AS & TS)*

Fig. 8: *Visitors attending the opening of the Transvaal meteorological station (AS & TS)*

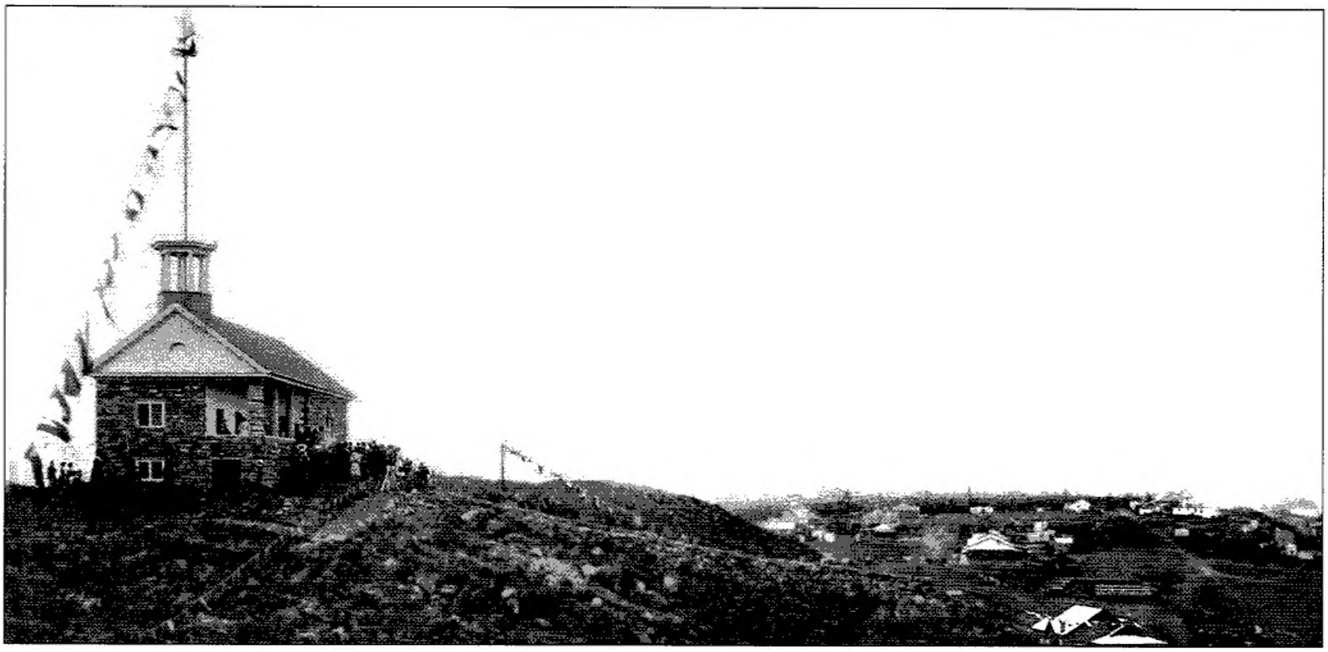


Fig. 9: *A view from the East of the Baker Library at the official opening in 1905. Note the emergence of the new suburbs of Yeoville and Bellvue East in the background (AS & TS)*

Fig. 10: *Some of the distinguished guests who attended the opening of the meteorological station. RTA Innes (with beard) is seated behind the lady with the veil, to the right of him is Viscount Milner followed by Sir David Gill and Theodore Reunert President of the South Africa Association for the Advancement of Science (AS & TS)*

He pointed out that Johannesburg with its dependence on technology already owed a great deal to science and that local donors might be willing to sponsor instruments so that Innes and his team could start making a contribution to astronomy.

In his opening address Lord Milner agreed that the observatory should provide both weather forecasts and become active in astronomy but that these functions would have to wait until funds became available. He stated that many things, including education and science, were unable to keep pace with the rapid growth of the town and were a constant drain on the available resources. Milner appealed to local commerce and industry to contribute to the development of the observatory and to the establishment of a university in Johannesburg.

Mrs Mary Wood, wife of HE Wood Innes's chief assistant, confirmed the rather bare appearance of the Observatory site when she first arrived from England in those early days.

.... It is hard to visualise the bare veld and kopies of the beginning of the century when the Union Observatory was started. There were no made roads and the tracks of red earth were a very dusty nuisance on windy days. There were no trees for windbreaks so that we were also subject to thick clouds of dust from the mine dumps. On the bad days it was quite impossible to see more than about fifty yards. There were no lights. We went about at night with hurricane or candle lamps and maybe bumped into stray horses or donkeys in the dark. We frequently killed snakes and buck, hares and wild cats were very much at home.

According to Innes's annual report for 1905[89] the staff of seven comprised the following: The director, two assistants (RT Sutherland & L Carpenter), a computer (Mrs M Abbot), a correspondence clerk and two labourers. The correspondence clerk, Mrs S Human, eventually changed to computing and lived for some years with the Innes family before she retired in 1925[39].

Innes and his wife had started a tree-planting programme using saplings from the Department of Agriculture nursery at Irene[89]. Early photographs show that these were mostly pines. This was confirmed by Mrs Pamela Sorgentini[59] who was born at the Observatory in the '20s and lived on the site for more than 20 years. In her youth, despite the many introduced species, she was acutely aware of the indigenous plant life such as protea, aloes, stamvrugte and wild flowers. It is interesting to compare this statement with the early photographs taken at the opening of the Library in 1905 (figs 7-10). She was equally impressed by the abundant bird life that was particularly evident at dawn when the chorus was indescribable.

Fig. 11: *The staff of the Transvaal Meteorological Department when it was opened in 1905. Rear RT Sutherland, RTA Innes, L Carpenter. Front Mrs S Human, Mrs M Abbot (CSIR Archives)*

The rather rough ground at the top of the hill was moderated by removing loose rocks and by building pathways. The library was enriched by many valuable documents received from leading meteorological observatories and scientific institutions around the world and by departmental purchases.

2.3 The meteorological network and its equipment

At that stage 290 meteorological stations were reporting temperatures, rainfall, cloudiness, wind direction and speed to the Observatory from most parts of the Transvaal (this figure does not tally with the 350 stations mentioned by Innes in his speech given at the opening on 7 January 1905). Of these 30 provided data every morning either telegraphically or by telephone. Their equipment consisted of a total of 290 rain gauges, 56 sets of maximum and minimum thermometers, 46 wet and dry bulb hygrometers, and 27 barometers (for more details of the equipment provided at the observatory see appendix 3). Daily weather reports were communicated to the local press and to the other centres in Cape Town, Durban, Bloemfontein and Salisbury[89].

Figs 12-18 show some of the meteorological instruments installed at the Observatory. For further information on the meteorological equipment see appendix 3

2.3.1 The lightning recorder

One of the few surviving meteorological instrument is the lightning recorder seen in fig 16 which was acquired by the Observatory in March 1905[89] and is now in the collection of the Historical Section of the South African Institute of Electrical Engineers. This most unusual device is very similar to the wireless telegraphy receivers made by Marconi at the end of the 19th Century and has recently created considerable interest both in South Africa and abroad[63]. Rather surprisingly the instrument was made by a Budapest company named Victor Hoser.

According to Jan Hers (Acting Director 1965-1971) Dr Finsen stated[25] that a similar instru-

Fig. 12: *Innes standing next to the library amongst several meteorological instruments ca 1907 (CSIR Archives)*

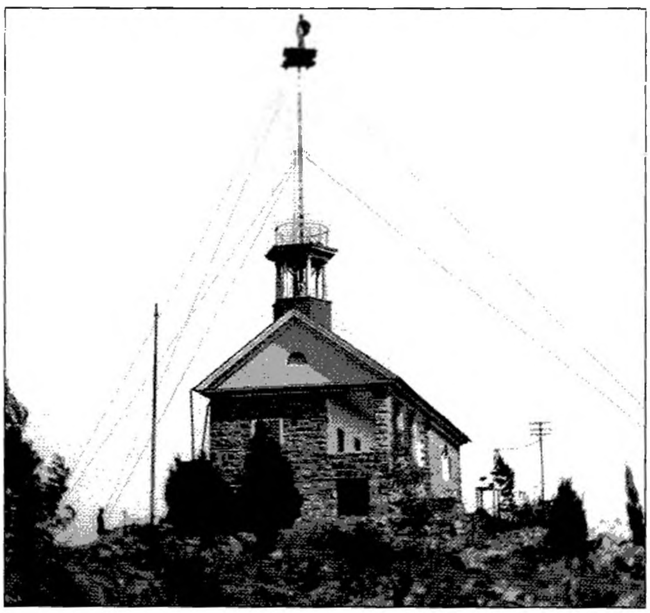


Fig. 13: *The Library from the East with the wind direction and velocity measuring equipment at the top of the mast being serviced (cf fig 136). Note the Symons evaporimeter supported on four legs and situated between the telegraph pole and the building (CSIR Archives)*

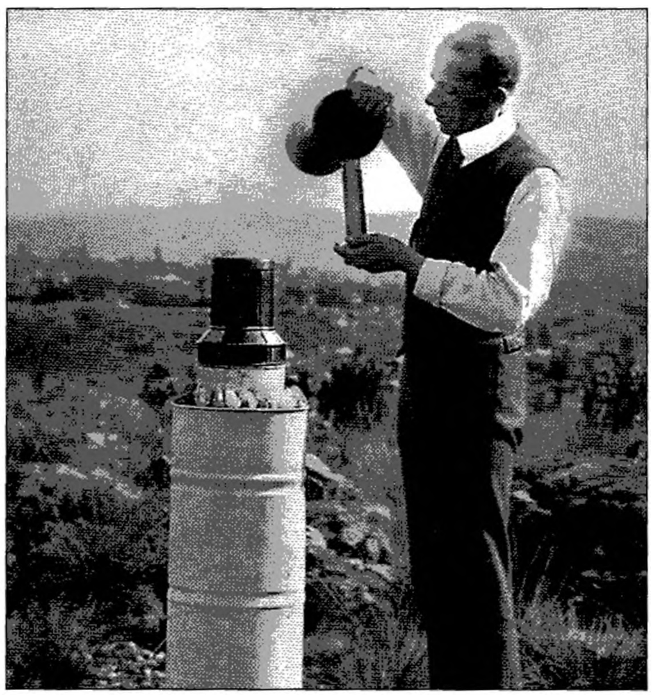


Fig. 14: *L Carpenter decanting one of the rain gauges into a measuring flask (CSIR Archives)*

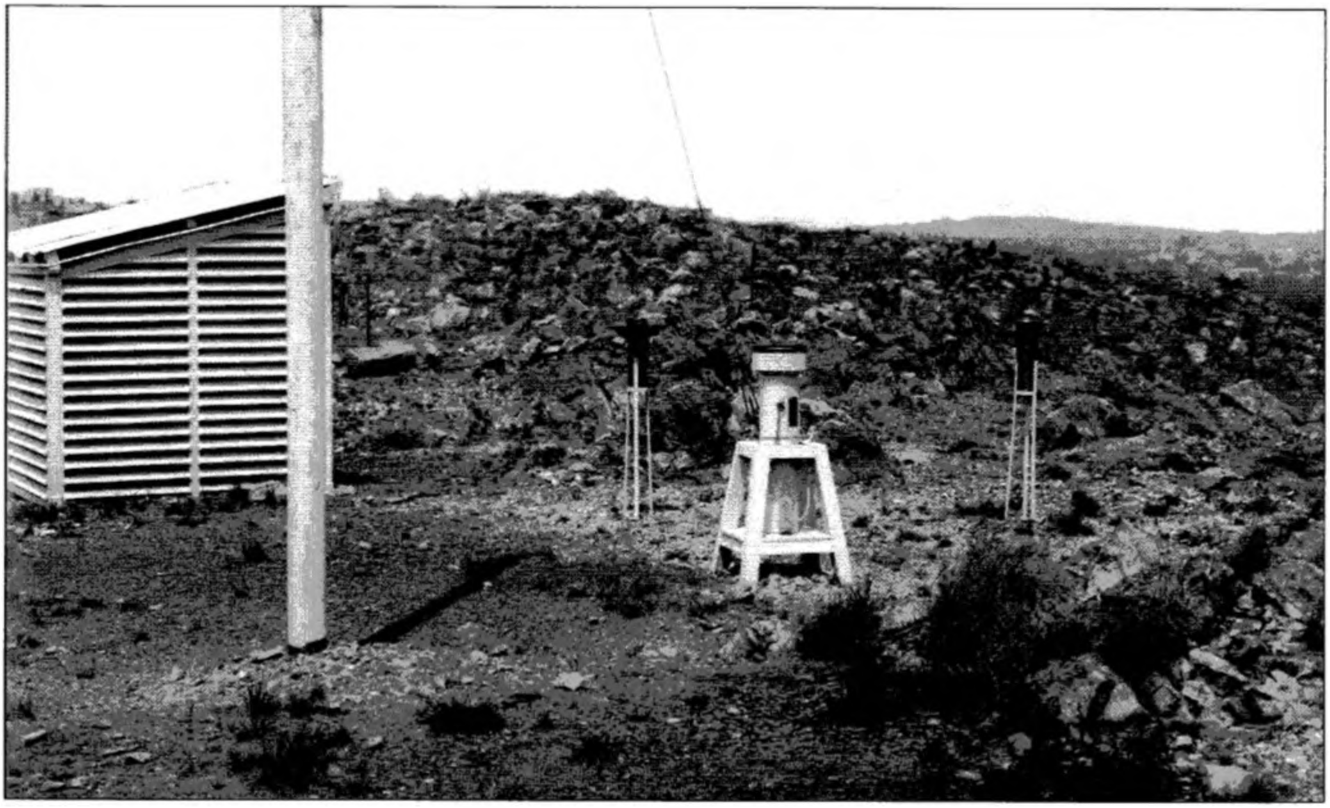


Fig. 15: *Three rain gauges and the louvered housing for the hygrographs and platinum resistance air temperature thermometers (CSIR Archives)*

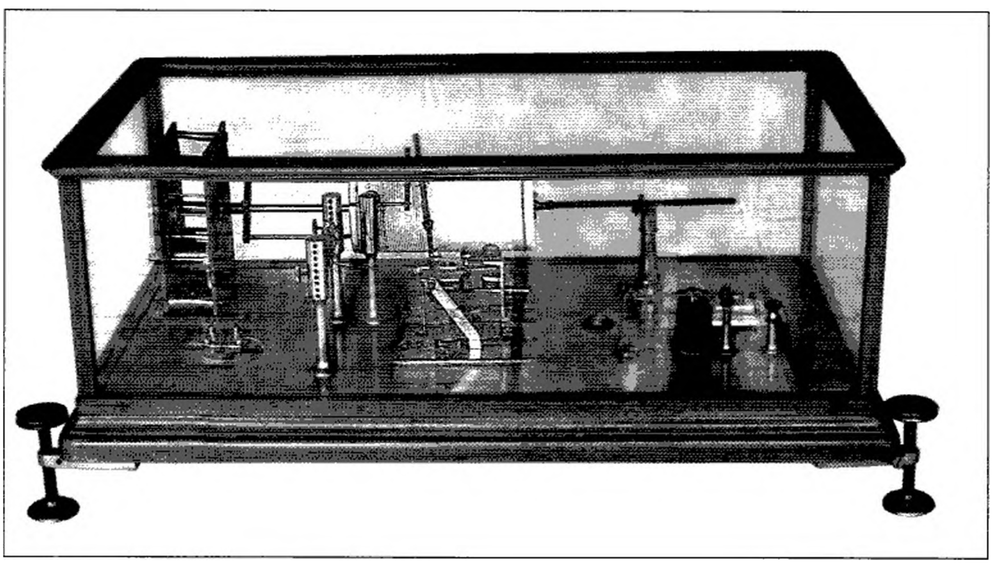


Fig. 16: *The lightning recorder used techniques similar to those employed by Marconi in his early wireless telegraphy receiving equipment (author)*

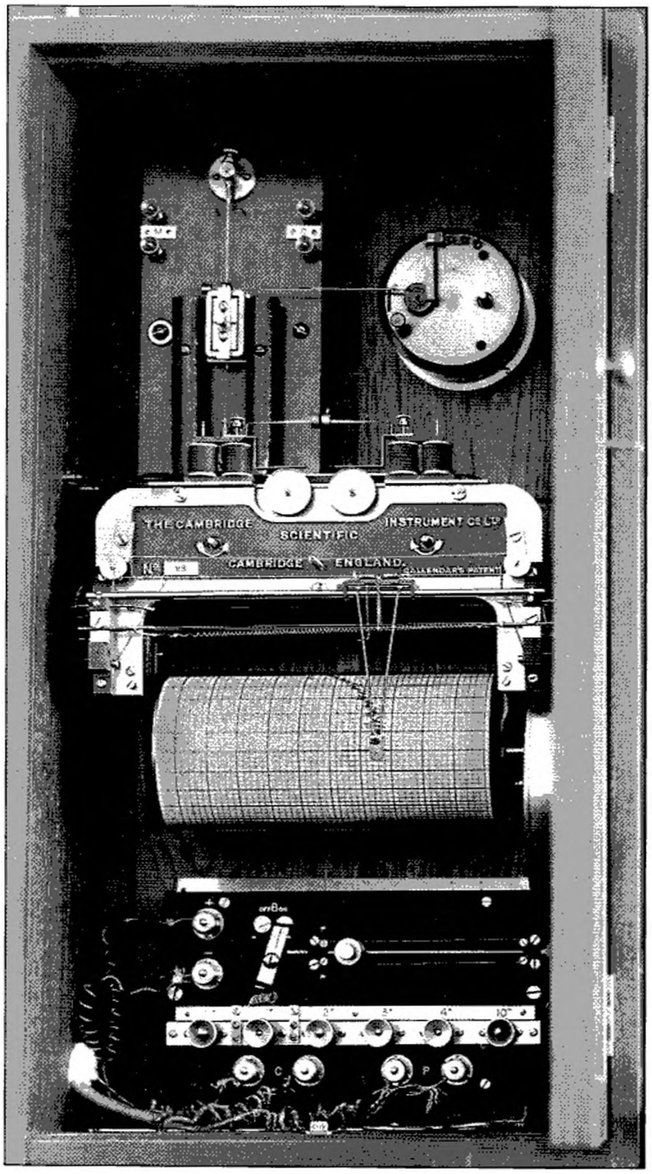


Fig. 17: *One of the Callendar recorders for the platinum resistance thermometers. For more information on this instrument see appendix 3 (CSIR Archives)*

ment was used at the meteorological station at the Modderfontein dynamite factory. Enquiries revealed that many of their specialist staff had been recruited in Europe. In particular the manager, Dr Franz Hoenig, had previously worked at an explosive factory not far from Budapest where he probably heard of such equipment. In an area with a high incidence of lightning, which can be hazardous in an explosive works, management would quite likely have purchased such an instrument as an early warning device and to gather seasonal statistics. The Modderfontein meteorology station reported data regularly to Innes[34] so he would surely have been aware of their lightning recorder and presumably felt that a similar instrument should be installed in Johannesburg.

2.4 Earth Tremors

A Wiechert seismometer located in the basement of the library building was installed to record earth tremors. From the annual reports of the Observatory between 1914-1919[75] these were sufficiently frequent (893 in 1915) and violent to cause public concern and led to the establishment of a commit-

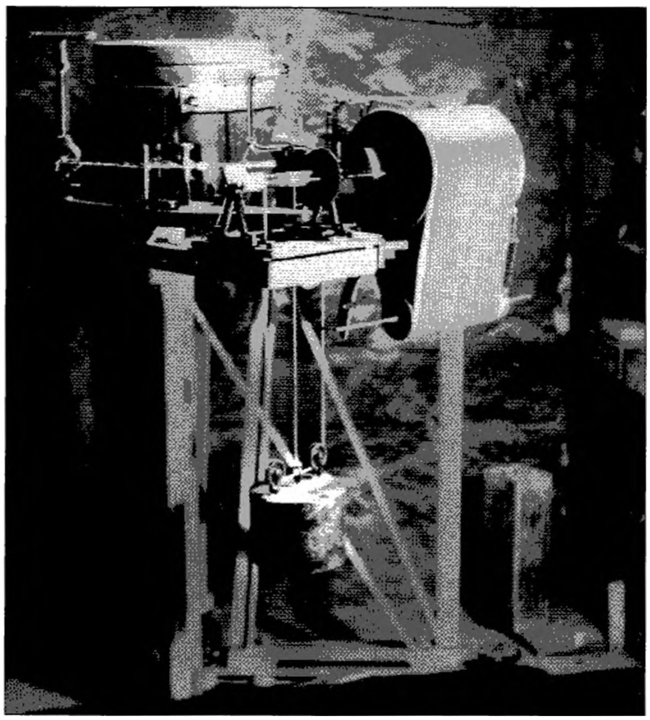


Fig. 18: *The Wiechert seismograph installed in the basement of the Library (the entrance to the cellar can be seen in fig 13) (CSIR Archives)*

tee of enquiry which included Innes. In the years that followed the frequency decreased although Innes made the following comment in his annual report for 1916[75] 'several shocks have been strong enough to rattle the whole town.' After 1919 the problem no longer appeared in the annual reports and it seems that the public had become accustomed to the regular tremors and accepted them as being relatively harmless.

In 1953 the problem again reached serious proportions and reappeared in the annual reports. At that stage Johannesburg was experiencing over 4 000 earth tremors a year. These were graded from light to very very strong and, on average, between 1953 and 1955 one of the latter occurred each week. On occasion windows were broken and walls were damaged by the more severe shocks.

Most people were convinced that these were due to mining activity but the mining companies denied this and maintained that they were natural. Dr WS Finsen analysed the accumulated seismic records and showed a clear correlation between tremors and blasting times on the mines. On Sundays when there was no blasting there was little seismic activity and on Saturdays, when blasting started an hour earlier, the tremors followed the same pattern.

It is noticeable how with time earth tremors are now almost unknown in Johannesburg.

Running a meteorological station in these remote parts was fraught with difficulties. Many of the delicate and expensive instruments arrived damaged and had to be returned to the manufacturer for repair. Barometric measurements could not be compared between stations of uncertain altitude and the observatory was the only station in the Transvaal with a known height. As an example from a more established part of the country the Meteorological Commission had assumed the altitude of the barometric station at King William's Town to be 1 647 feet. When the railway was completed and the height of the railway station was calculated by the surveyor they found the correct altitude to be 1 313 feet![34]

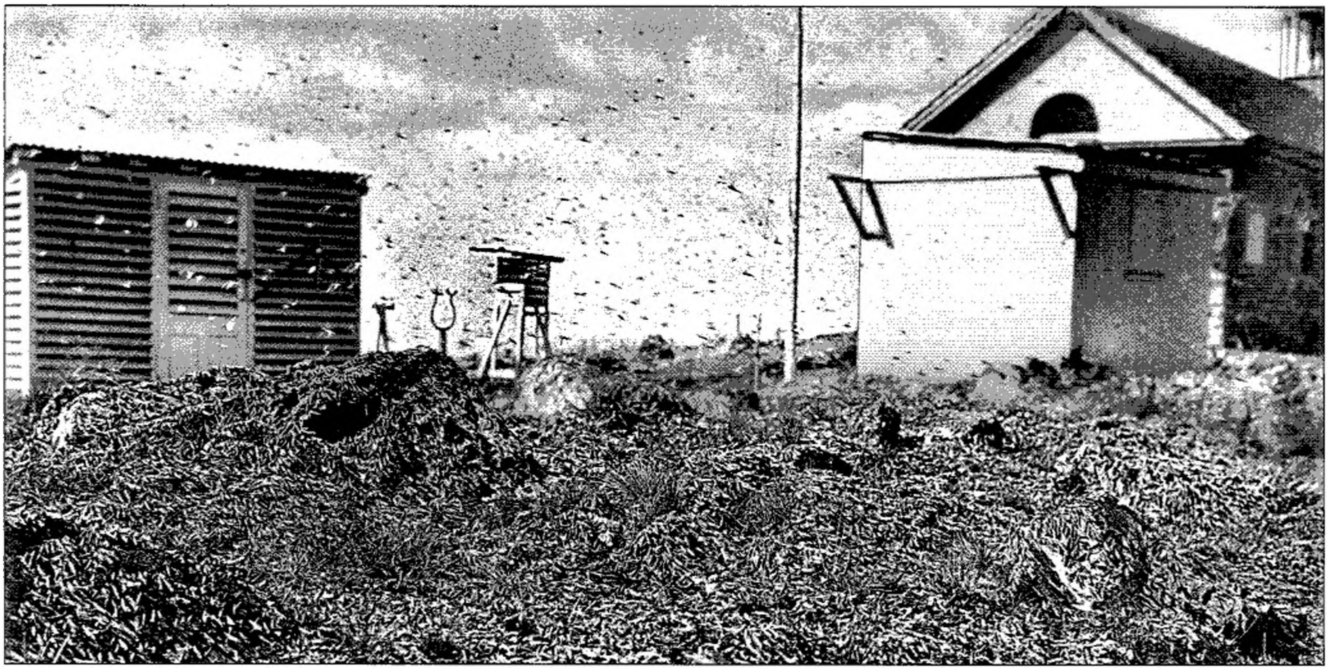


Fig. 19: *A plague of locusts descended on Johannesburg in the early days of the meteorological station (CSIR Archives)*

In spite of his predilection for astronomy Innes and his staff applied themselves enthusiastically to the task of creating a top class meteorological service. He persuaded the Central South African Railways to take measurements at railway stations and to report the daily results by telegraph.

By 1 July 1906 Dr H E Wood, having recently joined the staff, started the first regular weather forecasting service in South Africa[34 36]. These predicted the weather for the next 24 hours and were displayed at every telegraph office in the Trans-vaal[94].

2.5 Observatory residential township

In 1903 soon after the establishment of the site for the Transvaal Meteorological Department The Reserve Investment Co Ltd established the Observatory Township on the site of the farm Doornfontein.

2.5.1 The first two homes built at the Observatory

The wood and corrugated iron dwelling on the western boundary of the observatory site (fig 20) was prefabricated in the UK by Boulton and Paul and was still in use in 2001. Such houses were manufactured and exported to colonial countries such as India and South Africa to house military officers. Several were erected at Roberts Heights (later renamed Voortrekkerhoogte) at the time of the South African War and one of these was translocated to the observatory. General Smuts's house at Irene is another example of such a prefabricated house.

The double storey house on Gill Street was built for the director in about 1910 following plans drawn up by Herbert Baker in 1904. According to Martinson[41] the Public Works Department probably modified Baker's original design. The South African Institute of Electrical Engineers are the present owners of this building which had become known as Innes House (figs 22-24).

It is fitting that the road on the northern boundary of the observatory should have been named Gill Street and that Innes House should face down

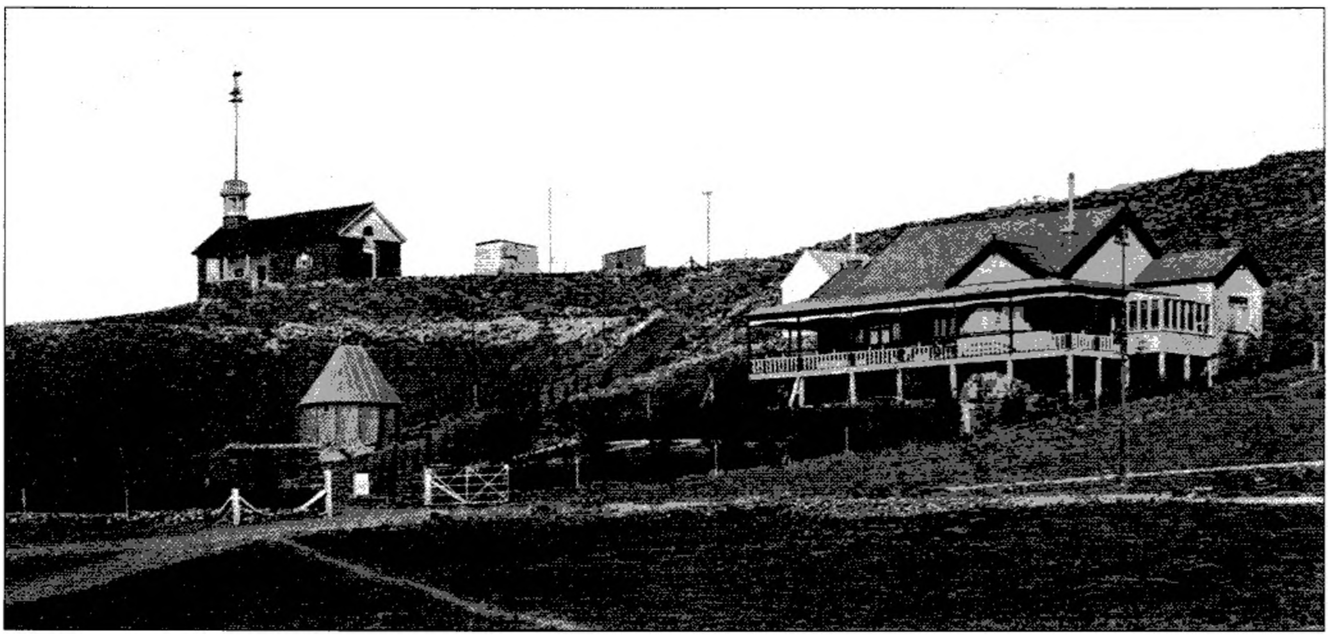


Fig. 20: *The Boulton and Paul prefabricated house, used by Innes from 1904-1910, can be seen on the West side of the site. Note the 9-inch telescope housing on the right hand side of the house (Museum Africa)*

Fig. 21: *Circa 1910 note the newly erected walls of the $26^{1/2}$-inch telescope dome and associated offices on the left-hand side and the roof of the housing of the Franklin-Adams 10-inch camera below and to the left of the library building (SAAO)*

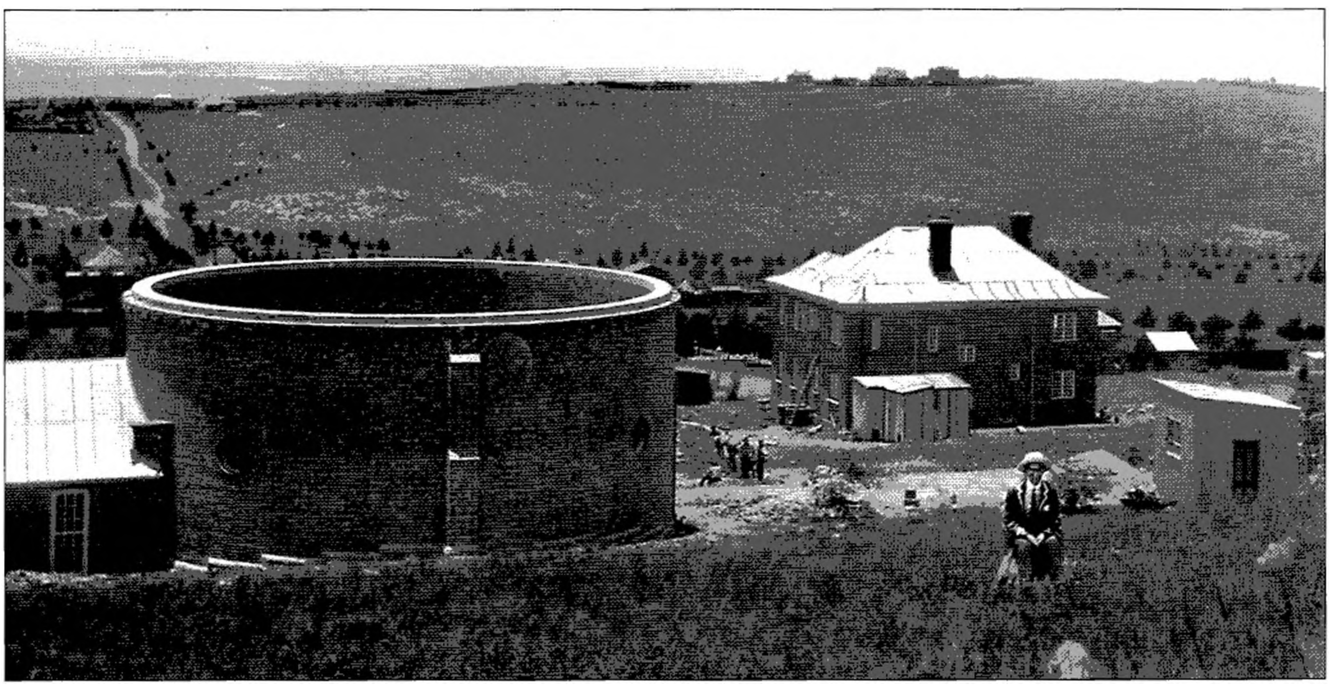


Fig. 22: *The Director's house and the $26^{1/2}$-inch telescope housing nearing completion ca 1910. Arthur Innes, youngest son of RTA Innes, is sitting on a rock in the foreground (CSIR Archives)*

Fig. 23: *The Director's house in June 1999 now known as Innes House has become the home of the South African Institute of Electrical Engineers (author)*

Fig. 24: *The inglenook in the vestibule of Innes House (June 1999) (author)*

Innes Street (fig 137). Several other streets surrounding the observatory were also named after astronomers. According to Anna Smith[58] Clerke Street on the western side of the site was named after Agnes Mary Clerke (1842-1907) a well-known British astronomer. Gascoyne Street was originally named Kapteyn Street after the Dutch astronomer who measured the photographic records produced by Gill to compile a catalogue of 500 000 southern stars (the CPD). Two residents, Messrs J Gassner and H Cohen, complained that their mail was being misdirected due to confusion with Kapteijn Street in nearby Hillbrow. In 1922 the Johannesburg Works Committee agreed to change the name to the composite name Gascoyne[58]. The origin of Steyn Street to the north east of the observatory is not certain but it has been suggested that it may have been intended to be Stone Street after E J Stone who had preceded Sir David Gill as Her Majesty's Astronomer at the Cape.

Figure 25 (probably taken by HE Wood ca 1908) shows the Observatory library building and the Boulton and Paul prefabricated house with some of the surrounding suburban houses (Observatory Avenue can be seen running through the middle of the picture). In figure 26 the double storey director's house and the 26½-inch telescope dome have been completed and several additional suburban houses have appeared – note that the saplings evident in fig 25 have grown considerably. Figure 27 shows a similar view from the intersection of St Georges and Innes Streets in 1936.

2.6 The Observatory leopard

On 5 July 1918 the Rand Daily Mail[79] reported the discovery of a leopard at the Johannesburg Observatory. At about 13:30 on the previous day one of the female staff working in the library at the top of the hill came out of the building and found a fully-grown leopard standing on a bare stony ridge not more than a dozen metres from her. Badly shaken she ran back into the building and telephoned the office next to the 26½-inch telescope exclaiming 'Hello! Come quickly! There is a leopard up on the koppie!'. It is not clear whether Innes or Wood answered the telephone but whoever it was his first reaction was to laugh as he was quite sure that she had been seeing things. Instead he quipped 'Well put some salt on its tail.' After further excited exhortations both Innes and Wood hurried up to the library to rescue her. On arrival they could find

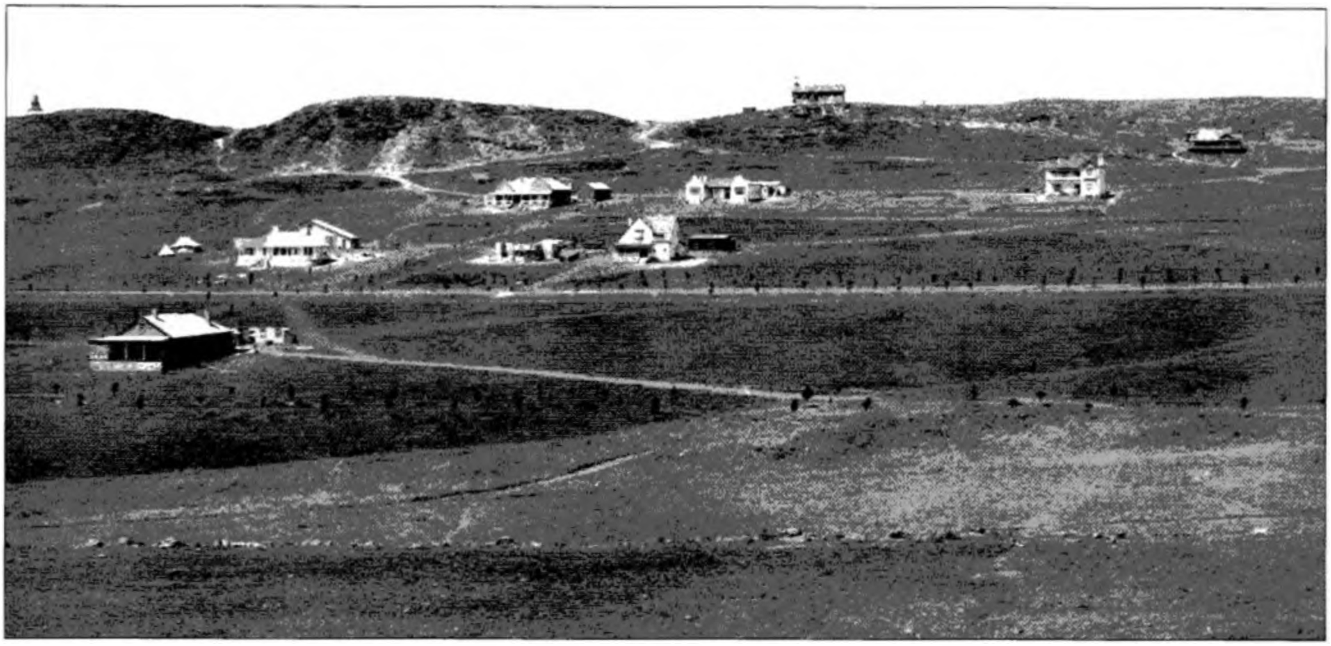


Fig. 25: *The two buildings of the Transvaal Meteorological Department at the top of the ridge are accompanied by some of the earliest residences in the new suburb of Observatory (ca 1908) (HE Wood))*

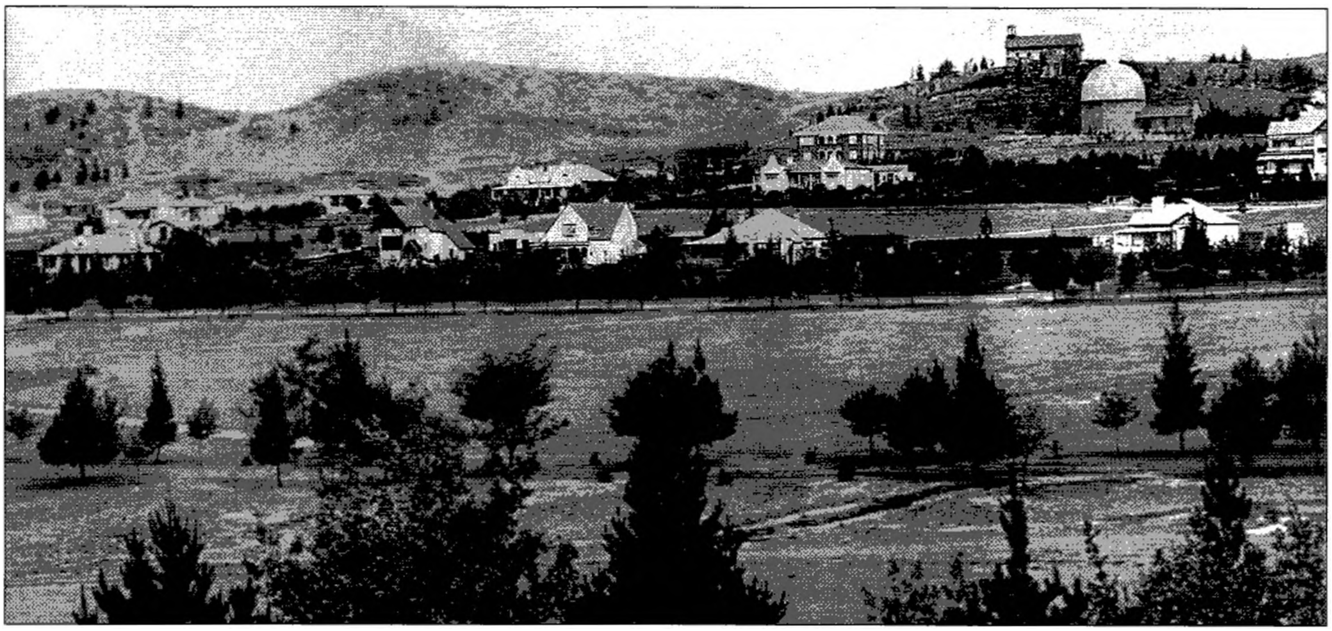


Fig. 26: *The saplings just visible in fig 25 are growing rapidly and several additional dwellings can be seen in this later photograph (ref 39)*

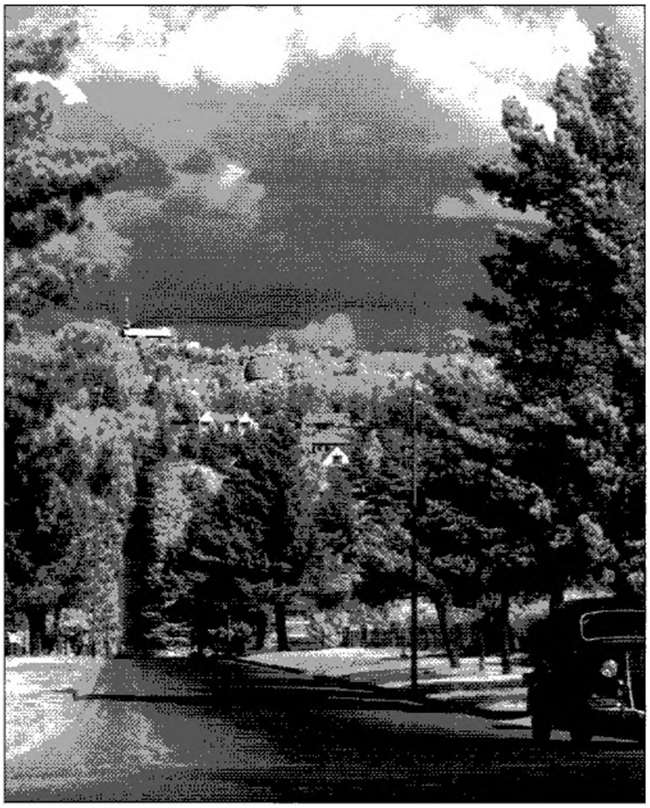


Fig. 27: *By 1936 the buildings of the Union Observatory were almost obscured by the trees of suburban Observatory (HE Wood)*

no leopard and started a search for the animal. Eventually one of the dogs started sniffing around some dense bushes at the north-western corner of the property facing Gill street. A fence separated the observatory from the street and the unfortunate animal had been trying unsuccessfully to break through the wire. In the meantime constables van der Merwe and Walsh of the Yeoville Police armed with rifles had arrived in Gill street. As the leopard made a further attempt to jump the fence it was killed by a shot in the forehead by constable van der Merwe (fig 28).

The most likely explanation for its appearance was supplied by Reuter's News Service as follows: Lord Buxton, the British High Commissioner, had been visiting Elisabethville (now Lubumbashi, Democratic Republic of the Congo) where he had been presented with a young lioness and a 3 year old leopard. The Pretoria Zoo had agreed to provide a home for them and they were despatched by rail. Unfortunately the leopard escaped on the way and it was believed that this was the animal that was shot at the observatory. The dead creature was in good condition and looked as though it had been well fed. How it had managed to traverse at least 3-4 kilometres from the railway through partially built-up areas without being seen was not explained.

Fig. 28: *The leopard shot on 5 July 1918 at the Observatory by constable (sic) van der Merwe who is assumed to be the policeman on the right whilst his colleague constable Walsh is in the centre holding the leopard (CSIR Archives)*

Astronomy comes to the Johannesburg Observatory

Chapter 3

At the beginning of the 20th Century there was a gross imbalance between the astronomical work being done in the southern hemisphere compared with that done north of the equator. The Science Yearbook for 1909 reported that there were only two telescopes larger than 15 inch in the whole of the southern hemisphere whilst the northern hemisphere had more than thirty times that number. Gill and Innes were well aware of the opportunities awaiting astronomers working in the south and did everything they could to gain official support for astronomical work to be started in Johannesburg.

In 1905 the British Association for the Advancement of Science (the BA) combined with S_2A_3 organised a special meeting in Cape Town which was attended by many leading scientists. Innes read three astronomical papers before this distinguished assembly[93].

Gill and Innes took the opportunity to ask members with an astronomical background to meet with the High Commissioner to support their appeal to the government for a large telescope at the new observatory. Professor Kapteyn made the following statement: 'In all researches bearing on the construction of the universe of stars, the astronomical problem of the age, the investigator was hindered by our ignorance of the southern heavens. Work was accumulating in the north, which was to a great extent useless, until similar work was done here. He was convinced that the erection of a large telescope here would be of the greatest service to astronomy generally.' Unfortunately the appeal fell on deaf ears.

In 1906 Dr Oskar Backlund, Director of the Imperial Observatory, Pulkowa in Russia and one of the delegates attending the BA meeting, asked Innes for assistance in an international programme of latitude variation observations. The axis of the earth's rotation is subject to slight but significant changes. Consequently the position of the poles change and cause variations in latitude. The International Latitude Commission was established to investigate these changes and stations in the northern hemisphere were established in Japan, Russia, Germany and the United States. They already had stations in Western Australia and Chile in the southern hemisphere but wished to have an additional station in South Africa.

The Transvaal Observatory was well positioned to assist Dr Backlund in this work but at that time they had no astronomical instruments. Dr Backlund offered to lend them a $2^{5/8}$-inch Bamberg transit telescope (fig 29). Government permission was required to undertake this work as it involved an estimated £300 to transport the instrument and to erect a suitable housing at the Observatory. A wood and corrugated iron shelter with a sliding roof was built to house the telescope which was mounted on a concrete pillar.

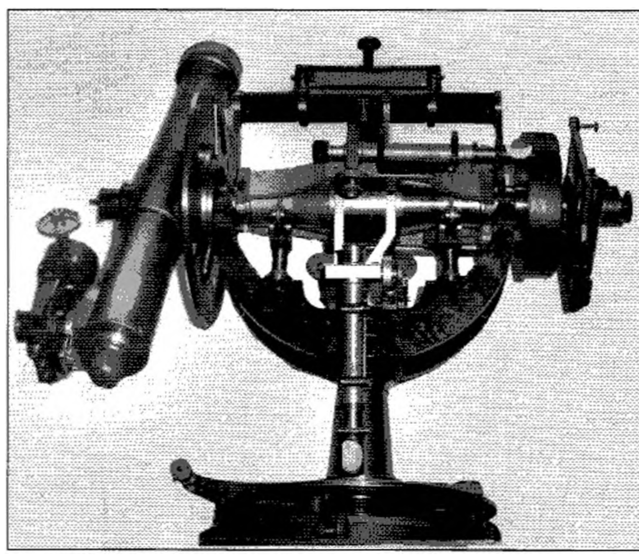


Fig. 29: *The $2^{5/8}$-inch Bamberg transit telescope (Ian Glass)*

By 1914 the Commission had satisfied themselves that the observations made in the northern hemisphere were compatible with those made in the southern hemisphere and the international observations were discontinued. The Russians never reclaimed the telescope and it remained in Johannesburg – it is now on display at the South African Astronomical Observatory (SAAO) offices in Cape Town.

3.1 Double stars

Innes had a special interest in double stars (or binaries as they are often called by astronomers) and the observatory subsequently became renowned for its work in this field. Binaries occur where two stars revolve around each other. The time taken for a complete revolution may vary from days to thousands of years depending on the masses and separation of the two stars.

From the observations of astronomers such as Innes it is now known that double stars are quite common. They have a special value because their masses can be determined from their separation and period of rotation. The mass of single stars can then be estimated by comparing them with the calculated mass of neighbouring double stars.

Even although Alpha Crucis, the brightest star of the Southern Cross, and Alpha Centauri, the brighter of the two pointer stars, appear to the naked eye to be single stars they are both examples of double stars (fig 30).

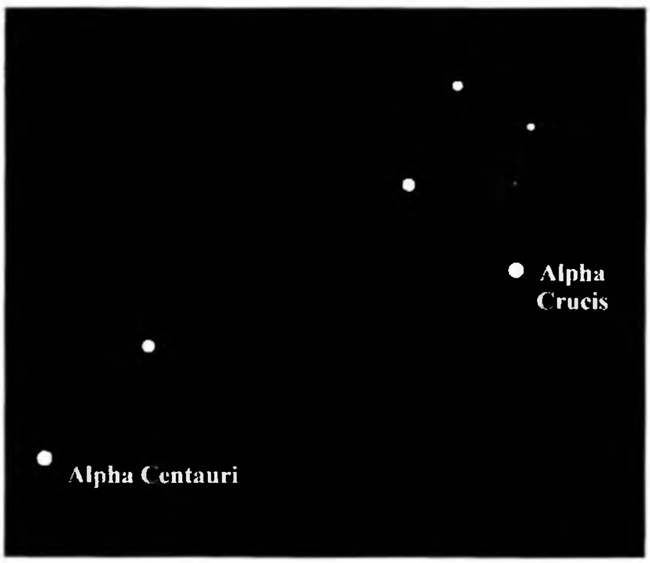


Fig. 30: *Although to the naked eye Alpha Crucis of the Southern Cross appears to be single it is an example of a double star whilst Alpha Centauri is a group of three stars including Proxima Centauri, the closest star to earth, which was discovered by Robert Innes in 1915*

3.2 The 9-inch telescope

In those days the clear air of the Highveld combined with its altitude made it an ideal environment for astronomical observations and Innes could not wait to get started on serious astronomy but unfortunately the Government was not willing to purchase a suitable telescope.

Innes persuaded one of the partners in Herman Eckstein's mining company, a Mr Reyersbach, to approach Alfred Beit with a request for a suitable instrument. Unfortunately Beit died in London in 1906 before Reyersbach was able to talk to him and the opportunity was lost.

Just before his retirement Sir David Gill, realising just how desperate Innes was to have a good quality instrument, offered him a complete telescope mounting which had become redundant at the Cape Observatory.

With the help of Reunert Innes was able to persuade the Witwatersrand Council of Education to grant him a personal loan of £250 to purchase a telescope for this mount. In the fullness of time Innes expected the State to take over this loan but initially it had to be guaranteed by Innes himself and as a last resort he would have had to repay the amount in monthly instalments.

The telescope was purchased and erected in 1907 (figs 31-33 & 137)[22] and one of the first observations made through it was the apparent disappearance of Saturn's rings as the earth passed through the plane of the ring-system. It was initially known as the Reunert telescope in accordance with the nameplate attached to the instrument but today it is usually referred to as the 9-inch (229 mm). Innes immediately used it to continue his work on double stars and amongst other things to observe the four large satellites of Jupiter. In 1908 the object glass (see appendix 5) was retouched by the manufacturer which improved its performance considerably. A micrometer which was essential for double star measurements was added in 1911[93]. This telescope is now at the University of South Africa (UNISA).

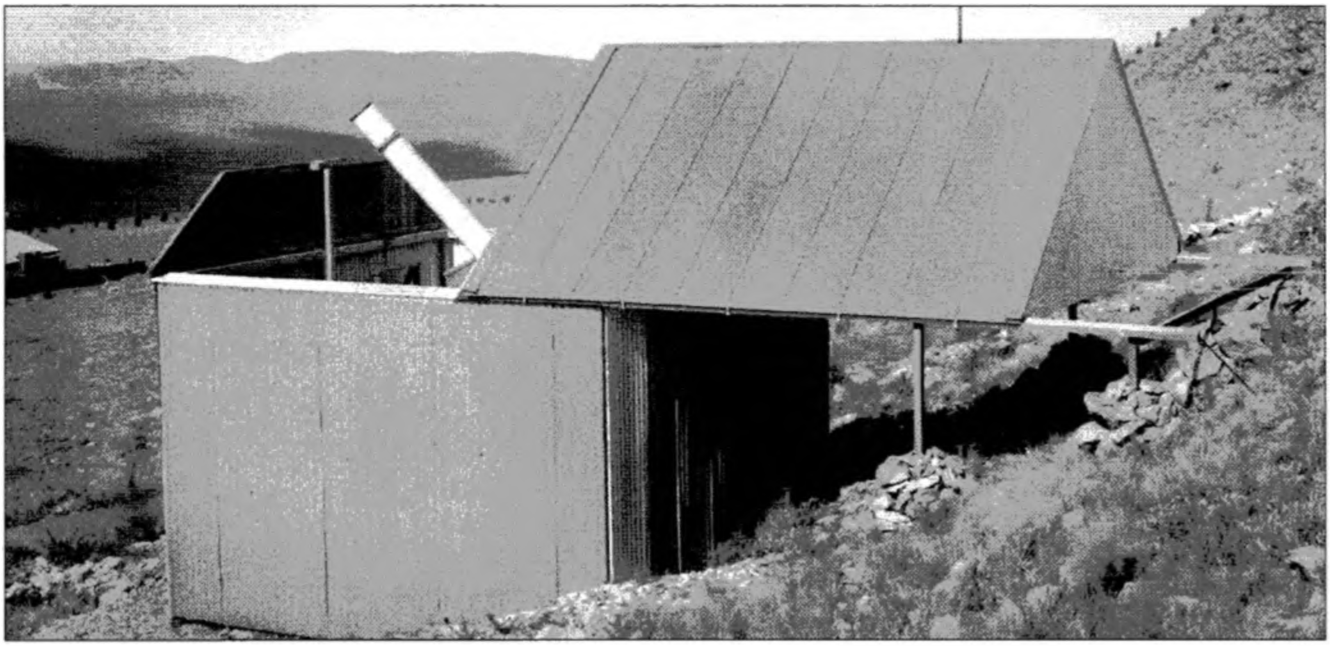


Fig. 31: *The 9-inch Grubb telescope in its wood and iron housing with sliding roof. This instrument was known as the Reunert telescope (CSIR Archives)*

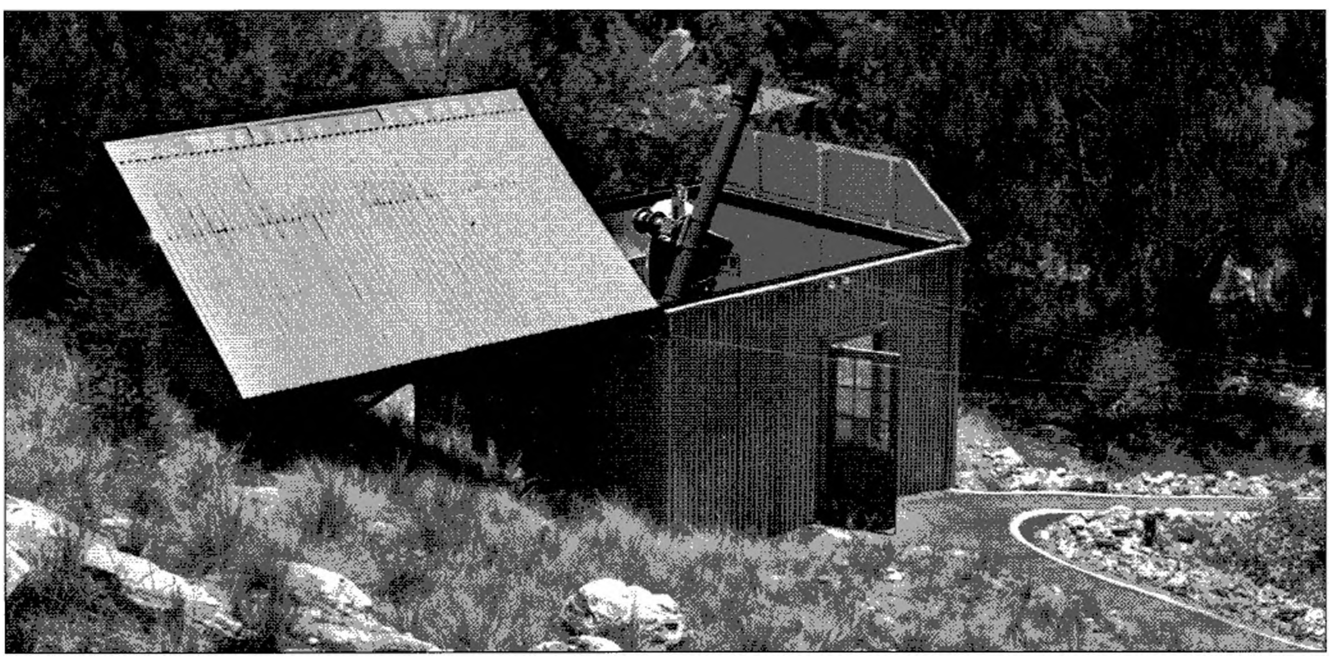


Fig. 32: *A view of the 9-inch telescope and its housing taken many years later than fig 31 (CSIR Archives)*

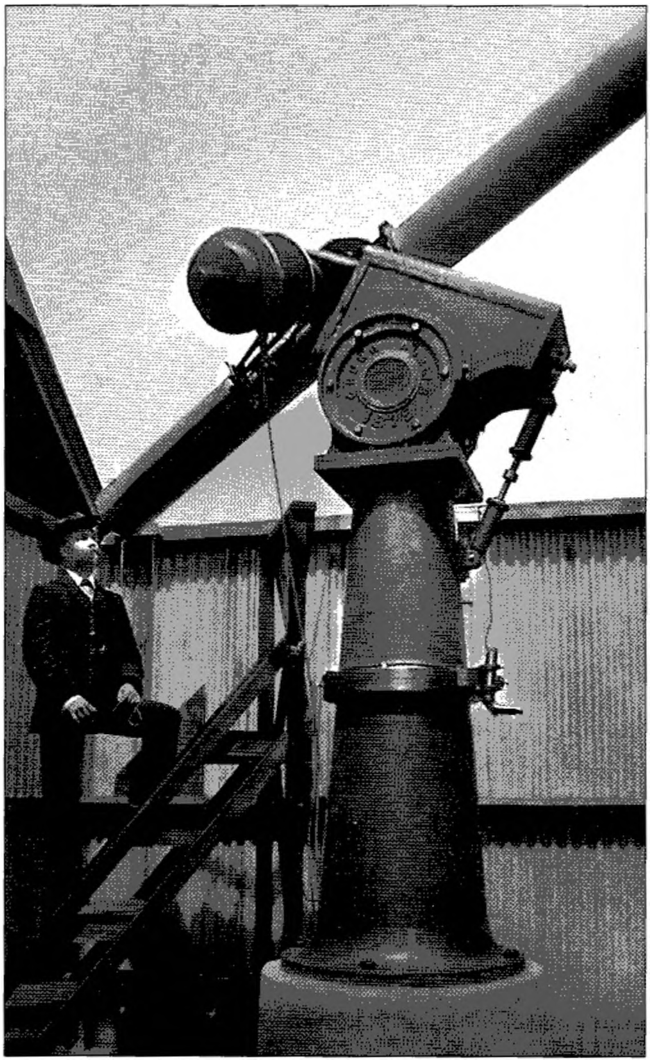


Fig. 33: *RTA Innes with the 9-inch refractor telescope (CSIR Archives)*

3.3 Sky mapping

In section 1.1 Gill's success with astrophotography and the subsequent CPD (Southern sky survey) was described. The technique was also used for the Carte du Ciel, a much wider survey undertaken by 18 observatories spread all over the world organised by the Paris Observatory. Although the Carte du Ciel was started in 1887 it was only completed in 1958[67].

3.3.1 The Franklin-Adams sky maps and telescopes

John Franklin-Adams was born in 1843. His father worked for Lloyds of London and it is presumed that his work required him to live in a series of foreign countries. John was thus educated in England, Berlin and le Havre and he travelled extensively throughout Europe during his early years. In 1863 John followed in his father's footsteps and joined Lloyds where he eventually attained senior member status. From an early age he had an interest in both astronomy and photography and after 1890 began developing his hobbies seriously. His income from the insurance business must have been considerable as he could afford expensive equipment.

Franklin-Adams attempted a photographic survey of the Milky Way and subsequently decided to produce a complete photographic star atlas of the whole of the Northern and Southern skies.

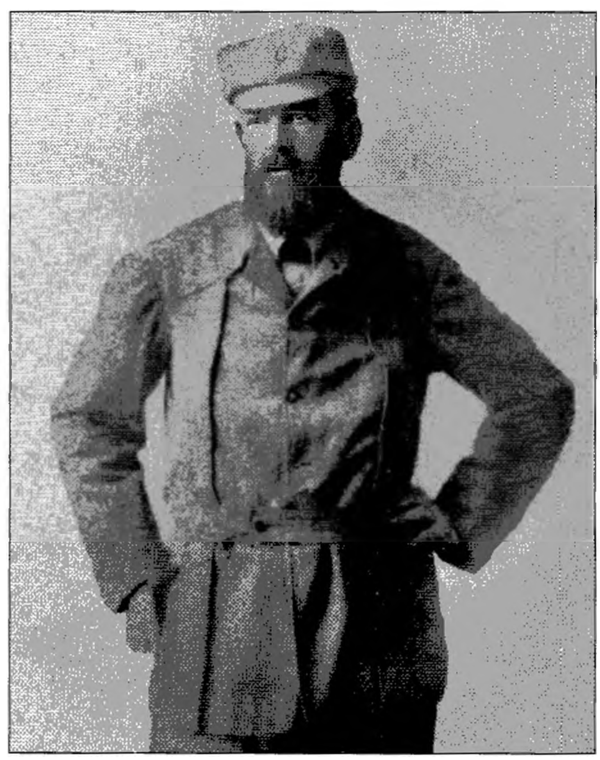


Fig. 34: *John Franklin-Adams (1843-1912) (British Amateur Astronomical Society)*

Working with the Cooke telescope company in York he acquired a series of specialised photographic telescopes culminating in one with a 10-inch three element objective lens having a focal length of 45 inches (1 143 mm) with an aperture of 1:4,5. This supported on an English equatorial mount and with a clock controlled driving mechanism provided a good combination for his intended sky-mapping project (for more information about this telescope see appendix 6).

Franklin-Adams had been suffering from acute rheumatism and neuritis for some time and by 1902 its severity increased to the point where his doctors suggested that he should visit the Cape to benefit from the hot springs at Caledon. Franklin-Adams saw this as an opportunity to start his sky-mapping programme and with Gills' co-operation had his special telescope (weighing 12 tons complete with housing) moved to a site at the Royal Observatory in Cape Town.

Gill obviously played an important part in this whole operation and it is interesting to read his comments as follows:

'He occupied rooms near the Royal Observatory during one-half of each month, and during the other half of the month, when moonlight would fog his long exposure plates, he went to the Sanatorium of Caledon, about 60 miles distant from the Observatory, where he took a course of baths at the celebrated hot chalybeate springs. It was in vain that his doctor and I urged him to first complete his cure and then to do his astronomy – nothing would turn him from his purpose, He would come back from Caledon at the end of a fortnight greatly benefited, and undo a great part of that benefit by long exposure at night, to return as cheerily as ever to Caledon at the end of a fortnight. At first he could not dress without assistance, nor wash without difficulty and pain. The condition slowly improved, but I never was convinced that he was entirely cured. There was about him an enthusiasm, an optimism and energy which I have seldom seen surpassed. These qualities told against the permanent improvement of his health and the ultimate quality of his first series of Cape photographs.'[15]

It seems that Franklin-Adams had plunged into the task without allowing time to experiment and

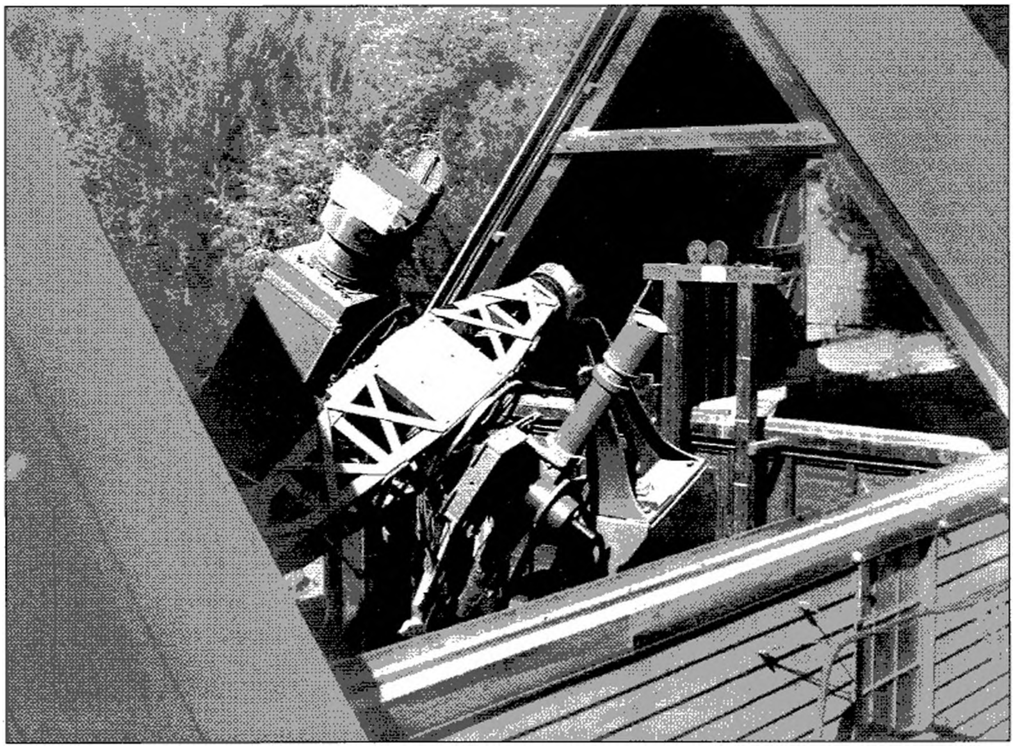


Fig. 35: *The Franklin-Adams 10-inch photographic telescope. (CSIR Archives)*

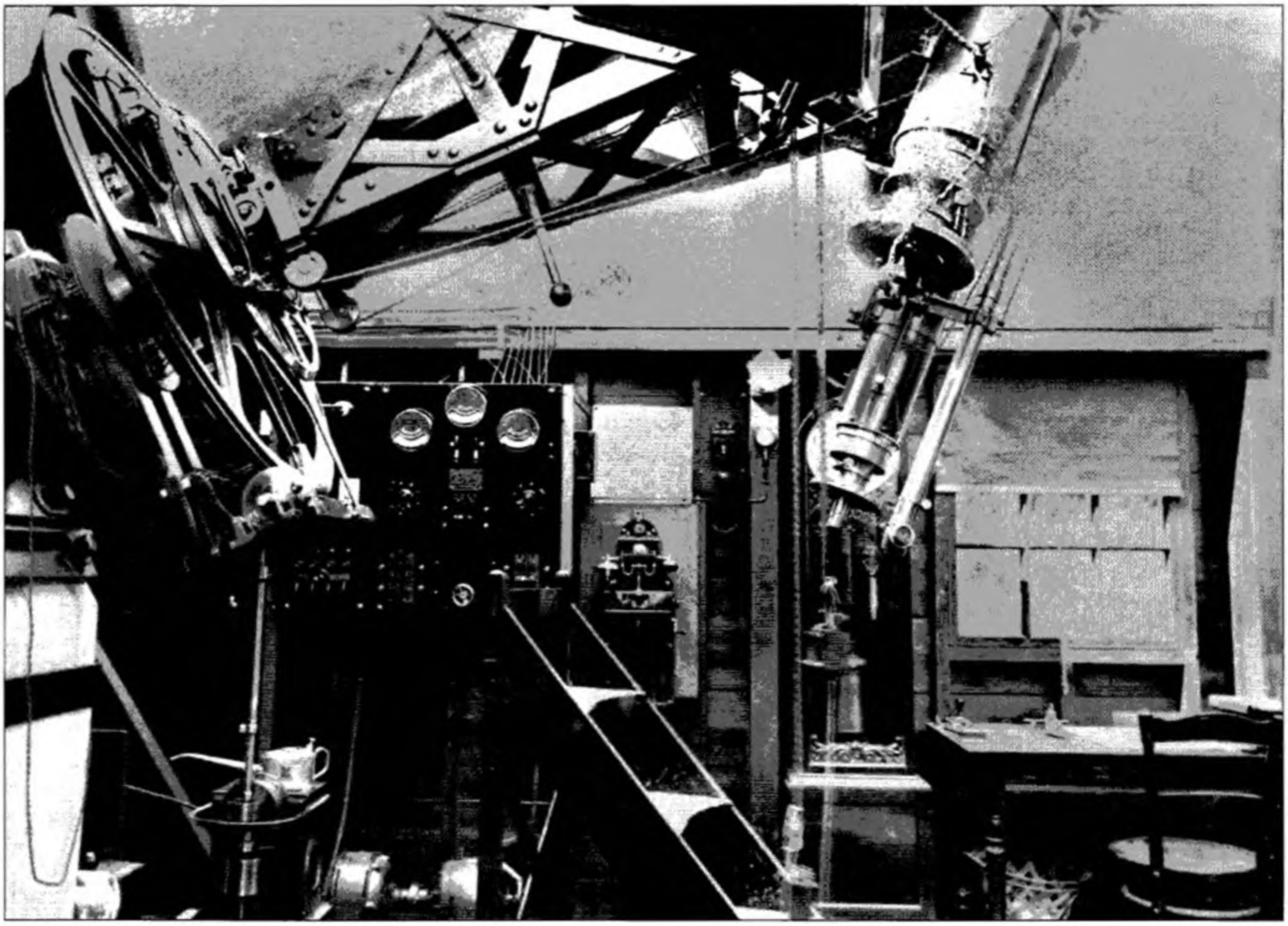


Fig. 36: *The interior of the Franklin-Adams 10-inch telescope housing (Museum Africa)*

optimise the technique. In spite of the fact that his equipment was well suited to this purpose the lens mounting could not be accurately squared and centred and the position of the wooden plate holder could not be adequately adjusted.

After 7 months he had completed the southern sky and returned to England with his astronomical camera and his precious records. The defects on his telescope were rectified and in 1905 he began photographing the northern sky. Building on the experience he had gained at the Cape the quality of his work improved steadily. By the time he had finished the northern hemisphere he realised that his earlier work was noticeably inferior and that the southern records would have to be repeated to maintain uniformity. He planned to return to the Cape in November 1909 but by then his health had deteriorated still further and he was obliged to consider alternative solutions.

It was probably Sir David Gill who persuaded him to take advantage of the superior viewing conditions available in Johannesburg. Franklin-Adams offered the Transvaal Colonial Government his astronomical camera together with all its accessories and housing. The donation was conditional on the Transvaal Observatory agreeing to photograph the southern sky to the same standards he had achieved in the northern hemisphere.

He pushed the authorities for a hasty conclusion to these official negotiations as Halley's Comet was due to re-appear in 1910 and everyone wished to see the equipment used to record this notable event in the southern hemisphere. In addition HE Wood had been on leave in England and was due to return to South Africa shortly with his newly wedded wife. The most valuable part of the telescope was the objective lens and Franklin-Adams was hoping that this precious item could accompany Wood on his return voyage.

Fortunately the Minister of Lands, Johann Rissik, understood the importance of this arrangement and cabled Franklin-Adams with the required assurances making it possible for the equipment, including its housing, to be forwarded to the Observatory without further delay. The Union Castle Line shipped the whole consignment free of charge reserving a passenger cabin for the objective lens where it was lashed securely on the floor to avoid any possibility of damage on the voyage.

When they arrived in Cape Town the customs officials wanted to look into such a suspicious object. Wood was armed with a letter from the High Commissioner covering its importation but had to take it to a senior official to gain permission to bring the lens into the country without detailed inspection. He left the packing case in the care of his wife with the instruction that on no account was anyone to open it. She had some difficulty in persuading the customs men to leave it alone and finally had to sit on top of the box refusing to move until her husband returned.

Franklin-Adams's assistant, RJ Mitchell, was sent out to assist with the commissioning of the telescope and to familiarise the Observatory staff with the required procedures. The equipment was functioning by the beginning of April and was used by Wood to photograph Halley's Comet soon after its complete tail became visible – fig 37 shows a record taken on 29 May 1910.

Just before Franklin-Adams died in August 1912 the Observatory staff had despatched the last of the completed charts to the Astronomer Royal. The

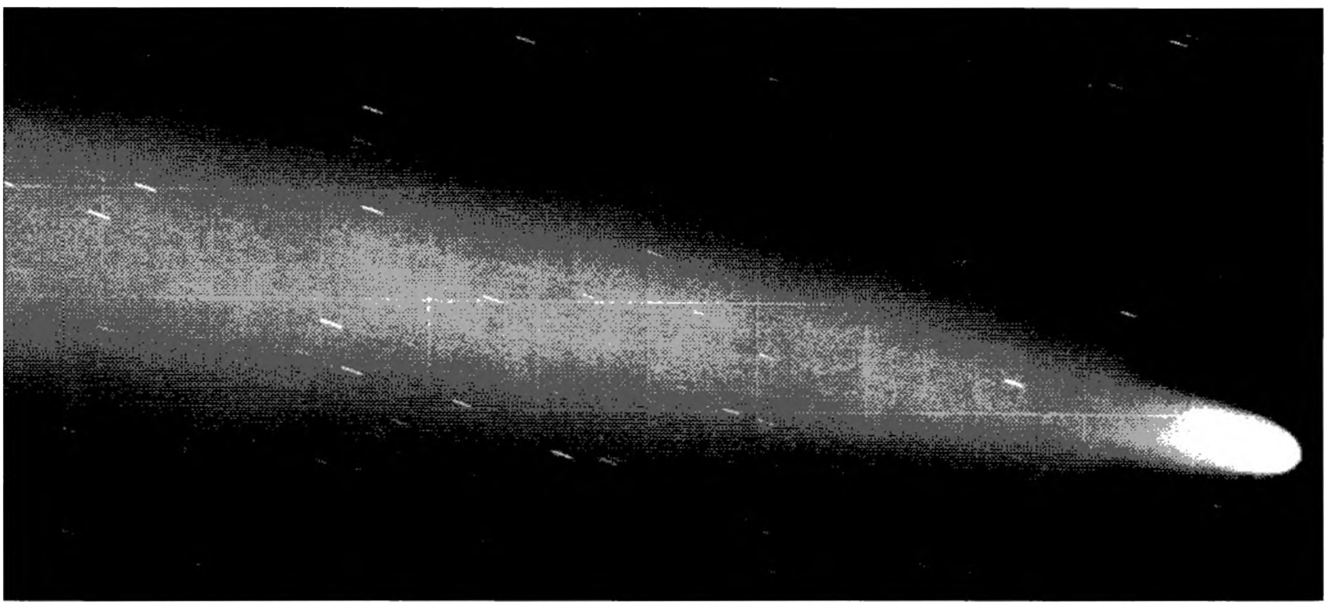


Fig. 37: *One of the first tasks of the Franklin-Adams telescope was to photograph Halley's Comet (1910) (CSIR Archives)*

Encyclopaedia Britannica[67] states that this was the first photographic atlas of the entire sky comprising a total of 206 plates covering all stars down to the 15th magnitude.

In 1912 Franklin-Adams donated his twin 6-inch (152 mm) photovisual refractor combined with a 7-inch (178 mm) visual telescope (fig 38) to the Union Observatory. The object glass of the 6-inch telescope was fitted with a prism which produced a spectrum of the light coming from the star in the form of a line instead of the usual dot[75] (1913). In 1929 an additional 10-inch photographic telescope having a focal length of 92 inches was added to the Franklin-Adams mounting[75] (1929). This telescope was originally erected on site T3 (see figs 123 & 137).

3.3.2 The Union Observatory sky maps

Innes and Wood realised that the Franklin-Adams star maps would not be readily accessible to other astronomers as they were in the form of glass plates stored at the Royal Observatory. In 1917 they therefore began a new more detailed photographic survey of the southern sky and transferred the glass plate records onto paper prints adding co-ordinates and curved grids. These prints were then reproduced by the Government Printer and distributed (free of charge) to observatories all over the world[75]. Fig 38 shows an example of one of these sheets which in their original form was somewhat larger than A4 format. A total of 559 such charts were produced to cover the sky south of –19° and the task was completed in 1938.

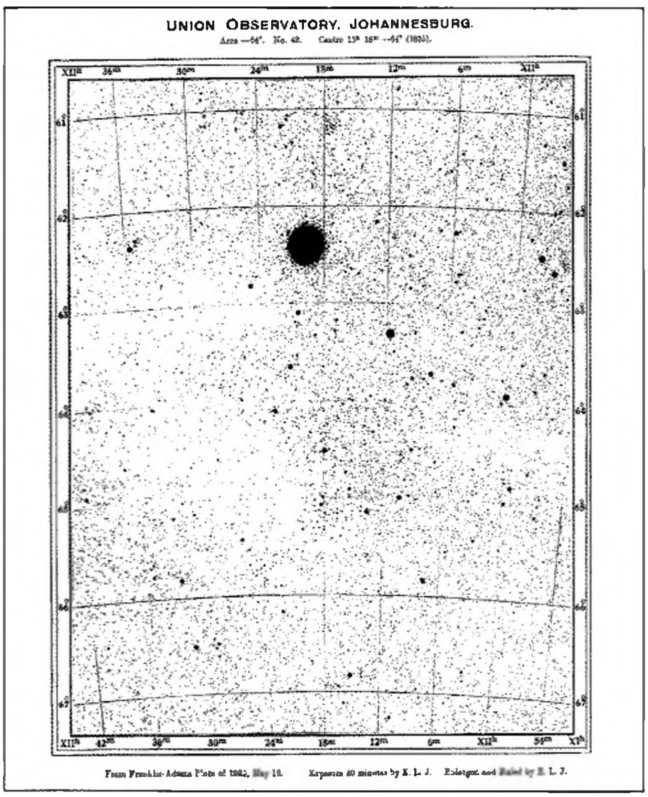


Fig. 38: *An example of one of the 566 charts produced at the Union Observatory to map the sky south of –19° (this particular chart was made by EL Johnson) (Danie Overbeek)*

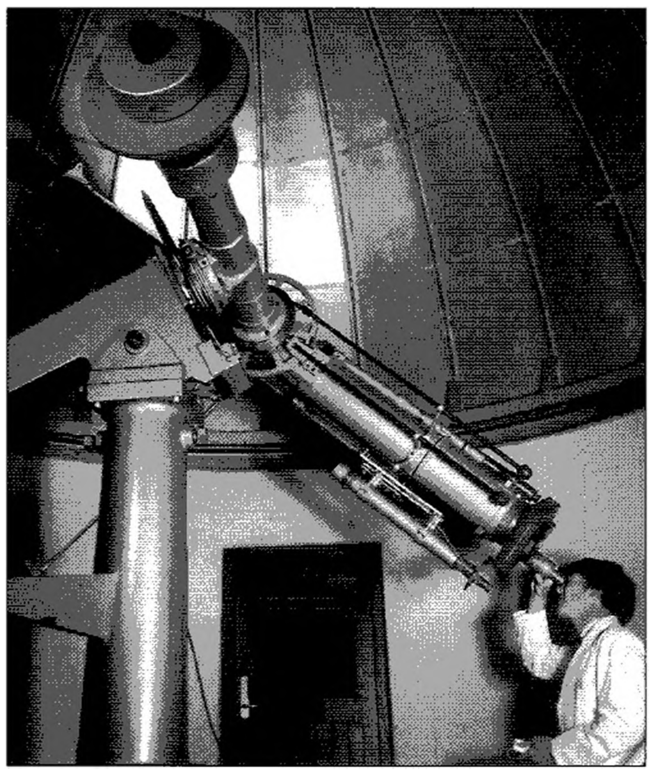


Fig. 39: *The Franklin-Adams 6/7-inch photovisual refractor telescope was donated to the Johannesburg Observatory in 1912 and housed in T3 (fig 137). This picture was taken in 1965 after it had been moved to T9 (CSIR Archives)*

3.4 The 26½-inch telescope

None of the preceding telescopes was really big enough to service Innes's desire to study double stars. By 1909 the Transvaal coffers had been well filled by the gold mines. At the same time the Orange Free State, Natal and the Cape were struggling to make ends meet. With Union approaching the Transvaal realised that they would have to share their riches and it became known that any reasonable proposal for using these funds would be favourably received. The Union Buildings were erected in this way and Innes believed that this would be a good time to ask for a large telescope.

According to Dr WH van den Bos, the third Union Astronomer[62], Innes received quotes from Howard Grubb and Cooke, Troughton and Simms for 18, 24 and 26 inch refractors (appendix 5) and applied to the Transvaal Government for a large telescope. He was asked to attend a meeting in Pretoria to discuss the matter with Jan Smuts and the Minister of Lands, Johannes Rissik. Van den Bos states that Smuts opened the interview by saying 'Well, Mr Innes, I see you want a large telescope – can you tell me what good this will do for the country'. Innes replied 'Nothing whatever, General, it is purely for my own pleasure.' Smuts and Rissik laughed and exchanged some words in Afrikaans which Innes did not understand[62]. When Smuts asked Innes if he knew what it would cost Innes revealed the quotes he had received for 24 and 26 inch telescopes. After further discussion amongst themselves Smuts said 'Well Mr Innes you may order the 26-inch.' By the time Innes was on the return train to Johannesburg he was saying to himself 'What an idiot I have been; I should have asked for a 36-inch; I would have got it too[62]!'

On 26 November 1909 a contract was drawn up with Sir Howard Grubb (Dublin) for a 26½-inch (673 mm) telescope to be designed especially for double star observing. The following extracts deal with the terms of delivery[22 27].

> I further agree to erect the stand and telescope complete in a covered building within 2 years from date of payment of the first instalment of the tendered prices in order that the mechanical working may be examined and tested in every particular by Sir David Gill.

They tried to impose a time limit for the completion of the whole contract but Grubb pointed out that the manufacture of the objective lenses (appendix 5) depended on the delivery of suitable blank glass discs by a sub-contractor which would be beyond his control. Clearly Grubb anticipated difficulty with the production of such large blank discs and could only promise that the object glasses would be ready 14 months after receipt of suitable discs. The following payment schedule formed part of the contract:

On signature of the contract	£1 200
When the working drawings have been finished and 1/12th part of the mechanical construction has been completed	£1 200
When the O. G. (object glass) is ready for testing	£600
When the mechanical portion of the work is in a complete state	£600
When the complete instrument is reported by Sir David Gill as packed and ready for shipment	£1 275
Total	£4 875

An official order for the manufacture of this telescope was placed with Howard Grubb (Dublin) in 1909. Grubb placed a contract for the objective lens blank discs with the Parisian company, Parra-Mantois, who had a virtual monopoly in this field due to the 'secret process' which they had developed. After exerting considerable pressure on the French supplier they had still not received anything by 1912 and Grubb moved the order to Chance Bros in Birmingham. Right up to the beginning of World War I (WWI) the new supplier assured Grubb that they would be able to produce the discs.

Work on the buildings to house the telescope at the Observatory had progressed to the point that the tower, roof and moving floor were practically complete by the end of 1912.

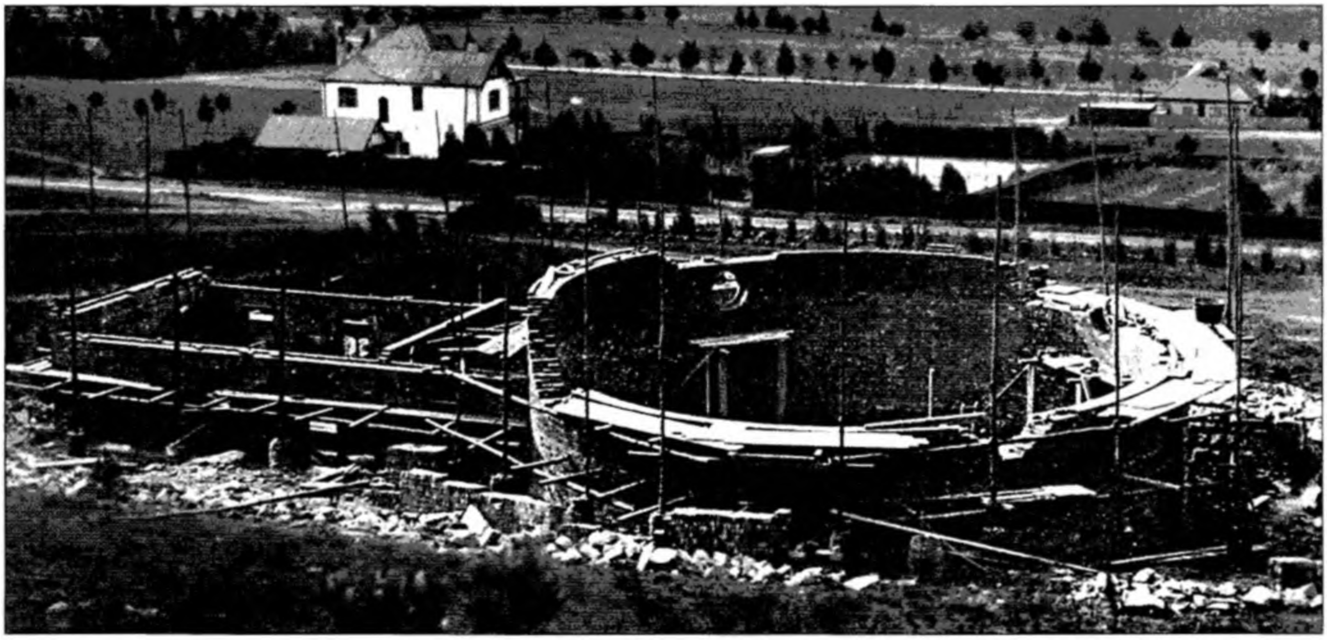


Fig.40: *Building the base of the dome for the 26½-inch telescope in 1910 (Museum Africa)*

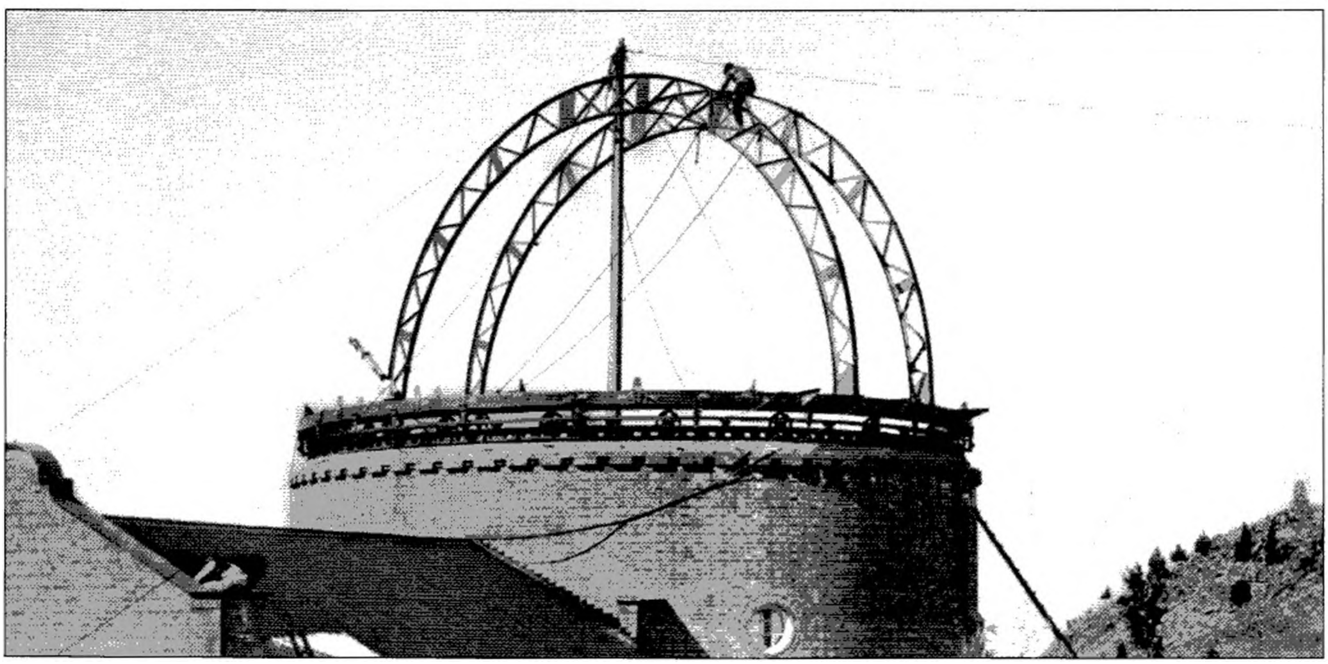


Fig.41: *Fixing the prefabricated dome girders in place. Note the 'Indian' monument on the right at the top of the hill (Museum Africa)*

Supervision of the contract on behalf of the Union Government had been placed in the hands of Sir David Gill who had retired from the Cape in 1906 and was then living in London. Hers[20] reports that Gill's supervision was probably rather ineffectual and in any case ceased when he died in December 1914. Once the war started little further progress was possible before the return of peace.

At the end of 1920 Grubb reported that 80% of the mechanical portion was complete but there were still no glass discs. Grubb switched to the Corning Glass Works in the USA and warned that the price of the lens would have to be increased from the original £1 000 to £3 500. Eventually the American company was able to deliver acceptable discs but it took them much longer than was originally expected.

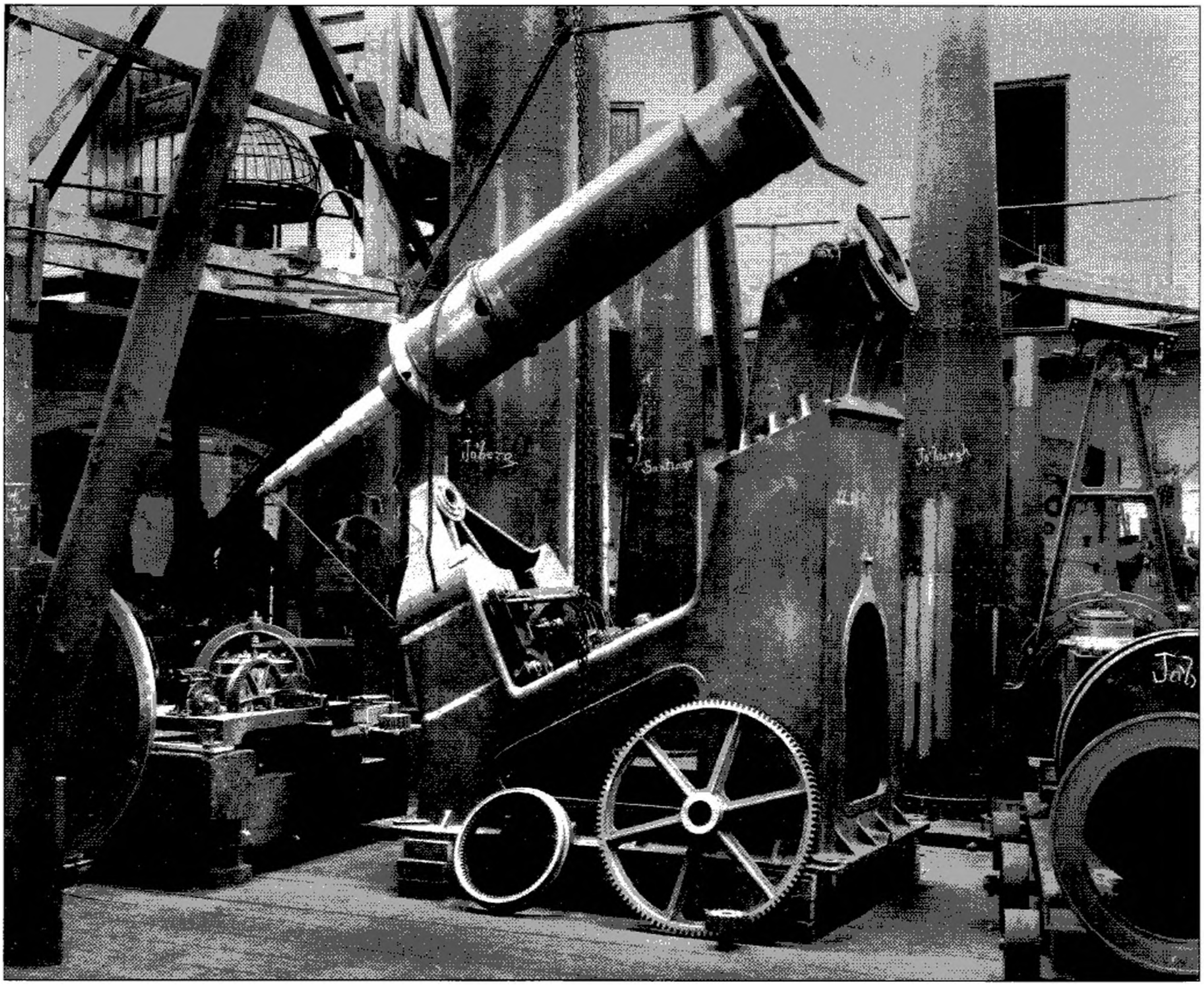


Fig. 42: *Parts of the 26½-inch telescope at the manufacturers works in Dublin*

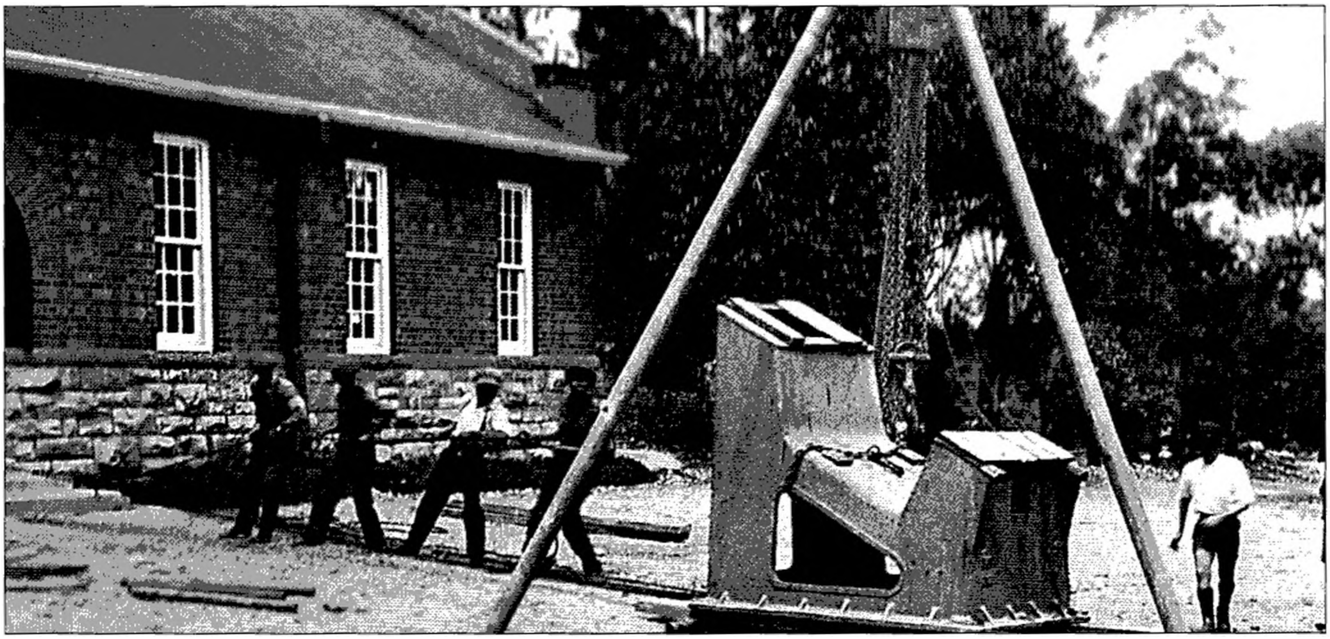


Fig. 43: *Hauling the base of the 26½-inch telescope into the dome (Museum Africa)*

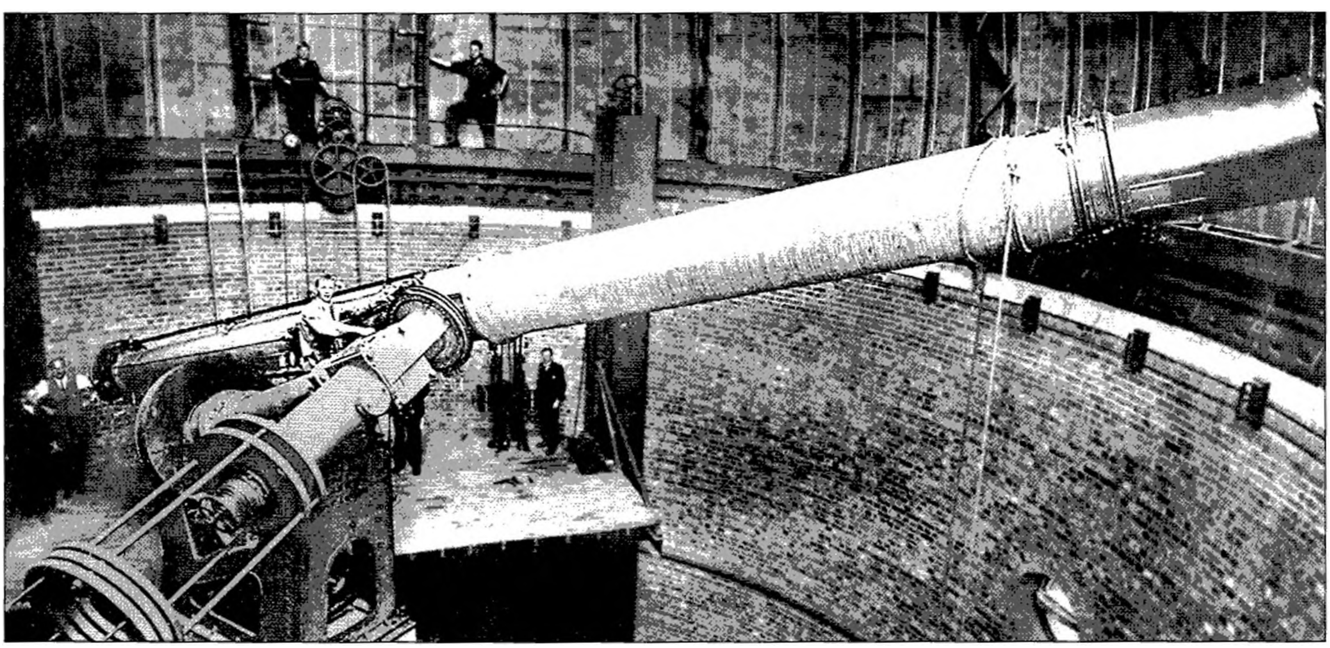


Fig. 44: *Erection of the 26½-inch Grubb telescope nearing completion ca 1924. H E Wood is standing nearest to the eyepiece, Trotter the Public Works Department engineer is poised on top of the instrument, Innes is partly obscured by the telescope and W M Worssell is on the right of the viewing platform. The other men were fitters from the PWD (Museum Africa)*

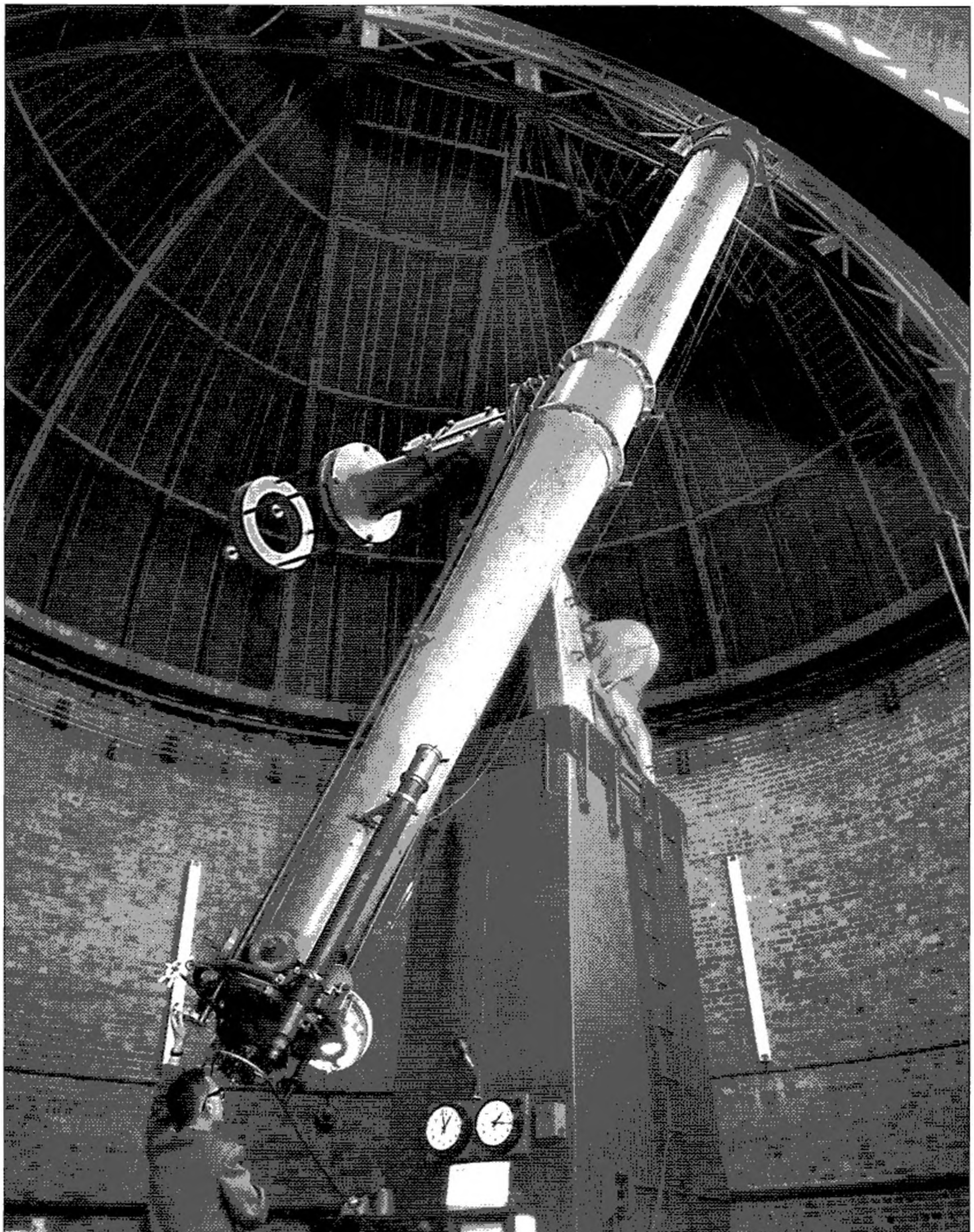


Fig. 45: *John Newburg with the 26½-inch telescope in the late 1960s (CSIR Archives)*

Just as the telescope was almost ready Grubb's company went insolvent. Fortunately the South African authorities in London had sufficient warning to arrange for all completed items to be shipped before they could be sequestrated. Sixteen years after being ordered the 26½-inch lenses finally arrived in 1925 and the telescope could be tested. Figures 40 & 41 show the construction of the telescope dome whilst figures 43 & 44 show the erection of the telescope. Fig 45 shows the telescope in about 1960 and fig 46 shows the pendulum clock that regulated the star tracking motion of the telescope.

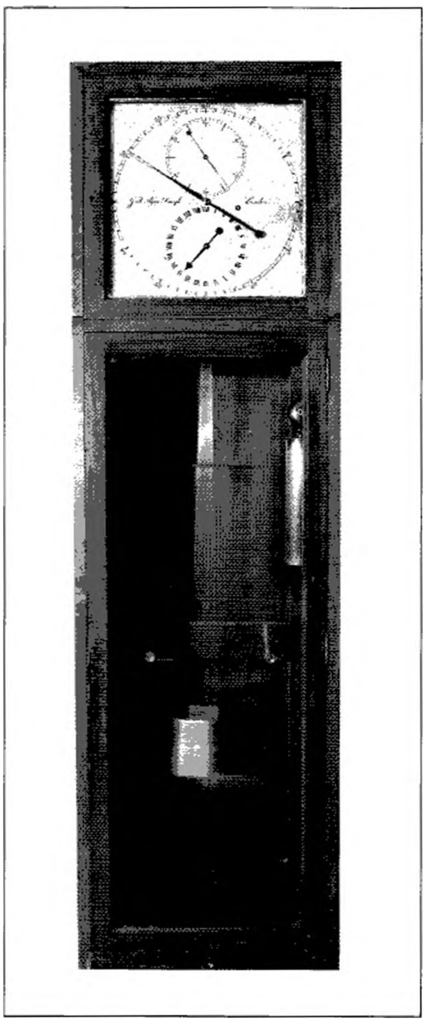


Fig. 46: *The clock that regulated the tracking movement of the 26½-inch telescope (author)*

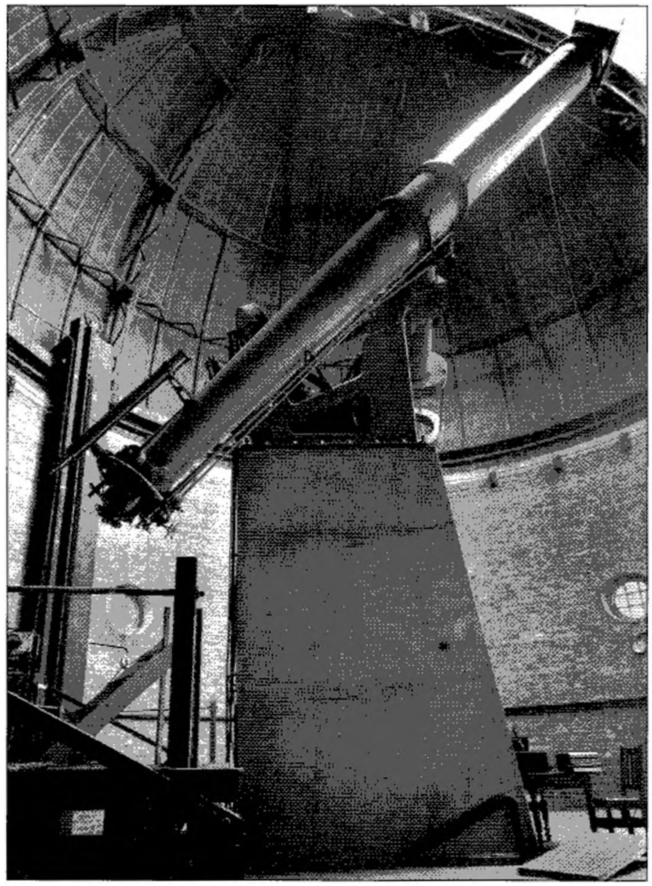


Fig. 47: *An earlier view of the 26½-inch telescope taken before 3-phase power feeds had been introduced (SAAO)*

According to the annual report for 1911[75] the pier, dome and moving floor had been completed and were ready to receive the telescope. The mechanical parts arrived by 1923, and the Public Works Department started to erect the telescope. At this stage an acceptable crown glass disc had been delivered to Grubb and was being figured in their factory but they were still waiting for the complementary flint glass disc. The mechanical parts were all in place early by 1924 but they had to wait a further year for the flint objective element to arrive.

By April 1925 the telescope was being used for observations even before the object glasses had

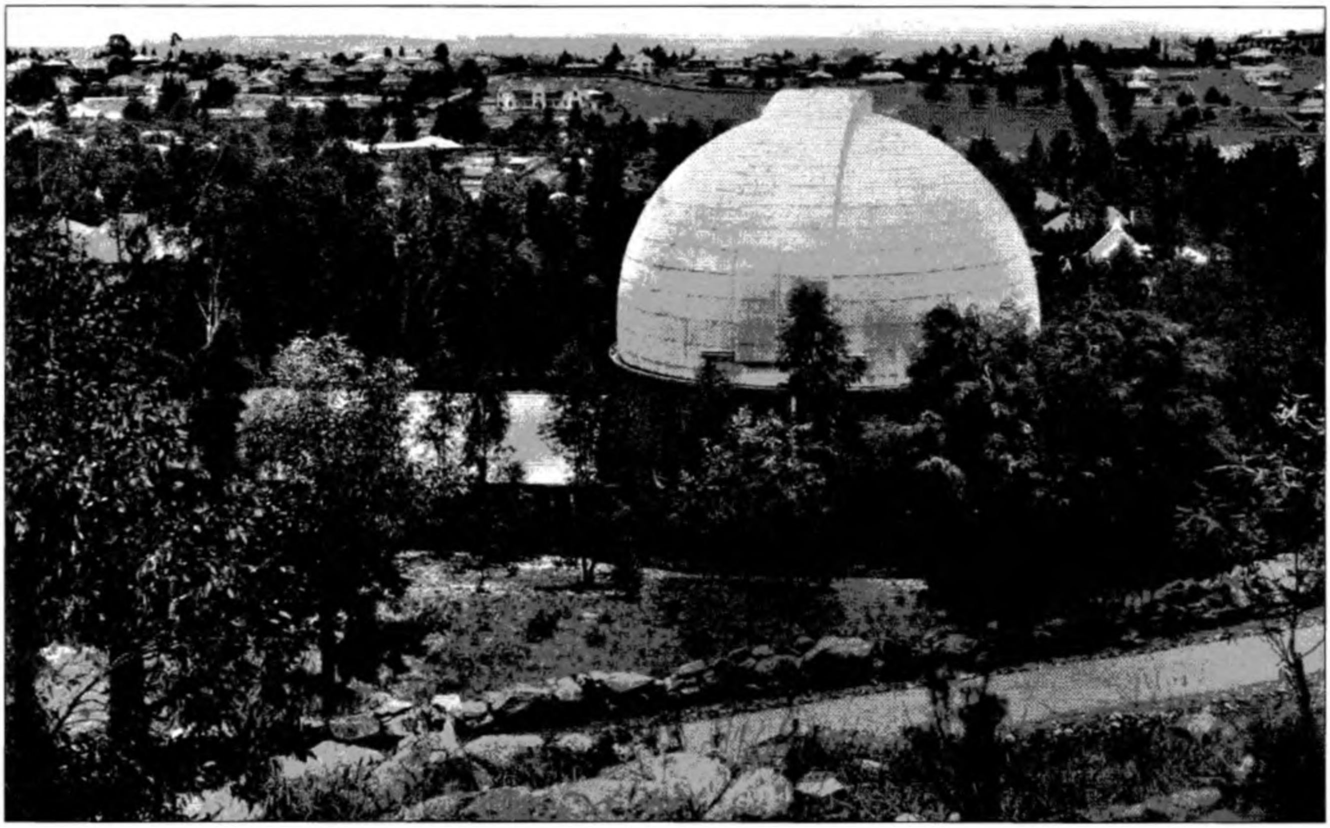


Fig. 48: *The completed 26½-inch telescope dome. Judging by the state of growth of the surrounding residential area this was probably taken in the late 1920s. Note the benefits of the Observatory tree-planting programme (SAAO)*

been finally adjusted. During the second half of 1925 the new telescope revealed 303 new double stars and 887 pairs were measured. The 1925 report was somewhat guarded in its enthusiasm for the new instrument but stated that the most noticeable feature to observers who were used to working with smaller instruments was its ability to bring out the colours of the stars. The report adds that it would be ungracious not to mention their indebtedness to Sir Howard Grubb and his skilled staff.

In 1926 amongst other discoveries Dr van den Bos revealed that Alpha Sagittarii was a double star with a measured distance of 0,21 seconds of arc and thus demonstrated that the resolving power of the telescope was equal to its theoretical limit.

As an indication of the remarkably good viewing conditions existing in those days Dr van den Bos told the following story about Professor Georg Struve (from Neubabelsberg Observatory)[62]. Struve who came from a long line of renowned astronomers visited Johannesburg in 1926 (fig 84) to observe the satellites of Saturn. At his home observatory using a similar telescope he had established a scale of viewing conditions starting at 1 to designate the poorest and rising to 5 when perfect. On his first few nights he recorded conditions ranging between 3 & 5 but then encountered a really good night which he designated as 5+. Not long after even better conditions emerged and he had to resort to a further extrapolation of 5++.

3.5 Availability of electric power at the Observatory

A 200/400 Volt single phase AC electric power supply became available at the Observatory towards the end of 1909[71]. The Franklin-Adams star camera required a DC supply and Innes ordered a motor/generator set to provide for this need (probably the electric motor coupled to a generator which can be seen underneath the switchboard and to the right of the oil can in fig 36). According to Mrs Pamela Sorgentini[59] an electric generator driven by an internal combustion engine was in service on the property in the 1930s. She believed that it was used to drive the telescope dome mechanism. In the 1950 annual report[75] van den Bos states that the electrical installation of the telescope was replaced during that year. Fig 44 shows that there were two contact wires feeding the revolving platform at the time of installation. There are now four such conductors (fig 45) and it seems that single phase AC motors were originally used to rotate the dome and viewing platform and that these were replaced in 1950 by three-phase motors.

In 1927 damage to the rails on which the dome ran was discovered and repairs were required. Fortunately the telescope could be parked facing the south meridian and the double star programme could be continued for the four weeks required for the repairs.

This saga ended with the Observatory finally having a fine telescope particularly well suited to the observation and measurement of double stars. At the time it was amongst the biggest refractor telescopes in the world and even today it is quite high on the list, the largest being the Lick (USA) Observatory 40-inch.

In July 1909 the name of the Observatory was changed from the Meteorological Department of the Transvaal Colonial Government to the Transvaal Observatory but it continued to fall under the Minister of Lands. Soon after Union in 1910 the astronomical observatories in Natal and the Transvaal were taken over by the Minister of the Interior. In 1912 the Union Weather Service was established with its headquarters in Pretoria. The Transvaal Observatory remained a first order meteorological outstation but it was thereafter able to concentrate on astronomy. It was renamed the Observatory of the Union of South Africa, or the Union Observatory, and Innes became known as the Union Astronomer.

The Union Observatory was fortunate in receiving regular state funding without having to show immediate benefits. It was accepted that astronomy was a worthwhile pursuit and that it was important for South Africa to make its contribution. This left the programme of work largely at the discretion of the director and his staff. They were guided by and worked closely with other institutions around the world. With the absence of commercial pressure there was a remarkable sharing of information by astronomers and a general understanding that knowledge gained by one institution should be made available to all.

Innes's personal interest in double stars was echoed by later directors and ensured that the search for new pairs would continue throughout the life of the Observatory. In addition the staff found many minor planets and comets and investigated variable stars. From the early 1920s regular measurements of occultations of stars by the moon (the obscuration of a star by the passage of the moon) were recorded and studied and the results published for the benefit of all astronomers. This pooled knowledge made it possible to determine the shape of the moon and to locate the position of the observing stations accurately. From 1923 occultations featured regularly in the annual reports and continued to do so until the Observatory closed down.

In 1921 the British Imperial Government looking for ways to economise asked the Union Government to amalgamate the Cape and Union Observatories. Innes was not in favour of this move as he maintained that there were too few southern observatories and that this would result in the closing of the Cape observatory. English astronomers supported him and eventually the proposal was dropped[75 (1921/22)].

Further evolution of the Observatory

Chapter 4

4.1 The catalogue of southern double stars

Towards the end of his career Innes and his colleagues, particularly Dr WH van den Bos, started a complete, comprehensive catalogue which eventually contained more than 20 000 southern double stars lying south of –19° and with a brightness greater than the 9th magnitude. The Observatory became recognised as the central office for all matters relating to double stars in the southern hemisphere.

The catalogue was recorded on handwritten cards stored in the cabinet shown in fig 81. It has subsequently been microfilmed and copies are available from the Lick Observatory in the USA. The manual catalogue has been preserved in its original cabinet at the Observatory.

According to the Index Catalogue of Visual Double Stars by Jeffers, van den Bos and Greeby (Lick Observatory publication, fig 119)[23] by 1961 the number of double stars discovered at the Union Observatory by the following observers was as follows:

RTA Innes	1500
HE Wood	2
WH van den Bos	4660
WS Finsen	393
Total	6 555

After retiring in 1957 Dr WS Finsen, the fourth Director, collaborated with the American astronomer, CE Worley, to produce an updated version of the catalogue which was known as the Double Star Orbit Catalogue. This was published in Republic Observatory Circular 129 entitled the Third Catalogue of Orbits of Visual Binary Stars.

In the mid 1950s during a time of severe sunspot activity daily counts of sunspots were made and regularly reported to the Telecommunications Research Laboratory (which subsequently became known as the National Institute for Telecommunications Research [NITR])[75]. Short-wave radio transmission is profoundly affected by sunspot activity and is therefore of considerable concern to those predicting the best choice of frequencies for reliable communication.

4.2 Asteroids (minor planets)

There are a large number of asteroids (or minor planets) in orbit around the sun. These vary in size from the largest (Ceres) with a diameter of about 1 000 km to less than 1 km. Approximately 200 lie in size between 100 km and 300 km and 10 have diameters greater than 300 km[69]. Their combined mass is only a fraction of that of the moon.

According to Finsen 579 asteroids were discovered in Johannesburg but this figure is not confirmed by the official register kept at the Minor Planet Centre of the Smithsonian Astrophysical Observatory. Their list attributes 148 asteroids to Johannesburg with the following discoverers:

C Jackson (this is the record for the southern hemisphere)	72
H van Gent (Leiden)	39
EL Johnson	18
HE Wood	11
J A Bruwer	4
J Churms	2
E Herzsprung (Leiden)	2

Van Gent and Herzsprung were visiting Astronomers from Leiden Observatory (see section 4.3).

Many of these were given typical South African names such as 715 Transvaalia, 790 Pretoria, 1320 Impala, 1324 Knysna. More recently minor planets were named to honour the four Union Astronomers as follows: 1658 Innes, 1663 van den Bos, 1660 Wood and 1794 Finsen in recognition of their contributions to astronomy. Appendix 7 contains a complete list of the minor planets discovered in Johannesburg with their official names and explanatory notes relating to each name.

4.3 Co-operation between Leiden and Johannesburg Observatories

Leiden Observatory in the Netherlands had a long association with the Cape which started when David Gill became Her Majesty's Astronomer at the Cape of Good Hope in 1879. Section 1 described how Gill and Kapteyn had become close friends through their combined efforts to produce the

CPD. In 1897 Kapteyn asked Gill to invite one of his promising young students, Willem de Sitter, to take part in the practical work of the Cape observatory. By the time he returned to Groningen in 1899 de Sitter and Robert Innes, the Cape Observatory administrative assistant, had established a warm relationship[8].

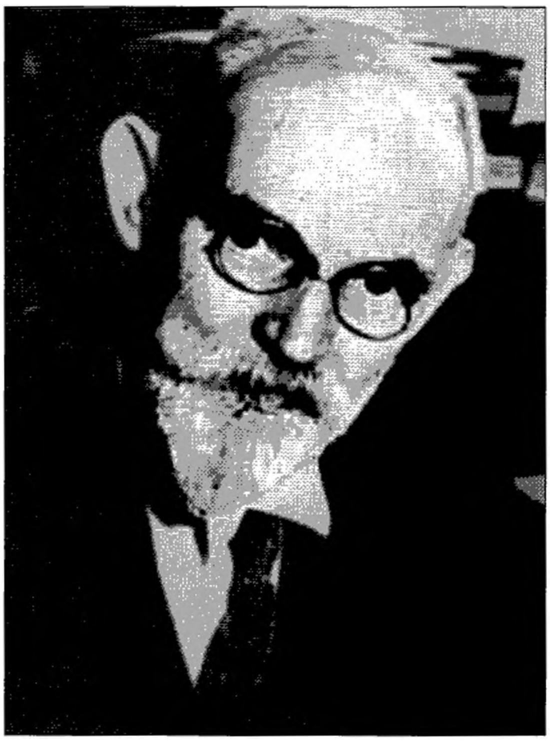


Fig. 49: *Willem de Sitter (1872-1934) Professor of Astronomy at Leiden University from 1908*

De Sitter became Professor of Astronomy at the University of Leiden in 1908 and in 1919 he was appointed as Director of the Leiden Observatory. With time the friendship between de Sitter and Innes developed and led to Innes being awarded an honorary doctorate by Leiden University in 1923. Whilst in the Netherlands to receive the degree Innes concluded an agreement between Leiden and the Union Observatory to encourage co-operation between the two institutions. This arrangement gave the staff of Leiden an opportunity to make observations of the southern skies under good viewing conditions whilst the Union Observatory was glad to have a firm connection with the wider astronomical community.

Soon after the agreement had been reached Prof Hertzsprung, the assistant-director of Leiden Observatory, spent over 18 months in Johannesburg exploring the Magellan clouds. In 1925 he was followed by Dr H van den Bos. After van den Bos completed his official visit he joined the staff of the Union Observatory and eventually became director in 1941. Dr H van Gent spent three lengthy periods at the Union Observatory between 1928 and 1946[73]. Dr W Martin also spent some time at the Union Observatory before World War II (WWII).

4.3.1 The 16-inch Rockefeller telescope

In the beginning the Leiden visitors used the Union Observatory equipment but in 1930 the American Rockefeller Foundation awarded Leiden University astronomy department a gift of $110 000. In conjunction with the Union Observatory It was decided to invest part of this money in a double astrograph (photographic telescope). This was eventually supplied by Grubb, Parsons & Co in 1938 and consisted of two 16-inch photographic reflectors each having a focal length of 90 inches with an 8-inch visual guiding telescope. The simultaneous records on each of the two 12 x 12 inch photographic plates were of particular value in recording fleeting occurrences when confirmation of questionable events might be required. Provision was also made for using spectral prisms to determine the colour of the incoming images. The English type mounting permitted photographing the polar region. Dr A de Sitter, son of Prof W de Sitter, came to Johannesburg for the installation of this telescope[46].

4.4 The Union Observatory Annexe at Broederstroom

By 1954 increasing atmospheric pollution from industrialisation in the Pretoria, Witwatersrand and Vereeniging areas combined with light scatter from burgeoning Johannesburg had spoilt view-

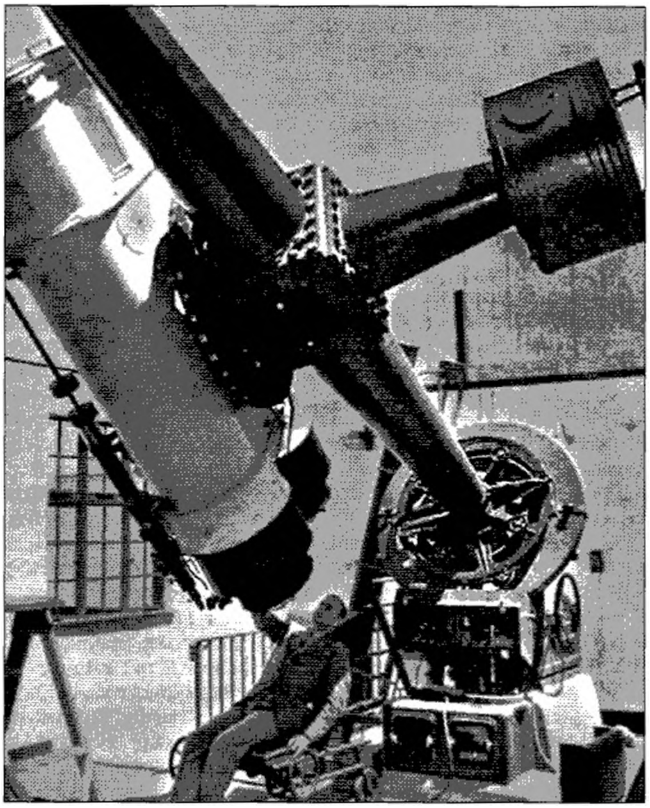


Fig. 50: *The Rockefeller double astrograph having two 16-inch photographic reflectors with focal lengths of 90 inches (ref 46)*

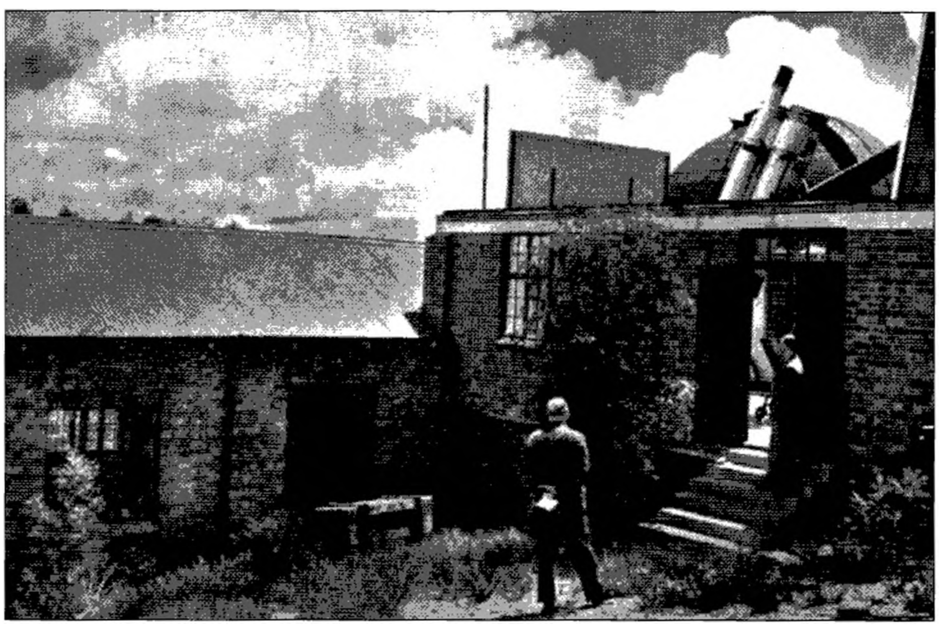


Fig. 51: *The Leiden offices, darkroom and Rockefeller double astrograph at the Union Observatory. The 26$^{1/2}$-inch telescope dome can be seen in the background but this was not connected to the Rockefeller buildings (ref 46)*

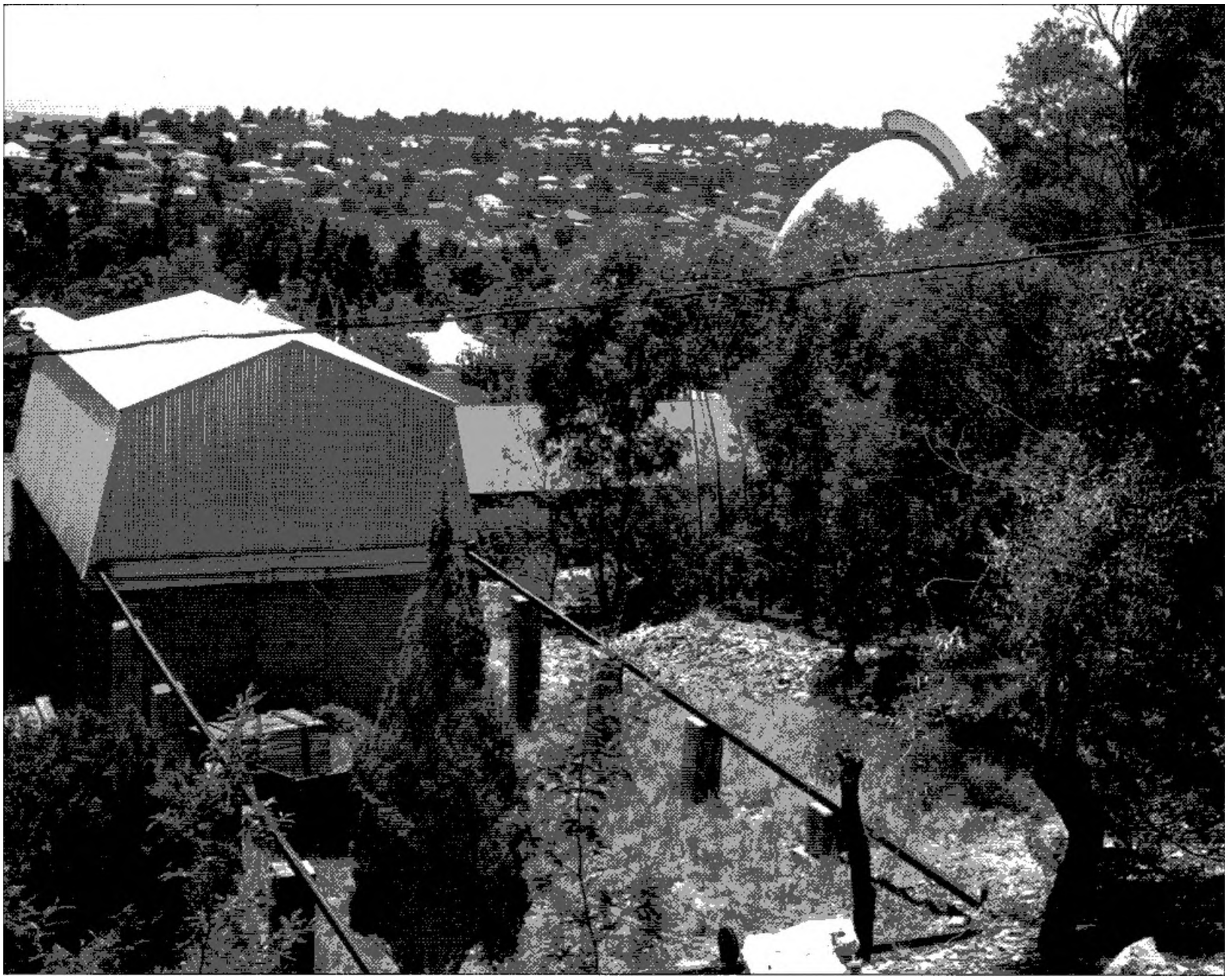


Fig. 52: *The housing of the twin 16-inch Rockefeller photographic telescope from the rear (CSIR Archives)*

ing conditions at the observatory. The smaller telescopes were no longer able to function adequately and a site at Broederstroom overlooking the Hartebeespoort Dam was acquired where seeing conditions were still good. In August 1954 the 10-inch Franklin-Adams camera was moved to this new site followed in 1957 by the 16/16-inch Rockefeller reflector. The Union Observatory Hartebeespoort Annexe and the Leiden Southern Observatory were officially opened on 9 September 1957 by Dr JE Baron de Vos van Steenwijk and the South African minister for Education, Arts and Science, JH Viljoen[8]. The chief Leiden astronomer was Dr T Walraven assisted by Dr AB Muller.

Soon after the opening of Broederstroom Leiden also installed a 'Lightcollector' which had a special 36-inch mirror lens system with a 126 inch focal length made by Yerkes Observatory (USA) and mounted in a framework constructed in the

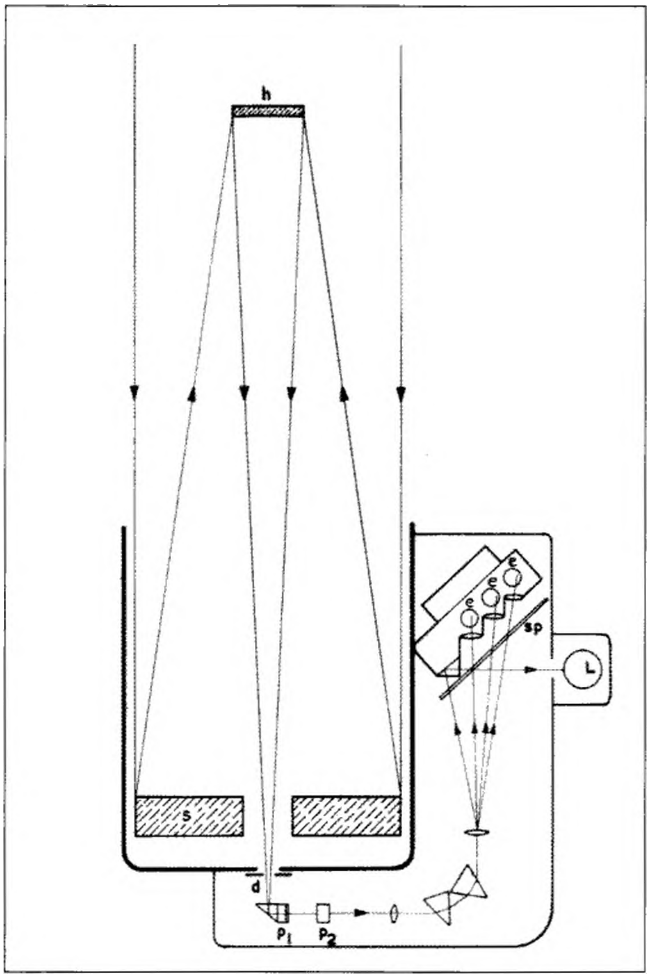


Fig. 53: *Diagram of the lightcollector with its photoelectric measuring system (ref 45)*

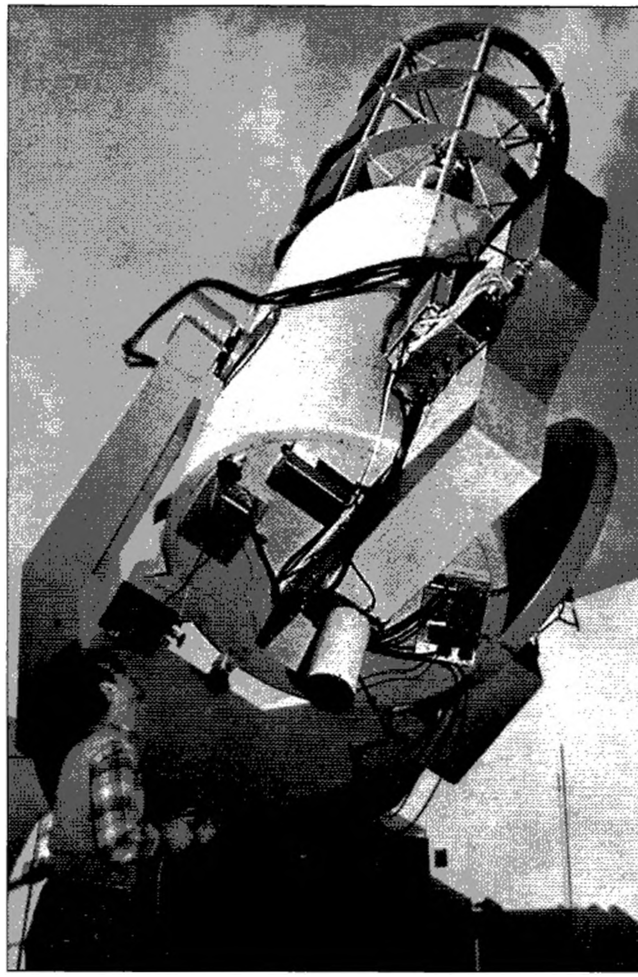


Fig. 54: *The Leiden Lightcollector had a special 36 inch mirror lens system with a 126 inch focal length (ref 45)*

Netherlands. This was designed to concentrate the light from a single star onto a photometric system capable of measuring its light intensity and colour spectrum (see figs 53 & 54)[45].

4.5 Later changes at the Johannesburg Observatory

In 1957 photomultiplier photometers were fitted to the 9-inch and the two Franklin-Adams telescopes to increase the accuracy of light intensity measurements.

Due to its long focal length and narrow viewing angle the 26½-inch Grubb refractor was the least affected by the deteriorating conditions and continued to yield good results in Johannesburg. In spite of the site problems the Union observatory remained the hub of inland astronomical activities.

4.5.1 The Republic Observatory

In 1961 when South Africa became a republic the Union Observatory was renamed the Republic Observatory and Dr WS Finsen became the first and only Republic Astronomer.

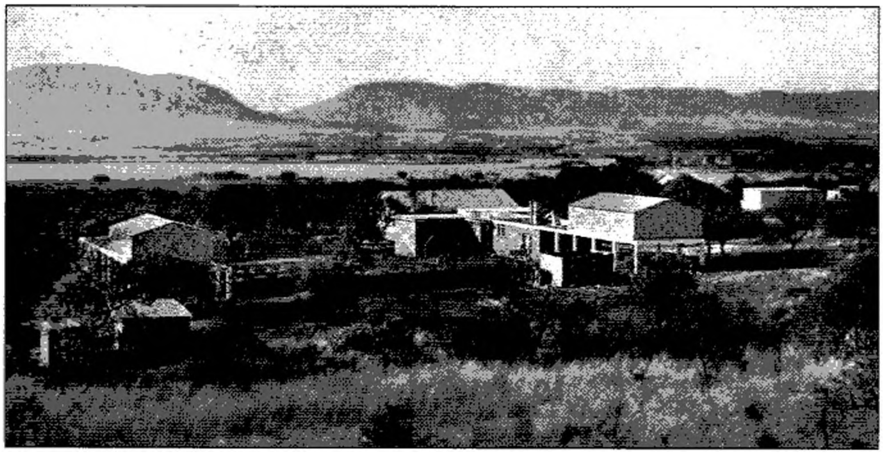


Fig. 55: *The Union/Republic Observatory Broederstroom annexe (also known as the Leiden Southern Observatory). The first housing on the left accommodated the lightcollector. The Rockefeller double astrograph was in the central housing with adjoining office and darkroom. The assistant astronomer's house lies behind the offices in the centre of the picture. The Franklin-Adams camera was in the right hand structure followed by the astronomer's house*[3]

4.5.2 The new office block

Office accommodation at the Observatory had been limited to that provided by the Baker building at the top of the hill and the rooms next to the 26½-inch telescope dome. This latter accommodation had been extended to its present size but after WWII conditions became increasingly cramped and the Department of Education, Arts and Science, under whom the Observatory then fell, agreed to provide a new administration block.

Dr Finsen's son Eyvind was studying architecture at the time and had produced a design for a set of buildings at the Johannesburg Observatory for his final year degree project. In the process he had learnt a great deal about the needs of the Observatory and its staff and although his academic design did not provide an acceptable solution he was advantageously placed to produce a more practical design. His revised plans were eventually accepted and construction of the new building began in October 1962 and was completed in 1964 (Fig 57 and block 6 in fig 137).

4.5.3 The 20-inch Boller and Chivens telescope

At the end of 1968 a 20-inch electronically controlled Boller and Chivens Cassegrain reflector telescope was installed at site T7 (the dome on the east side of the new building – figs 57 & 137).

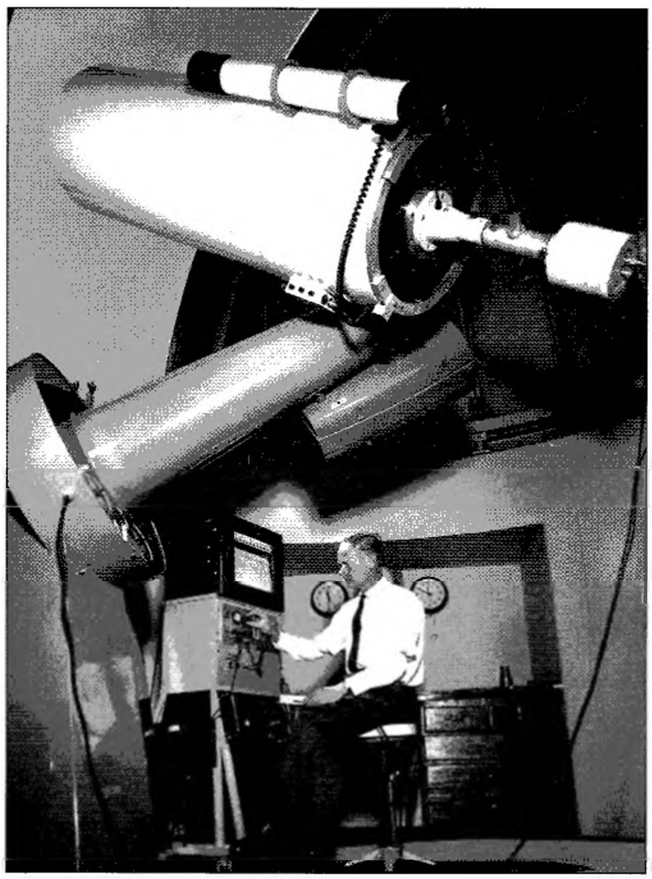


Fig. 56: *The 20-inch Boller and Chivens Cassegrain reflecting telescope with GF Knipe at the controls (CSIR Archives)*

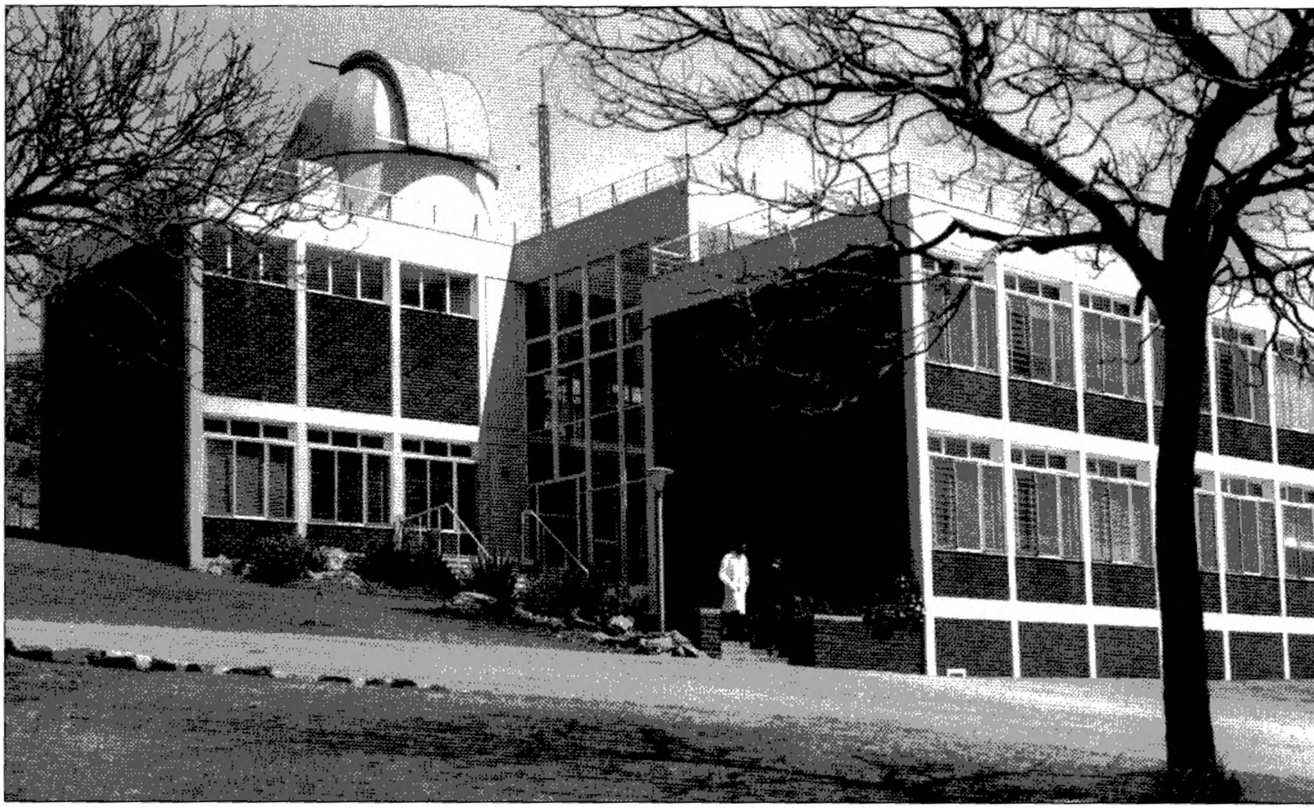


Fig. 57: *The new building completed in 1964 showing the dome that housed the 9-inch telescope from 1964 to 1968 and thereafter the 20-inch Boller and Chivens reflector telescope (CSIR Archives)*

4.6 Johannesburg Observatory Directors and changes of name

Name	Title	Name of Institution	Period
RTA Innes	Director	Transvaal Meteorological Department	1903-04-01 – 1909-06-30
RTA Innes	Director	Transvaal Observatory	1909-07-01 – 1912-04-30
RTA Innes	Union Astronomer	Union Observatory	1912-05-01 – 1927-12-31
HE Wood	Union Astronomer	Union Observatory	1928-01-01 – 1941-02-03
WH van den Bos	Union Astronomer	Union Observatory	1941-02-04 – 1956-12-31
WS Finsen	Union Astronomer	Union Observatory	1957-01-01 – 1961-05-30
WS Finsen	Director	Republic Observatory	1961-05-31 – 1965-07-31
J Hers	Acting Director	Republic Observatory	1965-08-01 – 1971-12-31
JA Bruwer	Acting Director	Republic Observatory	1972-01-01 – 1978-06-30

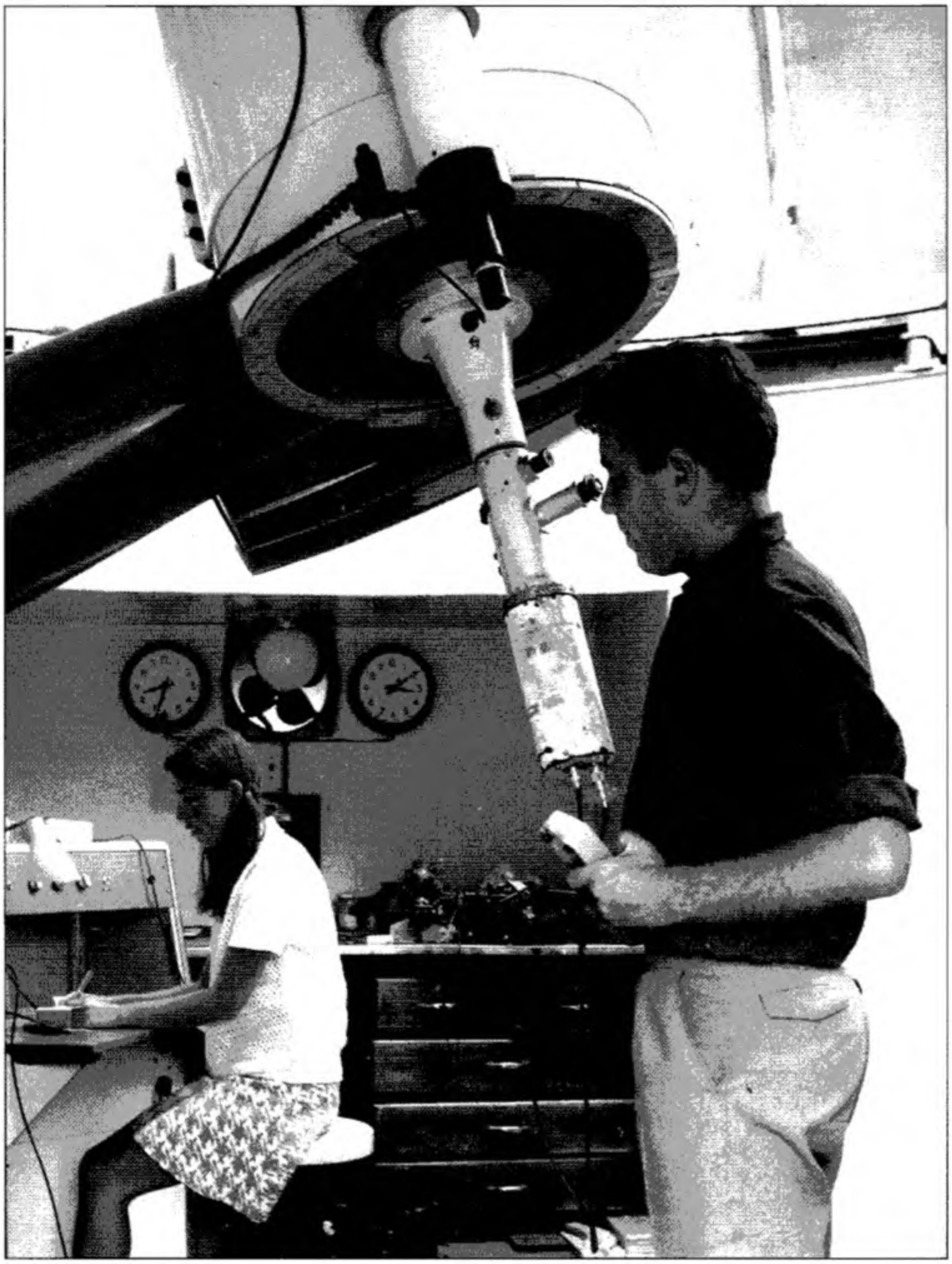


Fig. 58: *Mr and Mrs Wisse using the Boller and Chivens telescope for photometric observations (CSIR Archives)*

RTA Innes (1861-1933)

Chapter 5

Robert Thorburn Ayton Innes was born in Edinburgh on 10 November 1861. He was the oldest of 12 children born to John and Elizabeth (nee Ayton)[10]. He left school at the age of twelve and showed an early interest in mathematical astronomy publishing papers on the long-term perturbations of the earth's obit[93]. Despite his lack of formal qualifications he was elected a Fellow of the Royal Astronomical Society at the age of seventeen[7]. Even in later life when he had become renowned for his observational work he maintained that he was an observer by necessity but a mathematical astronomer by choice.

The story is told[25] that as he was watching the planet Venus descend low in the western sky a dwelling came into view with a girl visible through a window. As soon as he saw her he said to himself 'That's the girl I'm going to marry'. Her name was Anne Fennell and they were married in 1884.

They moved to London where he found a clerical job. To improve their position he sought work overseas and had the choice of becoming the representative for Rose's Lime Juice in Canada or to enter a wine business in Sydney, Australia[25].

5.1 Innes in Sydney, Australia

They chose the Sydney alternative and on 29 August 1890 sailed for Australia. where Robert became a partner in a wine business trading as Innes & Co and Boar's Head Australian Wines at 93-95 Pitt Street, Sydney (fig 59)[10,17]. Until quite recently it is said that he was still remembered for his 'Innes babies' which were small bottles holding sufficient wine for two glasses[25].

Soon after his arrival he met two of the local amateur astronomers John Tebbut, the doyen of Australian astronomy, and Walter Gale both of whom helped to develop his interest in the subject. From the beginning Innes had shown a preference for theoretical and mathematical astronomical studies and this continued in Australia but the 'intense purity' of the skies soon seduced him into observational work[47].

In 1894 Gale lent Innes a 15,9 cm Cooke refractor for a few months which he used to look for new double stars and by the end of that year he had discovered 26 new binaries and had published several papers describing his work[47].

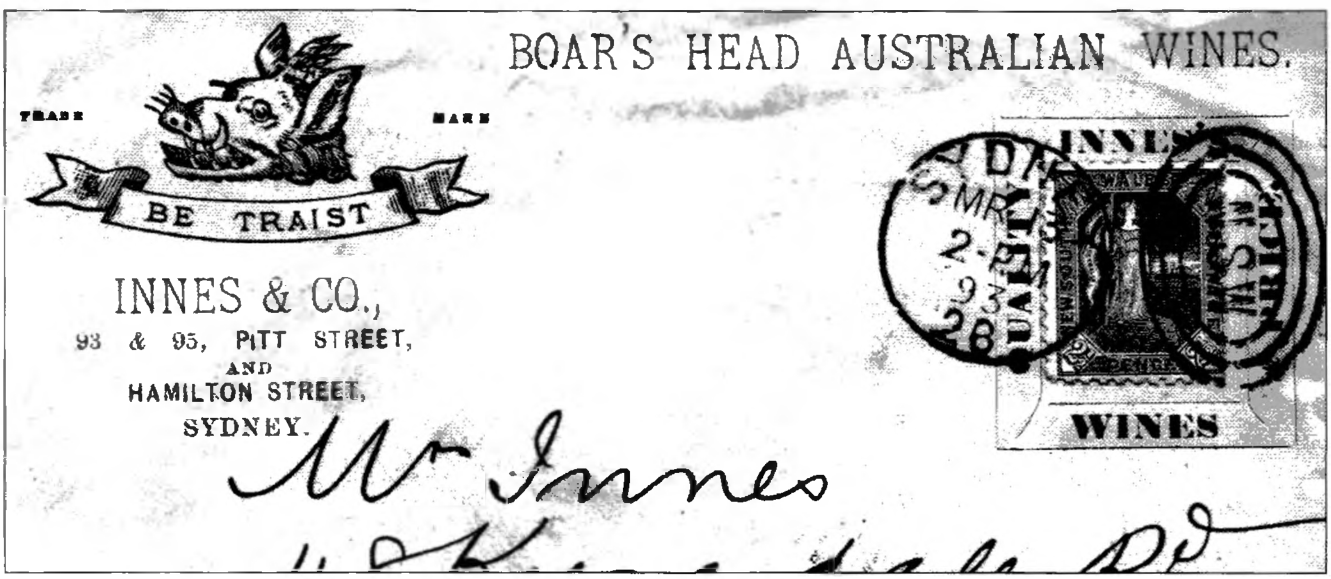


Fig. 59: *The emblem of RTA Innes's wine company in Sydney, Australia (Winifred Gracie)*

Innes and Gale were instrumental in the formation of the New South Wales Branch of the British Astronomical Association in 1894. Tebbutt was the first president supported by Innes as vice president and Gale as secretary. Later in the same year Innes began preparing his 'working catalogue' of southern double stars – this appears to be the start of his life long devotion to this subject.

Innes became increasingly dedicated to his hobby and began exploring ways to enter the profession. Amongst other feelers he contacted David Gill at the Royal Observatory at the Cape of Good Hope hoping that he could offer him a suitable post. Gill had read some of Innes' contributions to the Monthly Notices of the Royal Astronomical Society (MNRAS) and felt that he would like to help him enter the profession. Unfortunately he was not able to offer an astronomical post but late in 1895 an administrative position fell vacant which he thought might provide a stepping stone for Innes.

Gill knew Tebbutt by reputation and wrote to him asking whether he thought Innes would be suitable for the job. Gill attached an offer of employment which he requested Tebbutt to pass on to Innes if he felt that he would be a good choice. At age 34 Innes was too old to be offered a permanent post and the salary of £150 pa could not have been very attractive to someone who had been running a successful wine business. By then Innes and his wife also had three sons to support but Innes was so keen to enter the profession that he accepted the offer[47].

Gill expected him to take up the position by the end of 1895 but this was not possible as Innes had much to sort out before he could leave Sydney. Innes finally arrived in Cape Town on 29 March 1896.

5.2 Innes at the Cape observatory

The move proved to be successful as 'by international standards the Royal Observatory at the Cape of Good Hope was a major one and in scale it far surpassed any of the Australian observatories'[47]. The duties expected of him were a combination of secretary, librarian and book-keeper. Innes used to say that his new job consisted of little more than 'counting cakes of soap' but this left him with time to continue his interest in astronomy. Gill allowed him the use of an old Merz 7-inch (178 mm) refractor equatorial telescope with which, amongst other things, he became involved in the revision of the CPD (the standard catalogue of stars in the southern sky). He also continued his interest in double stars using an 18-inch (457 mm) McClean equatorial telescope honing his observing and measuring skills to a remarkable degree[25].

In 1899 the Cape Observatory published Innes' Reference Catalogue of Southern Double Stars[29]. This was the first catalogue of southern hemisphere binary stars and included observations that he and other astronomers had made in Australia. It listed 2140 pairs including the 280 new double stars that Innes had discovered since his arrival at the Cape[47] and was published in the Annals of the observatory[93].

Between his astronomical interests and administrative duties Innes acquired a working knowledge of meteorology. Thus when Gill was asked to recommend a suitable director for the new Transvaal Meteorological Department he had no hesitation in recommending Innes. Gill's suggestion was accepted and at the age of 42 Robert Innes was appointed as head of the Transvaal Meteorological Department.

5.3 Papers published by Innes after 1904

After taking up the position of Director of the Transvaal Meteorological Department Innes published several papers on meteorology as follows[94]:

The barometer in South Africa, read before the South African Association for the Advancement of Science (S^2A^3) in 1906.

Meteorology in the Transvaal published in the *Journal of the Scottish Meteorological Society* in 1909 in which he discussed the preparation of the first isobaric maps in South Africa and their use for forecasting, and correctly associated the periodic rain and north-west gales of the south-western Cape in winter with the passage of depressions from west to east.

Fig. 60: *Sketch of RTA Innes by Windham Robinson (CSIR)*

He also wrote papers dealing with the meteorological services of the Transvaal and the Union, different methods of measuring rainfall, the rainfall over South Africa, the reduction of temperatures to sea level, the distribution of temperature over northern South Africa, snow in Johannesburg, hail insurance, and effective protection from lightning[94].

Innes was a very versatile astronomer, delivering many papers on a variety of topics at the annual meetings of S_2A_3. These dealt with 'The earth and comet tails' (1909); Le Verrier's theory of the motion of Jupiter and Saturn (1910); determination of the places of the planets (1910); the mean distances of the planets (1911); the minor planets (1912); star positions and galactic coordinates (1913); cosmological hypotheses (1913); the masses of visual binaries (1915); and the parallax of Proxima Centauri (1917)[93].

His broader interests are reflected in the following quote from the S_2A_3 biographical notes[93]:

In addition to his work in astronomy and meteorology, he was interested in a variety of scientific topics and presented papers, mainly before the S_2A_3, on topics such as "Numerical summation of the reciprocals of the natural numbers" (1907), "Weights and measures for South Africa" (1909), "A logical notation for mathematics" (1910), daylight saving (1916), and metrication and the decimalisation of coinage (1916) In December 1905 he was appointed chairman of a commission to report on legislation pertaining to weights and measures for South Africa; its report recommended the legalisation, but not the compulsary use, of the metric system. Though he never attended a university, the quality of his work was such that an honorary doctorate was conferred upon him by the University of Leiden. In addition to his fellowship of the Royal Astronomical Society he was also elected a fellow of the Royal Meteorological Society and the Royal Society of Edinburgh. He was the first president of the Johannesburg Astronomical Association in 1918; and when it amalgamated with the corresponding association in the Cape he became a foundation member of the resulting Astronomical Society of Southern Africa, served as president in 1923-1924, and at the time of his death in 1933 was still director of its computing section. He was also a member of the National Committee in Astronomy, established in 1929. In 1902 he became a foundation member of the S_2A_3, served on its council for many years, was president in 1915, and received the society's South Africa Medal (gold) in 1918. In 1905 he also joined the British Association for the Advancement of Science. He was a member of the South African Philosophical Society from 1903, and in 1908 was elected a fellow of its successor, the Royal Society of South Africa. In 1920-1921 he served on the council of the South African Geographical Society. Innes was full of enthusiasm. Sometimes he appeared conservative, for example when expressing doubt about deductions based on interferometer observations, but at other times he fielded daring hypotheses, such as ascribing the ice ages to the visitations of comets. He had many interests outside astronomy and meteorology too. Thus he was an excellent chess player, competing in South African championship tournaments, and was active in the affairs of the Johannesburg Public Library from his arrival in the city until his death. He also presented papers on topics such as simplified spelling (1916), vocational training (1916), the eradication of venereal disease (1918), and the reconstitution of the Union Senate (1918).

5.4 The Blink Microscope

In 1912 the Union Observatory acquired a blink-microscope (figs 61 & 62) and Innes was one of the first astronomers to make extensive use of the instrument. With this device small changes in the position of heavenly objects against the background of the fixed firmament were readily revealed[30]. Two images of the same region recorded on photographic plates with some considerable time between exposures were laid side by side and viewed alternately to emphasise any changes in their relative position. Between 1916 and 1920 the Union Observatory was asked to examine 436 pairs of plates taken in the United Kingdom, and at Cape Town with the blink microscope[75].

5.5 Proxima Centauri

Dr van den Bos maintained that Innes' greatest achievement was his discovery in 1915 of Proxima Centauri[62]. Alpha and Beta Centauri are the pointer stars to the Southern Cross (fig 30). Alpha is the brighter of the two and Beta is the star nearest to the cross. The brightest stars in the sky are of the 1st magnitude and the unaided human eye can see stars down to the 6th magnitude. Alpha Centauri is a star of the 1st magnitude and was previously thought to be the closest star to our solar system.

Although these stars had been thoroughly examined by astronomers Innes was conscious of the frequent occurrence of companion stars to single or binary stars and he felt that there was a good chance

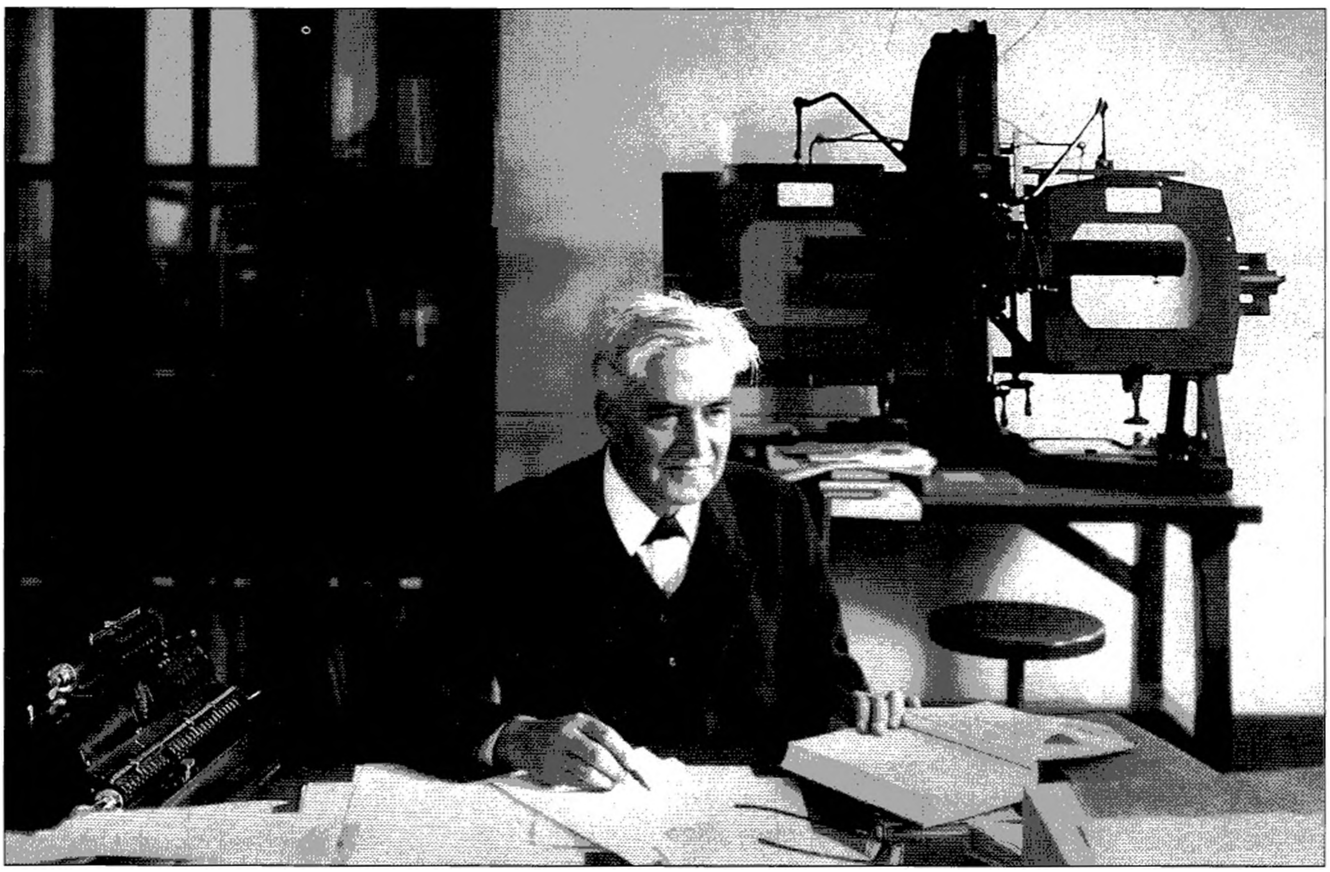


Fig. 61: *RTA Innes with the Zeiss Blink Microscope in the background (CSIR Archives)*

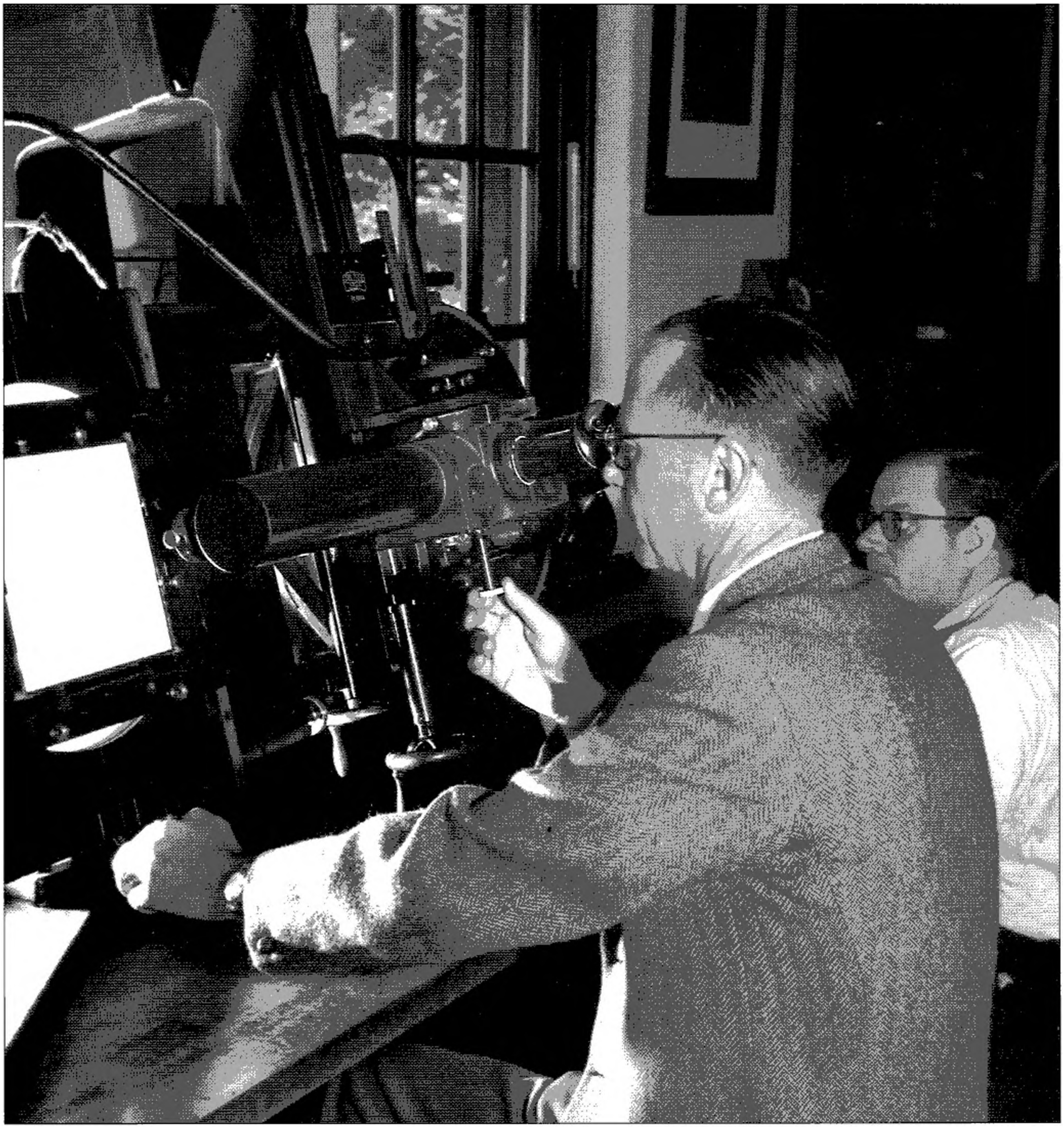


Fig. 62: *The Blink Microscope being used by JA Bruwer and J Churms (CSIR Archives)*

that Alpha Centauri would have a satellite. On 10 April 1910 HE Wood had photographed the area surrounding Alpha Centauri as part of the original Franklin-Adams survey using the 10-inch Franklin-Adams camera. On 30 July 1915 Innes asked Wood to record the same area again with the same camera. Innes compared the two plates using the blink microscope and discovered a new star[16] of magnitude 10,7 which had moved slightly during the intervening period[31]. Although separated from Alpha Centauri by more than 10^{12} km further investigation revealed that this was indeed a companion star having an estimated orbital period of about 500 000 years. In its current position it is closer to the sun than Alpha Centauri and is thus our nearest neighbour at a distance of 4,2 light years. Innes named it Proxima Centauri and this discovery became his best-known achievement[16]. Arthur Innes' eldest daughter, who was born soon after this discovery, was named Stella[10] in recognition of the event.

5.6 Period of rotation of the earth

Time has always been related to the rotation of the earth around the sun and to the passage of the seasons. Special astronomical equipment was devised to determine time accurately and this became one of the routine tasks of astronomers.

The Union Observatory programme had also included regular observations of the behaviour of the satellites of Jupiter and the transits of Mercury. Between 1909 and 1918 Innes published six papers on the perturbations of Jupiter's satellites in the Transactions of the Royal Society of South Africa[93]. This work eventually led Innes to question whether the period of rotation of the earth was completely regular. He made numerous accurate observations of the movement of the moon around the earth, of Mercury around the Sun and of the satellites surrounding Jupiter. In 1924 he published the results of his measurements and showed that in each case their movements were not entirely uniform when compared with the time of rotation of the earth[32]. He found a correlation between these irregularities and concluded that they were seated not in the motions of the external bodies, but in the common factor which was the motion of the earth. By including observations made by earlier astronomers he showed that this variability was about 1 second per year and had accumulated to as much as 30 seconds over long periods (about 100 years). Other astronomers had also suspected that the rotation of the earth was not completely regular but Innes was the first to show this quantitatively and to conclude that the changes were sudden rather than smooth. In spite of a growing acceptance that the rotation of the earth was erratic time continued to be based on this standard for several more decades. Although Innes' work on this subject was published it was not until Jan Hers drew attention to this at a meeting of the International Astronomical Union (IAU) in 1972 that Innes received the credit due to him[19] (for more details see appendix 4).

The irregular motion of the earth has subsequently been thoroughly investigated and it is now accepted that it is subject to sudden changes which although minute remain significant. Innes' conclusion has thus been fully confirmed and time is now standardised by Caesium clocks.

By the time he retired in 1927 Innes had discovered 1500 double stars and contributed much to the understanding of asteroids. His belief that the minor planet Eros had an unusual shape was justified when it was later shown that it is sausage-like being about 29 km long with a maximum diameter of 15 km.

In his obituary to Innes Willem de Sitter stated that 'Innes could measure with entire certainty a double star which Gill – one of the most accomplished observers that ever lived – did not even see double'. De Sitter also made the following comments: "First of all he (Innes) was a computer" and 'The speed and accuracy with which he performed the most intricate numerical computations was most wonderful to behold.[7]'

5.6 Innes: the man

Robert Innes was a remarkable person in many ways. In spite of his limited formal education he became a great astronomer and a respected figure in the scientific community. His remarkable intellect did not dampen his feelings for other people and his warmth was evident not only to his peers but also to woman and children. His soft spot also extended to animals and he was an active member of the SPCA campaigning for a ban on animal-drawn vehicles on the city streets.

Fig. 63: *Cartoon featuring Robert Innes which appeared in the Sunday Times on October 24 1909 (SAAO)*

Innes was perhaps best known for his unconventionality. In the warm climate he gave up wearing neckties even on formal occasions. His preference was for open neck shirts but it is also evident that he was quite willing to wear starched collars without neckties. (figs 61 and 84) At one of the formal meetings of the South African Association for the Advancement of Science (S_2A_3) Innes was seated next to the Governor General, Earl Clarendon. As befitted the occasion the Governor General was formally dressed in his cut-away coat and striped trousers whilst Innes was wearing an open-neck shirt – Clarendon turned to him and said 'Innes, you lucky dog'. According to Juliet Marais Louw[39] (née Rosenthal) Innes appeared before Queen Wilhelmina of the Netherlands to receive his Honorary Doctorate in an evening suit wearing an open-necked shirt.

In an obituary written by de Sitter he emphasises that this was typical of Innes' determination not to be bound by convention and apparently the same individuality could also be seen in his spelling. 'He held strong opinions and liked to express them strongly especially if they were somewhat paradoxical and contrary to accepted views.' In addition to all these remarkable qualities Innes was an expert chess and bridge player and a keen philatelist[25].

The Rosenthals had a close friendship with the Innes family and both Eric and Juliet wrote about them in their published works. According to Eric[54] RTA Innes was an ardent socialist in his youth which is confirmed by his scrap book which included amongst other anti-Establishment cuttings the words of the anthem 'The Red Flag'. Later in life his political views veered from the left to the right. This was evident when during the 1922 strike the police found him listed amongst those who were to be liquidated once the revolt had been successfully concluded.

Bill Finsen makes a point of stating that 'Innes was never anything else but genial' and that 'he was often spoken of as the genial Union Astronomer.' Juliet Marais Louw describes him as being eternally young and ebullient[39].

Mrs Innes was generally known as a charming old lady. Juliet Marais Louw describes her as being 'short and round and silver-haired, with that sweetness in her face which grows more lovely with the years'[39]. Willem de Sitter stated that the younger astronomers and their wives used to call her mother.

Fig. 64: *L to R rear: Unknown, RTA Innes, Edward Innes, John Innes. In front: Unknown, Mrs AE Innes (CSIR Archives)*

John, the eldest of Innes' three sons, became Chief Surveyor of the Consolidated Main Reef mine. The second son, Edward, held a senior position in the Victoria Falls and Transvaal Power Company (VFP).

Soon after WWI the youngest son, Arthur, developed a passion for wireless communications. The Post Office allocated him the call sign 2OB whilst he was living with his parents in Observatory. In the early 1920s he rented a house in Yeo St in the adjoining suburb of Bellevue East, and broadcast regular radio programmes (fig 65). This was before the Associated Scientific and Technical Societies began the first official broadcasts in South Africa from Stuttaford's Building, Johannesburg, in 1924. To his many followers Arthur was better known as Toby, a nickname derived from his radio call sign[56].

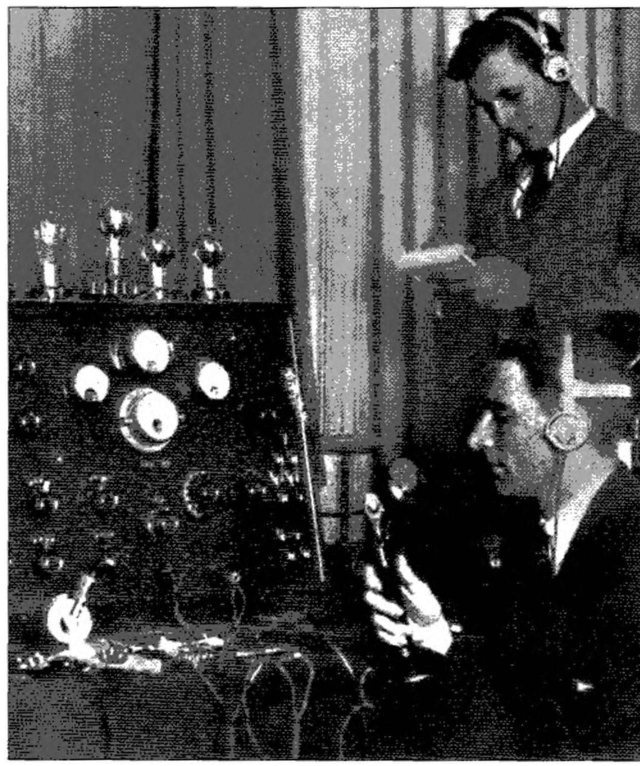


Fig. 65: *Arthur Innes (in front) operating his amateur radio station in 1922 with Alf Goodman in the background (ref 56)*

Innes' unconventionality was also evident in his family life. Although he, his wife, and their three sons appear to have had a good relationship this did not stop him from having affaires with other woman. Whilst this may also have been happening in many other marriages the difference in Robert's case was that he was quite open about it. In particular he was attracted to Rosa Clapton (fig 66) whom he probably knew through their common interest in philately. Rose, as she was known, practised as a freelance nurse and cared for Edward, the

Fig. 66: *Rosa Clapton mother of Winifred, Robert Innes's daughter (Winifred Gracie)*

Innes' middle son, when he was suffering from a critical illness sometime around 1916[17].

In 1919 Rose gave birth to a girl and Robert openly declared her to be his daughter. At the time Rose was living nearby in her own house at 22 Pope Street, Bellevue. Rose and Innes formed a trust to provide for their daughter's future. The Trust's assets consisted of Rose's house and the two adjoining stands (24 and 26 Pope Street). Sometime during the 1920s two pairs of semi-detached houses were built on the two stands[17].

The child was registered as Winifred Hamilton-Jackson. Winifred believes that Robert concocted the surname as the two initials lay on either side of I (for Innes).

The house in Pope Street was conveniently close to the Observatory and both Rosa and Winifred became part of the Innes family spending much of their time at the paternal home. Winifred used to refer to Mrs Innes as Gran (fig 67) and to Robert as Uncle and never questioned the inconsistency. Robert used to greet Winifred with the words 'Hello my pretty little sweetheart' or 'little lump of love' and seemed to take great pleasure in having her around him. By 1919 Anne was 60 years old and Robert 58 and their sons were adults but they all seemed to be happy to accept the new arrival[17].

Fig. 67: *Winifred Hamilton-Jackson, daughter of Rosa Clapton and Robert Innes, with Mrs Anne Innes (Winifred Gracie)*

Fig. 68: *Winifred Hamilon-Jackson (Winifred Gracie)*

After Winifred was born Rose was unable to continue her nursing career and instead turned her philatelic hobby into a livelihood. She aimed at the children's stamp collecting market which she could conveniently conduct from her home. She operated without a trading licence claiming that she was just another stamp collector trading with like minded enthusiasts but it is interesting that she marked her goods with Winifred's registered surname and her youthful clients knew her as Mrs Jackson.

The happy relationship between the Innes family and Rose and her daughter continued until Innes retired in 1927. It seems that provision was made in the Trust to accommodate Mr and Mrs Innes in one of the houses after retirement and they accordingly moved into number 26 Pope Street (the adjoining semi-detached house being number 26a). The garage and servants quarters were converted into accommodation for Rose and Winifred but as this included neither kitchen, bathroom nor toilet they were obliged to use the facilities in the house.

At this time Innes developed a stereoscopic cinema system which he named Projectile. When the invention reached the stage where it required promotion Innes tried to persuade Rose to sell her personal stamp collection and to invest the proceeds in his project. According to Winifred, Rose refused to do this and Innes then took the collection and placed it on auction without her consent.

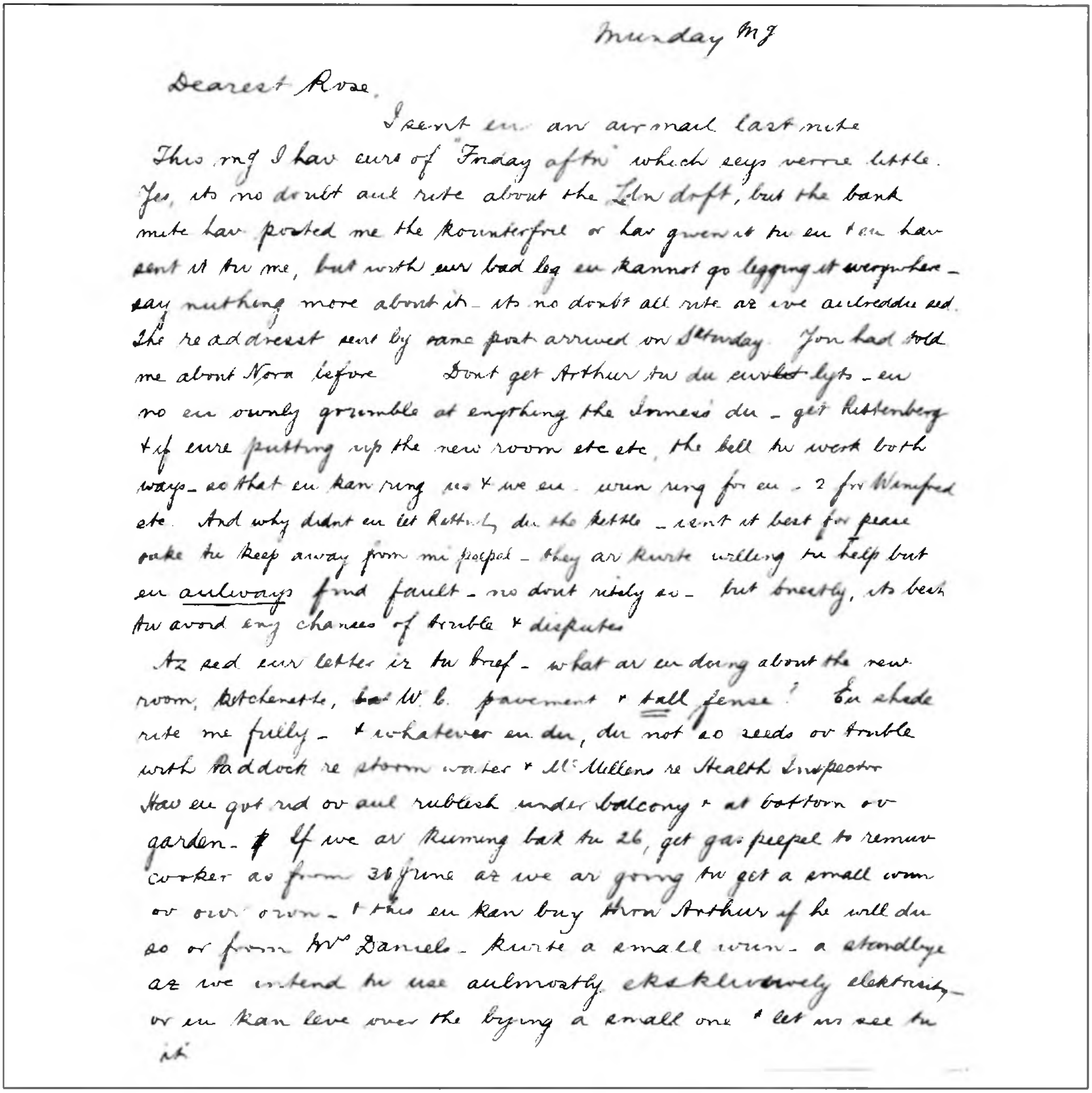
By this time the economic depression had seriously diminished the income from Rose's philatelic business. To make matters worse several tenants had defaulted on rent payment and Innes' two sons, John and Arthur, were occupying 24a and 22 Pope Street rent free[17].

At some point the situation led to a serious breakdown in the relationship with the family and Innes and his wife and their two sons moved to other premises.

Over time a close friendship had developed between Winifred and Arthur Innes' eldest daughter Stella. One of the greatest casualties of the break up was that these two girls were separated and never saw each other again.

Stella married and had a daughter called Ann. By the time this account was written Stella had died but the author had made contact with Ann who provided a much-valued link with the Innes family. One of the benefits of this research was that Winifred was able to make contact with Ann even if it was no longer possible to reconnect with Stella.

De Sitter drew attention to Innes' unconventional spelling. Earlier writings show that Innes was able to spell competently but in later life he appears to have developed a phonetic spelling system which he inflicted on his friends and family. Fig 69 shows a page from a letter he wrote to Rose which exemplifies his 'reformed' spelling. It also confirms that



Munday mg

Dearest Rose,

I sent eu an air mail last nite
This mg I hav eurs of "Friday aftn" which seys verrie little. Yes, its no dount aul rite about the Ldn dreft, but the bank mite hav posted me the kounterfoil or hav given it tu eu + eu hav sent it tu me, but with eur bad leg eu kannot go legging it everywhere – say nuthing more about it – its no dount all rite az ive aulreddie sed. The readdresst sent by same post arrived on Saturday. You had told me about Nora before. Dont get Arthur tu du eurlect lyts – eu no eu ownly grumble at enything the Inneses du – get Rittenberg + if eure putting up the new room etc etc, the bell tu work both ways – so that eu kan ring us + we eu – wun ring for eu – 2 for Winifred etc. And why didnt eu let Rettinly du the kettle – isnt it best for peace sake tu keep away from mi peepel – they ar kwite willing tu help but eu aulways find fault – no dout ritely so – but breefly, its best tu avoid eny chanses of truble + disputes

Az sed eur letter iz tu breef – what ar eu doing about the new room, kitchenette, W.C. pavement + tall fense? Eu shude rite me fully – + whatever eu du, du not sow seeds ov truble with Paddock re storm water + McMillens re Health Inspector. Hav eu got rid ov aul rubbish under balcony + at bottom ov garden – If we ar kuming bak tu 26, get gas peepel to remuv cooker as from 30 June az we ar going tu get a small wun ov our own – this eu kan buy from Arthur if he will du so or from Mrs Daniels – kwite a small wun – a standbye az we intend tu use aulmostly ekskluusively elektrisity – or eu kan leve over the bying a small one + let us see tu it

Fig. 69: *A letter sent by Robert Innes to Rosa Clapton after his retirement in 1927 illustrating his reformed spelling (Winifred Gracie)*

relations between Rose and the family were wearing rather thin.

Winifred trained as a librarian and worked in several organisations including the Government Metalurgical Laboratory. She married Frederick Gracie (fig 70) in 1989 after having lived with him for many years. Frederick was an amateur astronomer and worked on several projects at the Johannesburg Observatory[17].

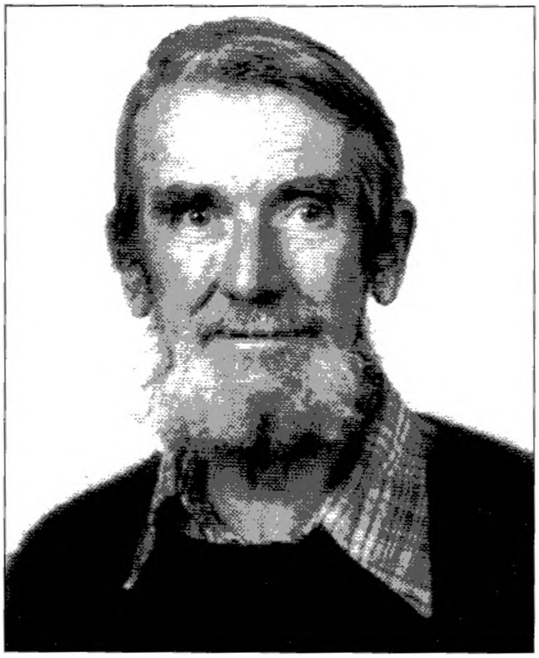


Fig. 70: *Frederic Gracie, Winifred's husband, an amateur astronomer who worked at the Union Observatory on several occasions (Winifred Gracie)*

In his unpublished memoirs Dr van den Bos[62] gives several examples of what he called 'Innesiana' which shed further light on Innes' personality. In his introduction to the Double Star Catalogue (1927) Innes stated categorically that Johannesburg was named after Johan Rissik in spite of the fact that the origin of the name had been the subject of considerable debate. Van den Bos was well aware of the controversy and asked Innes how he could be so certain that Johannes-burg was named after Rissik. His reply was quite clear – 'Johannesburg was named after Rissik, after Rissik alone and after nobody else. I know that because he told me so himself!'

In 1929 the British Association for the Advancement of Science met in Cape Town followed by a visit to Johannesburg. For four nights Dr Wood, Innes' successor, opened the Observatory to the visitors. On one of these nights Innes was present and, as was his habit, he tried to impress the visitors with the transparency of the Johannesburg sky. He looked up to the heavens and said 'Yes, I can see the Gegenschein'. The Gegenschein is a rarely visible oval patch of luminescence appearing in a position in the sky diametrically opposite to that of the sun. It is only visible under favourable circumstances and usually only in the tropics. The Radcliffe Observatory (Pretoria) astronomer, Knox-Shaw, was heard to say 'Bluffer'. In fairness to Innes it should be noted that the Transvaal Observatory Circular No. 5 contains reports on page 58 by Innes, Worssell, Wood and his wife of sightings of this phenomena in Johannesburg in late September 1910.

It is believed that Innes' patented technique for screening stereoscopic motion pictures was taken up by one of the film companies but they never did anything with it. After negotiating this sale and just prior to his return to South Africa he suffered a heart attack in London and died in 1933 at the age of 72.

According to Patrick Moore and Pete Collins[44] he was a great man as well as a great astronomer who had many friends, few critics and no enemies. He was an impressive person who had a considerable influence on current scientific thinking. He was self-taught and never attempted to gain any formal qualifications except for his Fellowship of the Royal Astronomical Society. Leiden University awarded him an honorary Doctorate in 1924.

When Robert, one of Innes' grandsons, was introduced to Edwin Hubble, the great American astronomer. Hubble asked him whether he was related to RTA Innes and when he indicated that he was a grandson Hubble commented 'What a great honour to shake your hand!'[10]

HE Wood (1881-1946)

Chapter 6

When Gill nominated Innes for the post of Director of the Transvaal Meteorological Department he also recommended that Innes should be supported by a properly qualified assistant to ensure that the weather station would be organised professionally. The post was advertised in England and Harry Edwin Wood was chosen from a large number of applicants.

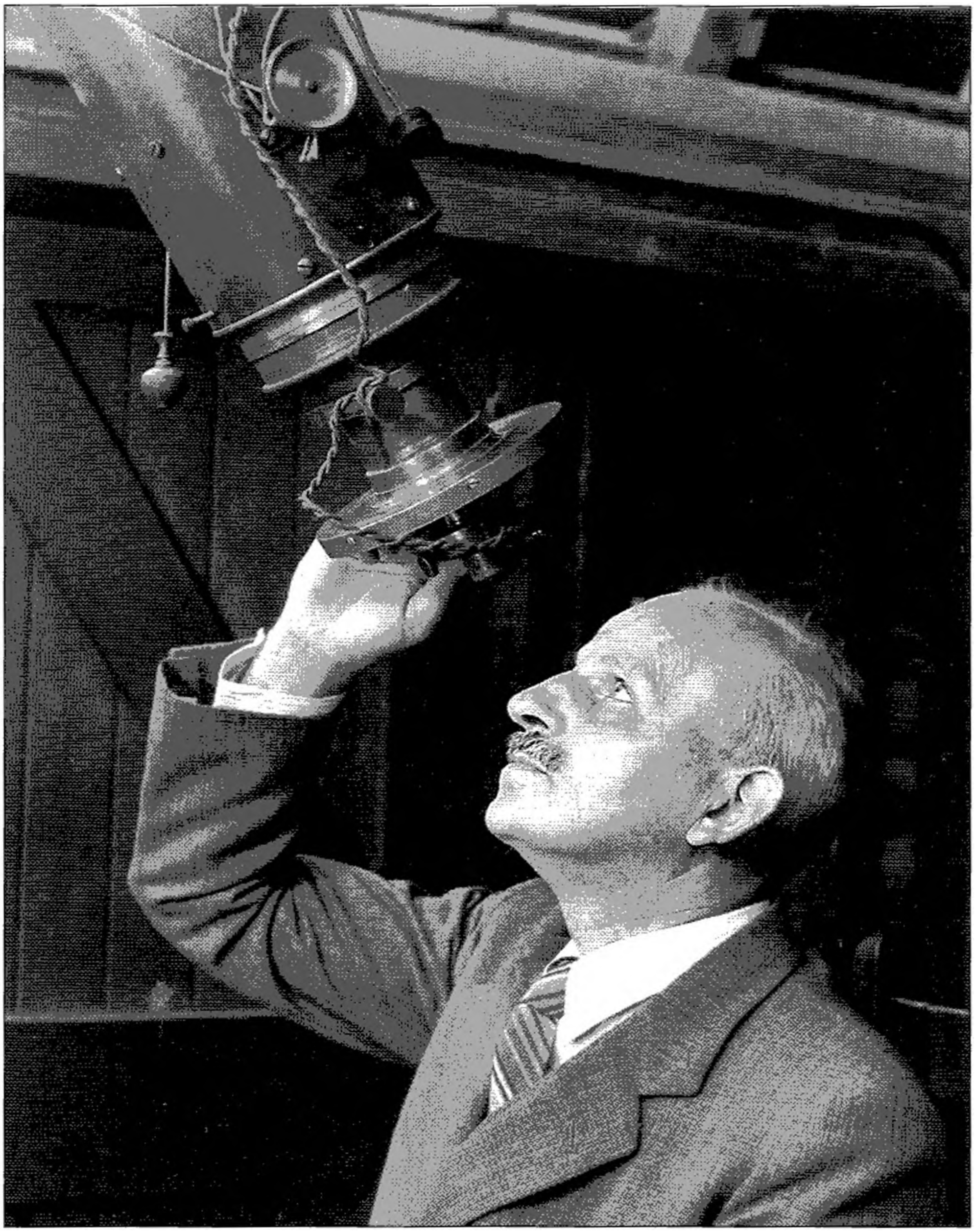


Fig. 71: *HE Wood using the Franklin-Adams 10-inch telescope (CSIR Archives)*

Wood had a brilliant scholastic record at the Manchester Grammar School and at Owens College where he had studied under Schuster and Lamb to gain a first class honours degree in physics. He subsequently achieved an MSc at Manchester University and became a senior lecturer in their department of physics. Dr Schuster drew his attention to the opportunity being offered in the Transvaal and encouraged him to apply for the position.

As his qualifications did not include a specialised knowledge of Meteorology arrangements were made for him to receive intensive training at the Meteorological Office in London and at the National Physical Laboratories at Kew. The distinguished director of the British Meteorological Office, WN Shaw (later Sir Napier Shaw), gave Wood special training in weather forecasting.

He arrived at the Transvaal Observatory in January 1906 and according to his wife he found 'a very immature establishment on a bare hillside and work must have been both difficult and disheartening for some time'. In spite of this by July he had organised the first 24 hour weather forecast in South Africa and this was distributed to telegraph offices throughout the Transvaal.

Wood was placed on a salary scale of £320 per annum which was to increase at the rate of £20 per annum to a maximum of £440.

Early in 1909 whilst on leave in England he became directly involved in the negotiations with Franklin-Adams relating to the gift of his astronomical camera to the Observatory. Franklin-Adams demonstrated the telescope to Wood and made sure that he had a sound knowledge of its features. After the instrument had arrived in Johannesburg it was thus natural that Wood should have been the one to use it to take 50 excellent photographs of Halley's Comet which were published in the Observatory circulars for 1910. Subsequently he also did most of the photographing to complete the Franklin-Adams sky charts so that by the time these were finished he had become the specialist in this type of work.

When the new Meteorological office was to be established in 1912 Wood was faced with the choice of moving to Pretoria to work under the new head of meteorology, CM Stewart, or to remain in Johannesburg to become an astronomer. He decided to stay and declared forever after that he had become an astronomer by act of parliament[64].

On 19 February 1909 during his leave in England he married Mary Ethel Greengrass, a fellow student at Manchester, and they both returned to Johannesburg (together with the Franklin-Adams camera lens). On numerous occasions his wife assisted him in his work at the Observatory. For example between 1913 and 1915 Wood spent some time observing Jupiter's satellites using the Franklin-Adams star-camera and according to the annual reports his wife assisted him in this task.

Fig. 72: *Mrs Mary Wood who assisted her husband, HE Wood, in many of his tasks (CSIR Archives)*

Fig. 73: *The snowman made by Mrs Mary Wood during the heavy snowfall of August 1909 (CSIR Archives)*

In a document which Mrs Wood wrote describing some of her life at the Observatory she mentions that one of the recurring difficulties was the danger of fires on the property. Looking at the bare koppie shown in figs 7-10 it is difficult to imagine that there was sufficient grass or bush to support a hazardous fire but both Mrs Wood and Mrs Sorgentini confirm that everyone on the property became involved in extinguishing the periodic veld fires.

In complete contrast the rare snowstorms occurring in Johannesburg appear in most collections of photographs of the Observatory. Mrs Wood was particularly impressed with the snow which fell in the middle of August 1909 soon after she had arrived in the country – there was sufficient for her to make the snowman shown in fig 73.

In April 1916 Wood entered the army for service in German East Africa returning in February 1917. Whilst there he contracted malaria which persisted until he and his wife retired to the dry air of the Karoo.

6.1 HE Wood Union Astronomer (1928-1941)

In 1928 Wood was appointed Union Astronomer and one of his first tasks was to organise co-operation with the double star work being done at the Lamont Hussey Observatory in Bloemfontein and to arrange cross visits by the staff of both observatories to minimise duplication of work[75(1928)].

In 1937 the University of the Witwatersrand conferred an honorary DSc on Wood. According to Dr Finsen[25], in complete contrast to Innes, Dr Wood was uncompromisingly orthodox. Finsen also mentions that he was a very 'touchy person' giving as an example that after a newspaper reporter had addressed Wood as Mr he refused to speak to him again. He was very fond of his dog and cat but when the latter killed a bird Wood refused to speak to it for a week.

Wood attended a meeting of the IAU in Stockholm in 1938. On his return he commented that one shouldn't waste one's time going to these meetings because they were very social.

Whilst Dr Wood, a keen naturalist, was living in the Boulton and Paul house he assembled a collection of reptiles preserved in jars. When he was promoted to Union Astronomer he moved out of the prefabricated house into the Director's house. EL Johnson and his family then moved into the vacated dwelling and in the process their young daughter, Pamela, had the fright of her life when she came upon Wood's collection of snakes and other horrifying creatures[59].

He was the honorary secretary of S_2A_3 for 23 years and was President from 1929-1930. In 1924 Wood presented the first scientific talk to be broadcast in Africa from the Associated Scientific and Technical Broadcasting station.

Wood succeeded Innes as the Union Astronomer in 1928. He was married but had no children and in 1941 he and his wife retired to a farm near Mortimer in the Karoo.

Fig. 74: *HE Wood (1881-1946) with the 10-inch Franklin-Adams telescope (CSIR)*

DR WH van den Bos (1896-1974)

Chapter 7

At the instigation of his daughter, Elizabeth, Dr van den Bos wrote his memoirs, the source of much of the information reproduced here[62]. Born in Rotterdam on 25 September 1896 Willem Hendrik van den Bos (figs 75 & 76) was the second child of W H van den Bos and Johanna Rijken. His mother came from a family of musicians and passed on to Wim (as he was known amongst the family) a full measure of this talent. Wim did not wish to become a teacher, as both of his parents had been, but his father hoped that failing this he would study medicine. Wim's main interest lay in mathematics and physics and when he announced that he wished to become an astronomer his father retorted 'my boy, could you not have selected a useful profession, if you do not like medicine?'

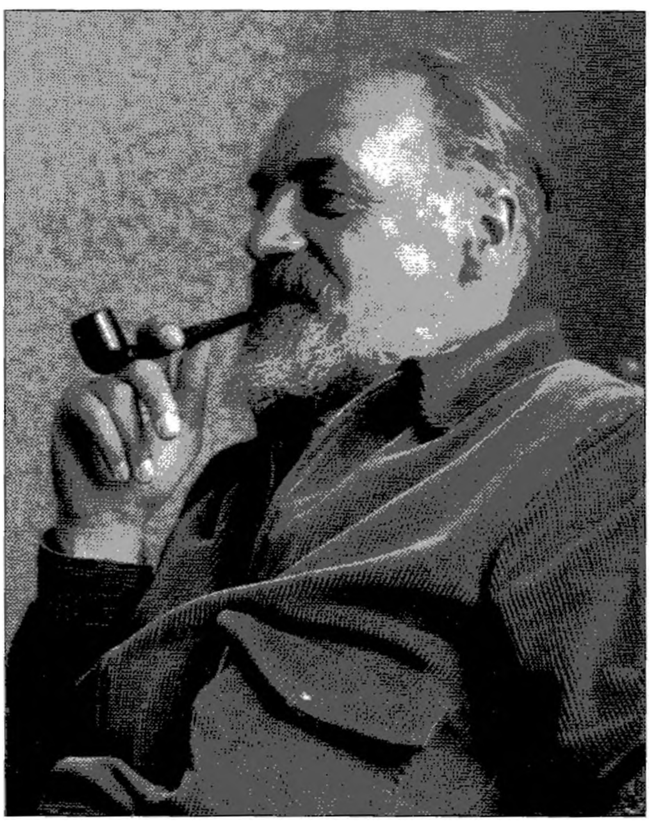


Fig. 75: *Dr WH van den Bos (1896-1974) Union Astronomer from 1941-1956 (E Lockwood)*

Fig. 76: *Dr van den Bos in playful mood at Katwijk in Holland (1935) (E Lockwood)*

Wim studied under Professor de Sitter at Leiden University and met Cornelia Johanna Francisca Manders (born 24 May 1894) soon after completing his military service. A close relationship developed fuelled by common interests such as their love of music. Amongst her family Cornelia was generally known as Cor but the friends she would later make in South Africa knew her as Corrie.

Wim still had to prepare a dissertation for his Doctorate and Corrie was able to help him but they had to wait until August 1923 before they could get married. Their first child, Willem Hendrik III, was born in 1924 and Wim gained his doctorate in 1925.

Following the Leiden/Union Observatory co-operation agreement and with the new 26½-inch telescope nearing completion Innes was looking for young astronomers to join his team and de Sitter arranged for van den Bos to spend 3 years in Johannesburg as the Leiden Observer.

7.1 Permanent appointment in Johannesburg

Dr W van den Bos arrived in Johannesburg to take up the position of Leiden astronomer in August 1925. Wim so enjoyed the work during his 3 year contract that as it drew to a close he and Corrie decided that they would like to remain in Johannesburg. Wim was required to become a South African citizen before he could join the permanent staff and Leiden agreed to continue the loan of his services for a further two years so that Wim could satisfy the five year residence requirement for naturalisation. The South African Government paid Leiden University £600 a year for this arrangement allowing them to more than double Wim's previous income and making life a little easier for the van den Boses.

The family had been staying in a rented house in Yeo St with Bill Finsen as a lodger to augment their income. Even on Wim's increased salary they found it difficult to make ends meet. Corrie discovered a low priced prefabricated asbestos/cement house on display at the Rand Easter Show and they decided to spend the remainder of their savings to have one erected at Observatory on the east side of the telescope dome (fig 77 & 137). Originally it consisted of a single room but this they extended in 1929 by adding a kitchen, toilet and bedroom. They managed with a small single bed as Corrie would sleep at night while Wim was observing and he occupied the bed during the day – but it was a tight squeeze on those nights when they slept together. On nights when Wim was observing Corrie would sometimes spend time with 'Mum' Innes – if Dr Innes was there he often used to provoke Corrie into discussion on a controversial subject and after she had argued for some time he would remark 'My but your English conversation is improving!'

Fig. 77: *Mrs Corrie van den Bos at the door of the prefabricated house they erected at the Johannesburg Observatory (block 3 in fig 137) (E Lockwood)*

Fig. 78: *Dr and Mrs van den Bos sitting in front of their house at the Observatory (P Sorgentini)*

Soon after their arrival they met Dr Harold L Alden who was the superintendent of the Yale telescope situated on the Witwatersrand University campus. Both Wim and Corrie formed a close relationship with the Aldens spending alternate Christmases with each other (fig 79).

Fig. 79: *Christmas 1929 spent with the Aldens at the Yale Southern Observatory on the University of the Witwatersrand University campus. Back row: Wim van den Bos, unknown, Corrie van den Bos with Liesbeth, Mildred Alden holding Lee, unknown. Front row: unknown, Willem van den Bos, Ruth Alden, unknown, Marie-Louise Alden (E Lockwood)*

Yale University had erected their 26-inch (66-cm) photographic refractor telescope on the Witwatersrand University campus in 1925 and Dr Alden ran the observatory from 1926 until 1945. Cyril Jackson took over from Alden and remained in charge until the Yale-Colombia observatory was closed in 1952[37].

In 1928 Leiden University hosted a conference of the IAU. Wim was precluded from attending as he did not wish to break his five-year continuous residential period. Corrie was so familiar with Wim's work that it was decided that she should attend on his behalf taking young Willem to meet the family in the Netherlands. Although Innes had retired by then he decided to accompany Corrie and Willem leaving Wim to board with 'Mum' Innes.

Their first daughter, Elizabeth, was born on 10 November 1929 which happened to be not only her brother Willem's birthday but also that of Dr Innes. Antonia followed on 26 February 1931 and the family was complete (fig 80).

Wim was appointed Chief Assistant Astronomer in October 1930.

The whole family returned to Europe in 1935 so that Wim could attend the IAU Congress in Paris. Dr Voûte of the Indonesian Observatory at Lembang was due to retire and wanted Wim to take over his position. At the conclusion of the Congress he invited Wim to visit his observatory and offered to share in the travelling costs. Driven largely by Corries's enthusiasm for the idea and although they could ill afford it they decided to convert the trip into a world wide tour leaving their children in the care of two nurses in Rotterdam. The trip included a lengthy stay in the United States giv-

Fig. 80: *Antonia and Elizabeth van den Bos on the steps of the prefabricated house at the Observatory (E Lockwood)*

ing Wim the opportunity to visit several observatories. Time was also spent at Hawaii, Japan, China and Java. In the end Corrie came to the conclusion that the proposed job would not be such a good idea as the Indonesian observatory was controlled by a committee and they returned to Johannesburg.

Corrie had, of course, to return to Rotterdam to bring the children back to South Africa and when they arrived with all their luggage she took one look at the small prefab and declared that they could no longer continue live that way. By then arrangements were already in hand to build a house on the property for the assistant astronomer but due to bureaucratic delays work had not yet started. Corrie approached Dr Wood and declared that if he would not go to Pretoria to hurry things up she would. Wood was able to get the project going and the family took up temporary residence in a rented house in Becker St. They sold the pre-fab to Sylvia Bosman for £160 (it was finally demolished in about 1972). Just before the new observatory house was completed the builder went insolvent and the work remaining had to be to put out to tender which further delayed completion.

At the outbreak of WWII Johnson and Jackson enlisted for active service and all the work at the observatory had to be done by Wood, van den Bos, Finsen and Bruwer.

7.2 Union Astronomer (1941-1956)

Wood retired at the start of 1941 and van den Bos was made Union Astronomer with Finsen as his chief assistant.

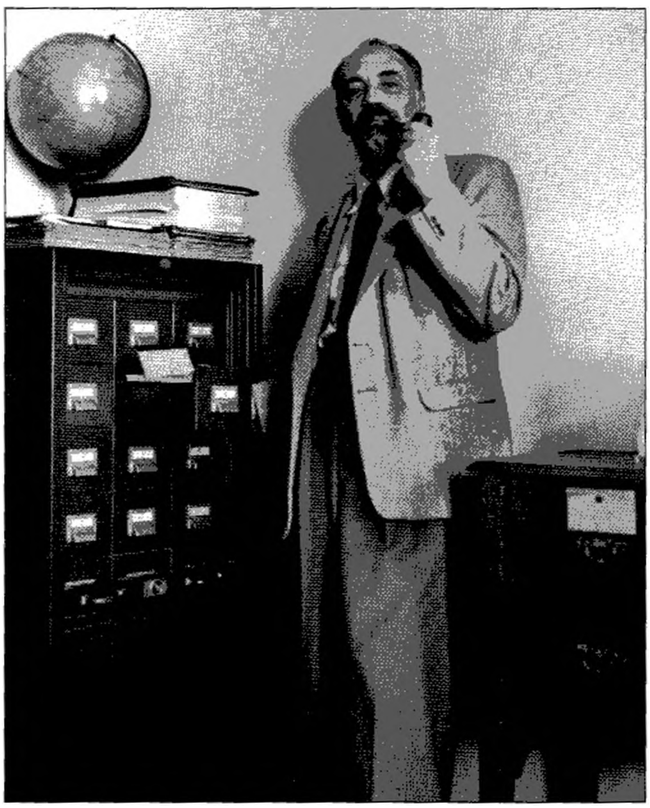


Fig. 81: *Dr W H van den Bos consulting the catalogue of over 20 000 double stars which he helped to create (E Lockwood)*

Dr van den Bos retired late in 1956 after 26 years of service at the observatory. Early in 1957 he and Corrie departed on an extensive tour during which Wim enjoyed working at several of the leading observatories in the USA. He was deeply impressed by the 200-inch (5,08 m) telescope at Mount Palomar. From the basement to the top of the dome was the equivalent of a five storey building – the observer sat in a cage which travelled with the telescope so that he had to communicate with his assistant by telephone. One observer used to pin a card at the entrance to the cage carrying the words 'Have you urinated' to remind him that a visit to the toilet in the middle of a session would eat significantly into his observing time.

From 1959 van den Bos was able to continue working as a guest astronomer at the Union Observatory taking advantage of a research grant from the CSIR.

In 1961 he took up a two year Associate Professorship at the University of California and they decided to make this their second round-the-world trip travelling this time from east to west. Wim was very pleased by the 12 934 astronomical measures he was able to make at the Lick observatory. Combined with the 5 738 measures he had made on his previous visit Wim felt that his American trips had yielded a good harvest.

During his time in Johannesburg he had investigated all stars in the southern skies south of declination minus 19° having a brightness down to the ninth magnitude. This required 71 929 measures which, according to Dr Finsen, was a world record[25].

Both Wim and Corrie continued to develop their musical talents when they first settled in Johannesburg. They were both competent pianists but Corrie's strength was as a singer and Wim's was on the flute. Soon after their arrival they made contact with other musicians and enjoyed musical evenings with them.

Corrie started giving singing lessons and they joined the music section of the German club. They soon made friends with the leading musicians of the day such as Bram Verhoef and Professor Percival Kirby. Bram's father lent Wim a flute so that he could join the small orchestra at the club. Later on Wim was able to get an almost new Mollenhauer flute for £12 10s.

They helped to organise several concerts, including one in the Selbourne Hall at which Corrie sang lieder accompanied by Bram Verhoef, Otto Hooper and Wim. Wim eventually became first flautist of the Johannesburg Symphony Orchestra, an amateur body started by Joseph Trauneck, an Austrian refugee, in about 1938 (fig 82).

Fig. 82: *The Johannesburg Symphony Orchestra held a Concerto Festival in the great hall of the University of the Witwatersrand in 1954. Dr van den Bos (first flute) is just visible in the back row (E Lockwood)*

7.3 Corrie van den Bos

By the mid '30s the van den Bos children were well into their schooling and Corrie had time to expand her horizons. At first she became involved in children's and international programmes at the SABC.

After the outbreak of war she joined a group called the Truth Legion which was formed to counteract the anti-war propaganda of the Ossewa Brandwag. She was also involved in establishing a branch of the International Red Cross in Johannesburg which did much to maintain contact between people from Europe with their families in the occupied territories. Corrie was appointed leader of a group of the Truth Legion which addressed public gatherings around the country to inform them on what was happening in Europe. Some meetings were like battlegrounds – members of the audience were armed with rotten eggs and tomatoes, large hat pins and bicycle chains. Late in 1941 Corrie became Press Attaché to the Netherlands in spite of the fact that she was by then a naturalised South African and not really eligible to hold such a position.

In 1948 a visitor from England, Irene Ashton-Jones, put out feelers to see whether there would be any interest in starting Business and Professional Woman's Clubs (BPW) in South Africa. As a result a club was started in Durban and Corrie's name was given as a contact in Johannesburg. She became the first President of the Johannesburg club as well as founder president of the South African Federation of BPW Clubs.

She was elected as a vice-president of the International Federation of BPW in 1950. This organisation was represented at the United Nations and became involved in many aspects of human rights. Corrie was conscious of the fact that the Charter of Human Rights laid emphasis on various rights but there was no mention of the duties which should be associated with those rights. With the support of the SA Federation this concern was presented to the International Federation of BPW and after much lobbying at the United Nations the word 'duties' was finally incorporated into the Charter.

At this time Corrie also took on the job of organising the United Party Information Library and by the time she retired in 1956 they had an extensive well-organised information centre.

Fig. 83: *Staff and visitors to the observatory at the east entrance to the Director's House. At the back are Miss SS Bosman and EL Johnson, Second row: unknown, Dr HL Alden with spectacles (Yale Southern Observatory), unknown, unknown, RTA Innes. Front row: WM Worssell, HE Wood with receding hairline, WH van den Bos with beard, C Jackson (P Sorgentini)*

Corrie attended several International Conferences and lectured extensively to overseas audiences ranging from school children to women's groups. She took a special interest in the work of the World Health Organisation and attended the conference on Atomic Energy for Peaceful Purposes.

In June 1952 the Rev JB Webb married their elder daughter, Elizabeth, to Peter Lockwood. The ceremony was performed in the entrance hall of Innes House (see fig 24).

Corrie died in 1970 followed by Wim in 1974. Fortunately during their retirement their daughter Elizabeth had persuaded each of them to write their memoirs and this has been most helpful in preparing this history.

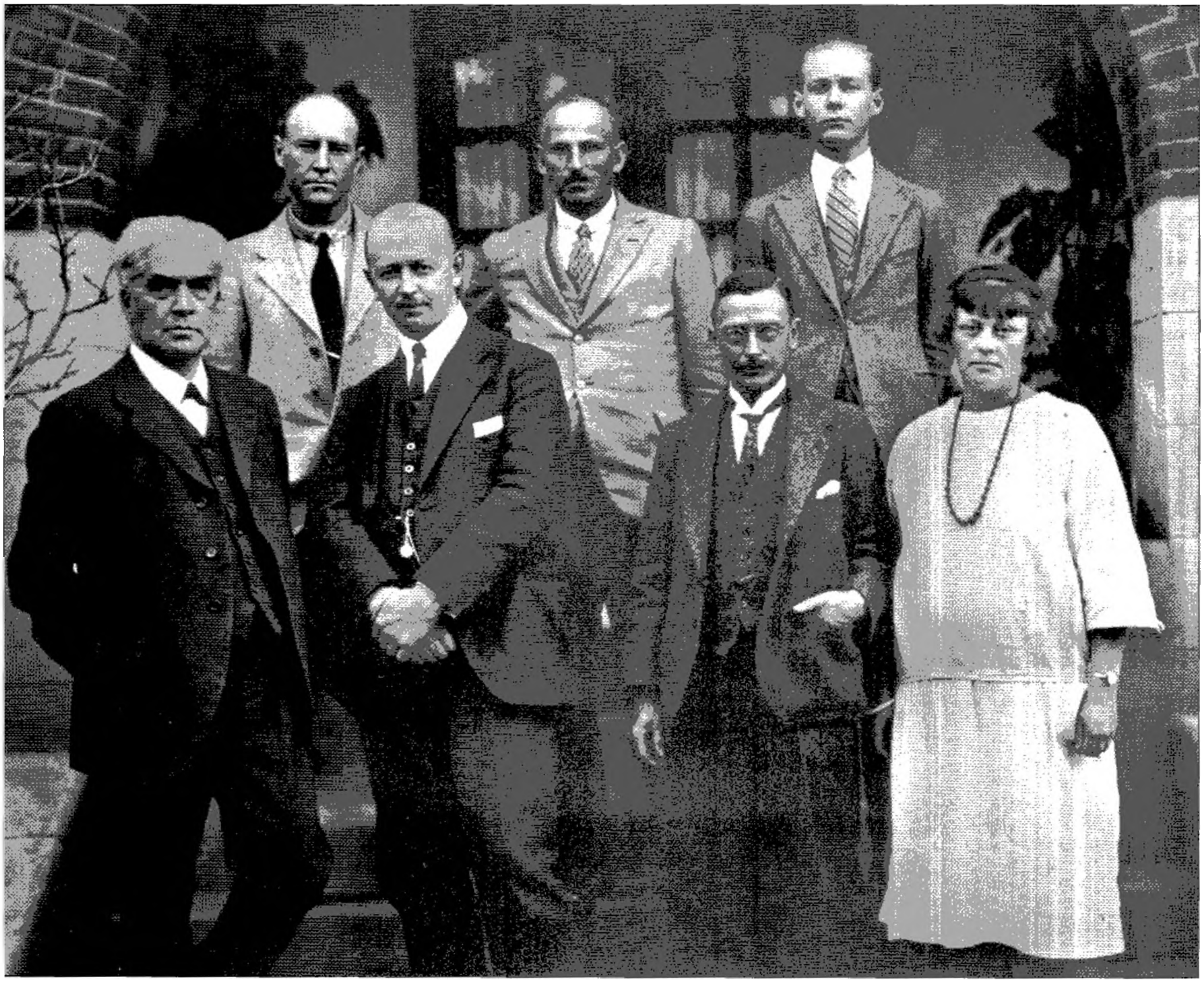


Fig. 84: *From left to right in front are R T A Innes, Prof Georg Struve (Neubabelsberg Observatory), WM Worssell and Miss SS Bosman. In the rear are EL Johnson, HE Wood and W S Finsen (about 1926) (P Sorgentini)*

DR WS Finsen (1905-1979)

Chapter 8

William Stephen Finsen (note that ref 35 incorrectly gives Stephan) (figs 85, 86) was born in 1905, in Parktown, of Danish parents. He attended Yeoville Government School and the King Edward VII high school (KES) where he was awarded the only first class matric in Johannesburg in 1923. He applied to enter the Faculty of Science at the Witwatersrand University in 1924 and at the same time began voluntary work at

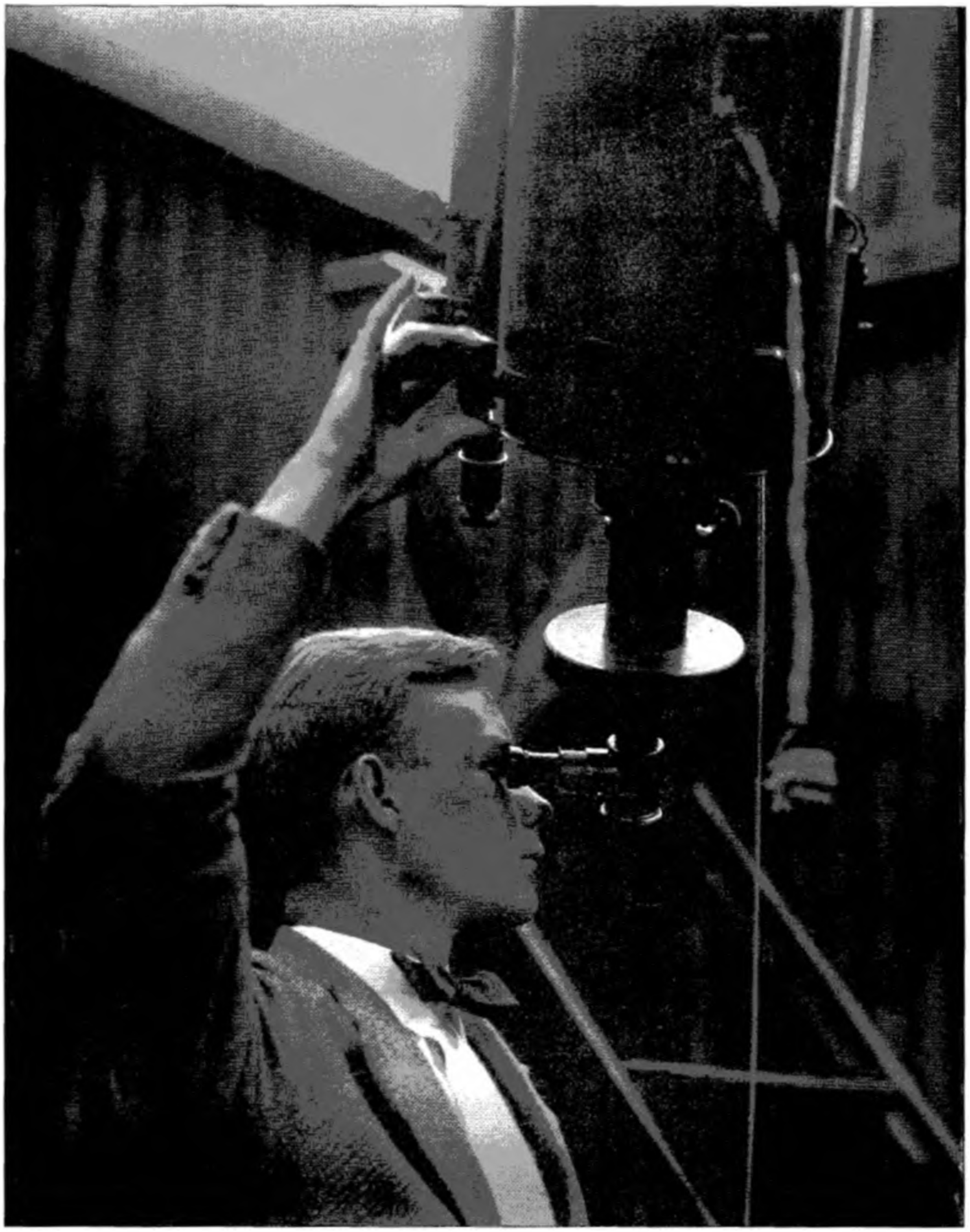


Fig. 85: *WS Finsen (1905-1979 using the 9-inch telescope (E & P Finsen)*

the Union Observatory. Dr Innes persuaded Finsen to relinquish his full-time university application and continue working at the observatory taking a degree in his spare time. He remained an unpaid assistant for 14 months until Mrs Human (the human computer at the Observatory) left in April 1925. Finsen was then given her position (second grade clerk) and enjoyed the salary of £15/month. He enrolled with the University of South Africa to study subjects appropriate to astronomy. At that time there were no correspondence courses; students were simply given the syllabus and a list of textbooks to study in preparation for the annual examinations. Finsen, like most other people who took degrees this way, found the process difficult but he eventually gained a BSc followed by an MSc from the University of the Witwatersrand and finally Cape Town University awarded him a DSc on the strength of his published works[23, 35].

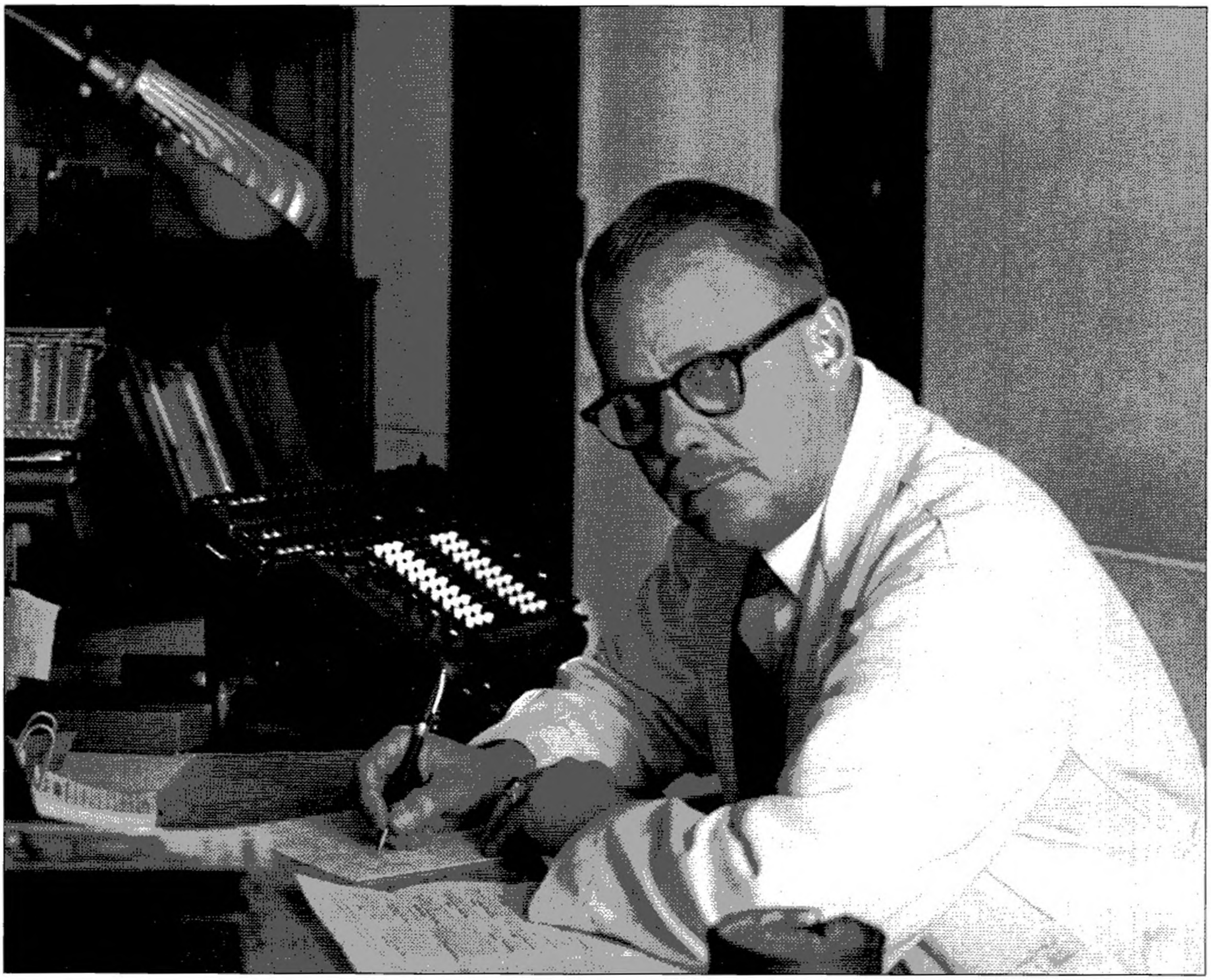


Fig. 86: *Dr W S Finsen at the observatory (E & P Finsen)*

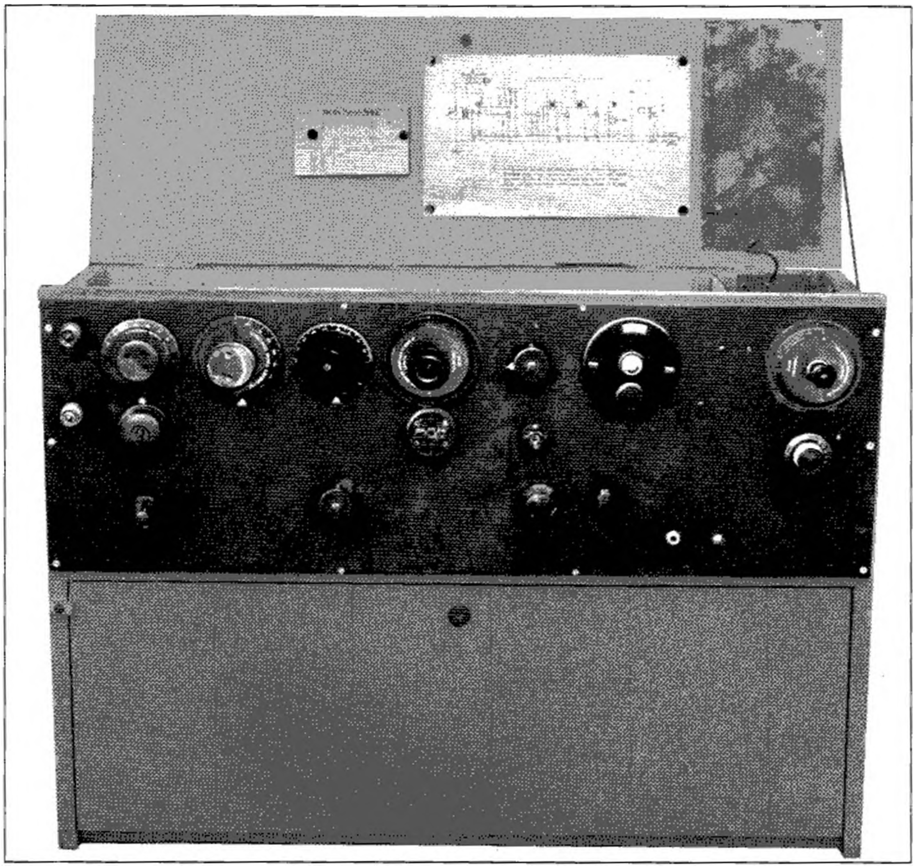


Fig. 87: *The long-wave (20 000 m/ 15 kHz) radio receiver built by Dr Finsen in the early 1930's to receive European time signals (author)*

From the beginning Finsen shared in the routine meteorological and seismological observations and with the running of the time service. In the 1930s he made an elaborate radio to receive time signals from Rugby and Bordeaux. For a start the components were spread over a table 2,5 m long by 1 m wide but eventually these were mounted in a 1,5 m wide wooden cabinet (fig 87)[11]. Reception was never very good but provided a more or less regular time check until 1939 when WWII started and it was felt that a more reliable receiver should be provided. Finsen's receiver is now in the collection of the Historical Section of the South African Institute of Electrical Engineers.

Finsen devoted much of his time to the traditional observation and measurement of double stars and contributed to the catalogue of southern double stars. In March 1928 he was examining Nova Pictoris with the $26^{1/2}$-inch telescope at the request of Professor BH Dawson of La Plata Observatory. At first he found that this star appeared to be split into 2 parts but subsequent observations revealed that it consisted of four components. Astronomers in the UK found it difficult to believe and it was some time before the findings were generally accepted. At the 1935 meeting of the IAU in Paris a cable arrived announcing that the star Nova Hercules had been observed to consist of 2 nuclei (a so-called split). Sir Arthur Eddington one of the distinguished astronomers present immediately asked where the observation was made. When he was told that it was in the USA he accepted the news remarking 'as long as it wasn't in Johannesburg because they see everything double'.

In 1948 Finsen produced a remarkable eyepiece interferometer which he designed and made himself. This device was invaluable for revealing double stars which were too close to each other to be separated visually. Finsen attached the instrument to the $26^{1/2}$-inch refractor and examined over 8 100 stars searching for close pairs (fig 88). He continued this search even after retirement and found 73 binary stars which were previously thought to be singles. In addition he calculated the orbits of 12 of them[13].

During WWII Dr Finsen, with the help of his wife, produced a film to show soldiers how to find their way through featureless territory with the help of the heavenly bodies.

8.1 The Observatory sun compass

At the same time the army had a problem navigating armoured vehicles in the Western Desert as the massive steel structures rendered on-board magnetic compasses useless. They considered using the rather crude sun compasses available at that time which required special charts for each latitude. As these were only available for the northern hemisphere they were not suitable for training in the Union. The Union Observatory was asked to produce suitable charts for use in the South. This they were quite willing to do, but they pointed out that they could probably devise a more practical instrument. Dr van den Bos discussed the problem with Dr Finsen

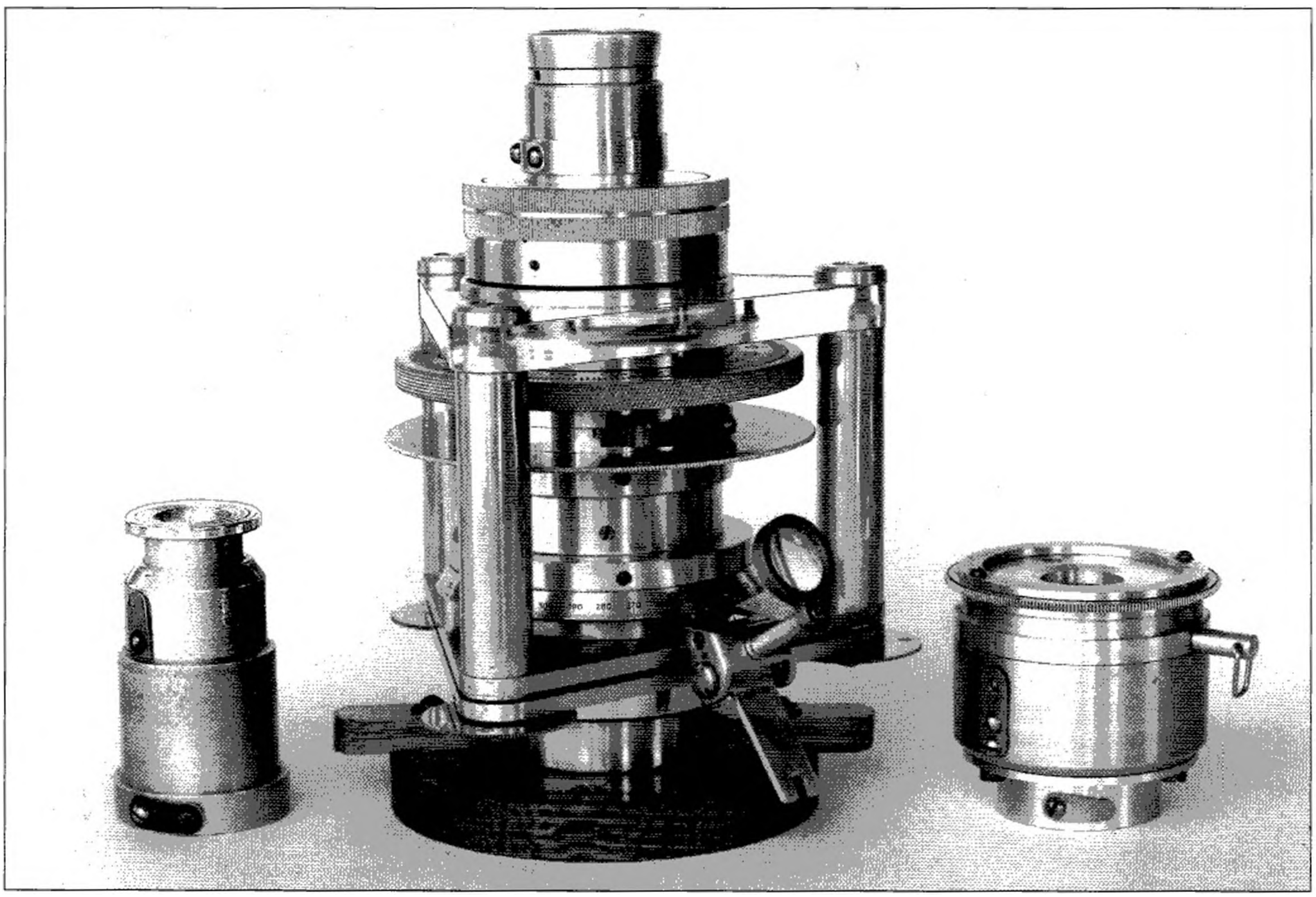


Fig. 88: *The Eyepiece Interferometer developed by Dr WS Finsen (CSIR Archives)*

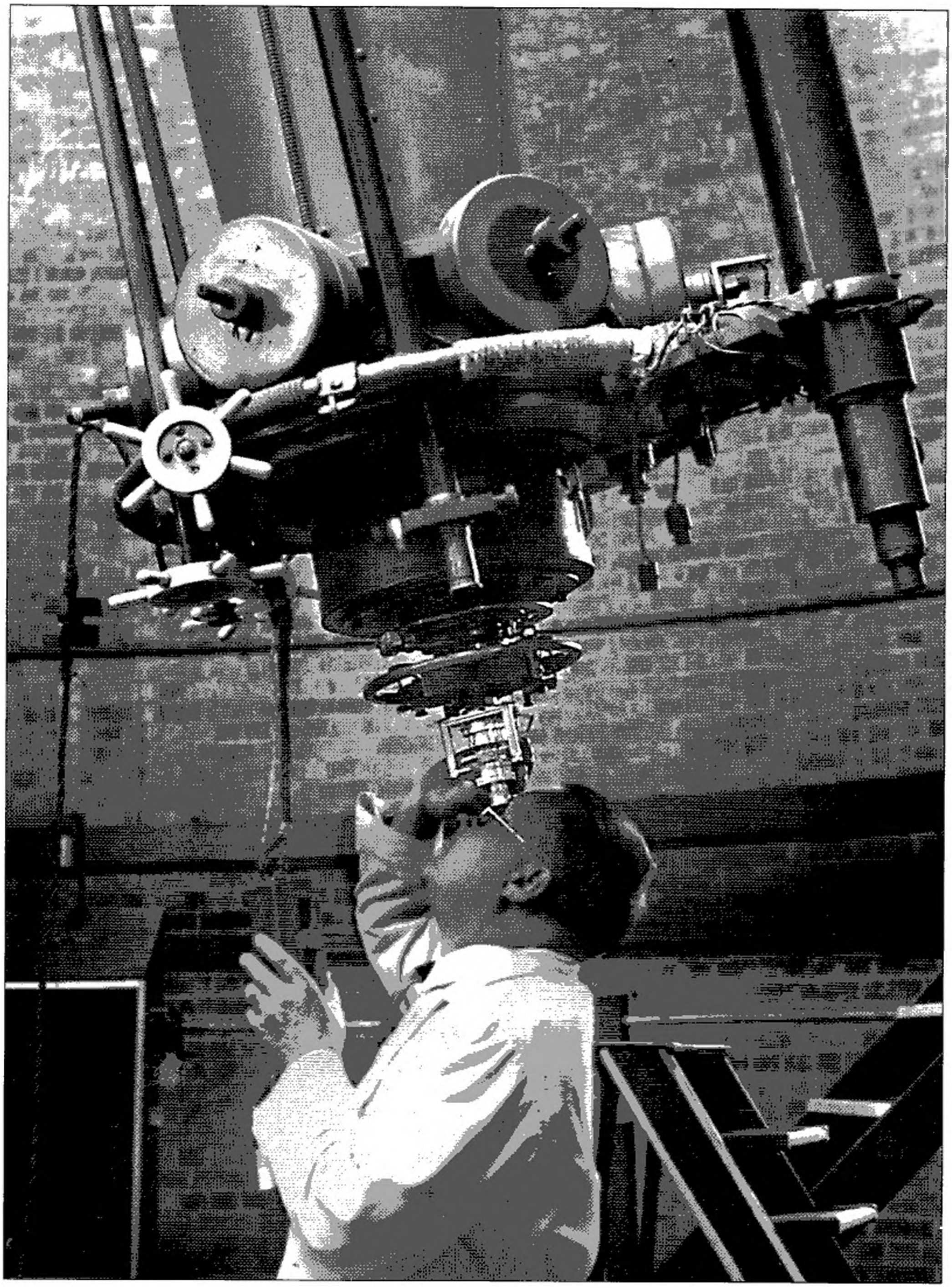


Fig. 89: *Dr Finsen using his Eyepiece Interferometer on the 26½-inch telescope(E & P Finsen)*

and together they conceived a possible solution. Finsen produced a wooden model to demonstrate the principle (fig 90) and when this was shown to the military they became so interested that they insisted on testing the model in the field. Finsen pointed out that, as it stood, it was not suitable as it was only roughly calibrated and lacked refinements such as a spirit level but the military were insistent and arranged for an immediate demonstration. They chose a site near Mafeking which was notorious for the erratic behaviour of magnetic compasses and a small expedition set out in September, 1941 for Mafeking to test the instrument in the thick bush country west of that town, between Jan Masibi and Logaging. An off-road route through featureless bush country terminating at a landmark consisting of two tall bluegum trees near Logaging was specified. Finsen was able to maintain the required bearing over the distance of more than 60 km and reached the intended destination with a deviation of only 320 m. The official report stated: 'The vehicle arrived 350 yards from the objective. The test has conclusively demonstrated the practicability and accuracy of the instrument.' So high an accuracy with so hurriedly contrived instrument used under the most adverse conditions undoubtedly had an element of good luck.

The military authorities were impressed and asked the Trigonometrical Survey Office in Mowbray to design and make a working prototype (fig 91). After further modifications components for about 100 instruments were manufactured in the Cape and these were assembled and tested by the Instrument and Wireless section of the Directorate of War Supplies in Chrysler House, Johannesburg. In their final form the instruments were expected to provide true bearing to within 1/4 of a degree.

Van den Bos and the Military Instruction Manual give guidance on how to get the best out of the instrument[61, 90].

By the time these became available the war in the desert was over but the instruments were later used in the Italian campaign[12].

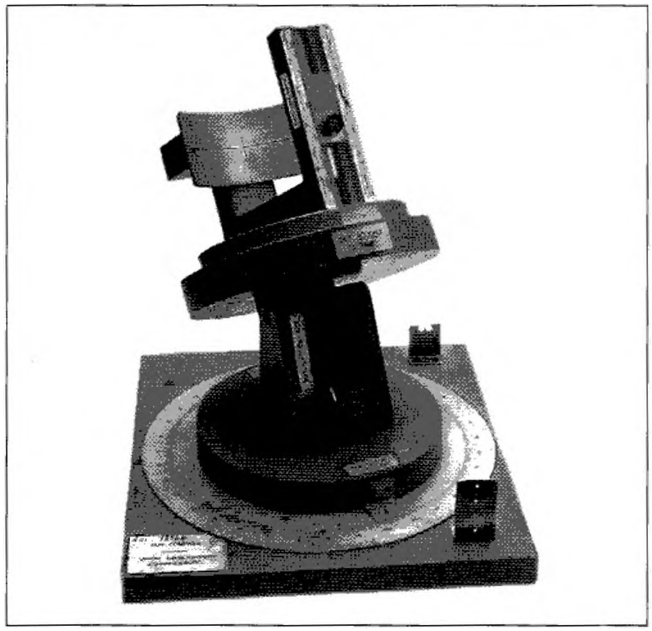


Fig. 90: *The prototype sun compass developed by Dr Finsen during WWII (author)*

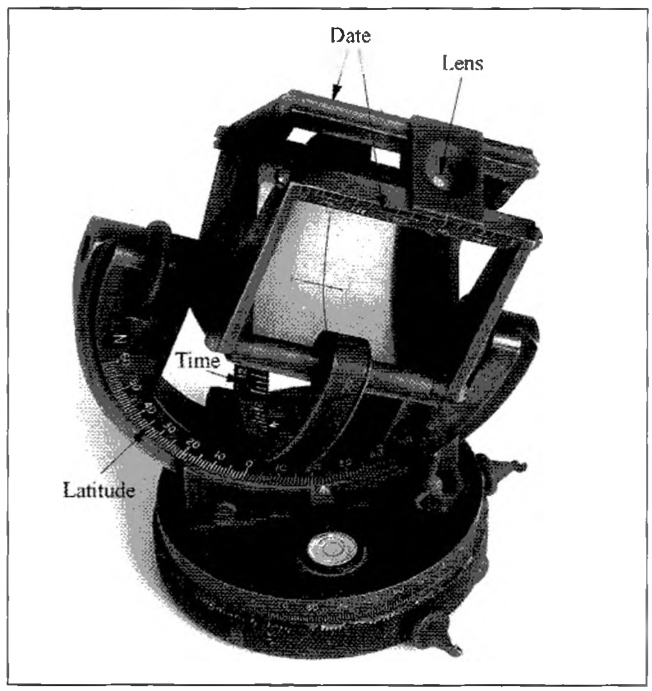


Fig. 91: *The pre-production model of the sun compass (author)*

Finsen published some notes on the instrument in the Military History Journal (Vol 2 No 4) which described the final development as follows:

At a rather late stage in the war, Col. Baumann urged me to explore the possibility of designing and manufacturing a sun compass with an accuracy of the order of several minutes of arc for use directly in laying guns, thus obviating complicated survey methods. The idea was to design it as an attachment to a standard Gun Director and so make use of already existing accurate azimuth and altitude "circles" (actually worms and worm-wheels), telescope, bubble, etc. I was rather doubtful of the feasibility of this but agreed to try. With the rather limited resources of the Chrysler House I & W, DGS workshop, I succeeded in making such an attachment for a Gun Director borrowed for the purpose, which seemed to justify Col. Baumann's optimism, yielding true bearings with errors of the order of one or two minutes of arc when used by the correct method. Subsequently, the TSO (Cape Town) made two or three "Chinese copies", one of which, when attached to a small theodolite, gave even better results. The latter, incidentally, was used for laying out the meridian for a telescope at the Observatory's Hartebeespoort Annexe, giving in a few minutes a better determination than a day's conventional observing with a theodolite.

8.2 Finsen's photographs of Mars

In 1939, 1954 and 1956 the orbit of Mars brought it unusually close to earth (about 56,6 million km) and at the same time it was almost directly overhead when viewed from Johannesburg. Dr Finsen took the opportunity to produce some of the best colour photographs ever taken of the planet from earth. To achieve this he attached a 16 mm cine camera to the $26^{1/2}$-inch telescope (fig 92) and made a total of about 24 400 exposures on colour film over 36 nights (Messrs Seligman and Churms assisted Finsen to complete the task). The telescope was stopped down to a 13 inch aperture and the camera was arranged to take one shot at a time exposing each frame for a few seconds to produce a series of small images of Mars.

The best 25 frames of a particular view were selected and projected in turn through an enlarger for 1/25 of the normal exposure. The superimposition provided reinforcement of the stable part of the image and a smoothing of the film grain (in those early days colour film had a very coarse grain) resulting in unusually detailed pictures (fig 93). Finsen devoted a considerable amount of time (most of it his own spare time) to the preparation of these images. After seeing so many recent pictures taken from outer space Finsen's Mars images may look rather inferior but to place them in perspective it is necessary to read what his contemporaries thought of them. In the September 24, 1956 edition Life magazine reproduced 5 of his Mars images to illustrate an article reporting on the event. One of the captions makes the following comment 'The photographs above and on the next page, published here for the first time, are considered by many astronomers the best colour portraits of Mars ever made.'[74]

In 1969 the Observatory again had the opportunity to photograph Mars using more sophisticated equipment see section 9.2 for further details.

8.3 The Moonwatch teams[24]

As part of the International Geophysical Year (IGY 1957-1959) the Americans planned to place the first artificial satellites in orbit around the earth. The Smithsonian Astrophysical Observatory in Cambridge, Massachusetts organised and co-ordinated teams of observers in the USA and other countries to report on sightings and radio reception of these satellites. These were known as Moonwatch teams.

As South Africa was the first land mass to be crossed by satellites launched from Florida it was important that they should provide adequate teams of observers for the forthcoming events. Two teams of amateur astronomers were organised by the Union Observatory under the leadership of Dr Charles N Williams in Johannesburg and Roy Smith in Pretoria. Together with a team in Hawaii these were the first registered outside the USA. This was followed by a team in Cape Town under Dr DS Evans who was also made co-ordinator with the US headquarters. Bloemfontein also recruited a team under Dr J Stock.

The Americans undertook to supply the teams with suitable viewing instruments but by mid 1957 nothing had materialised. No one was very concerned as the first satellite launch was not expected before 1958.

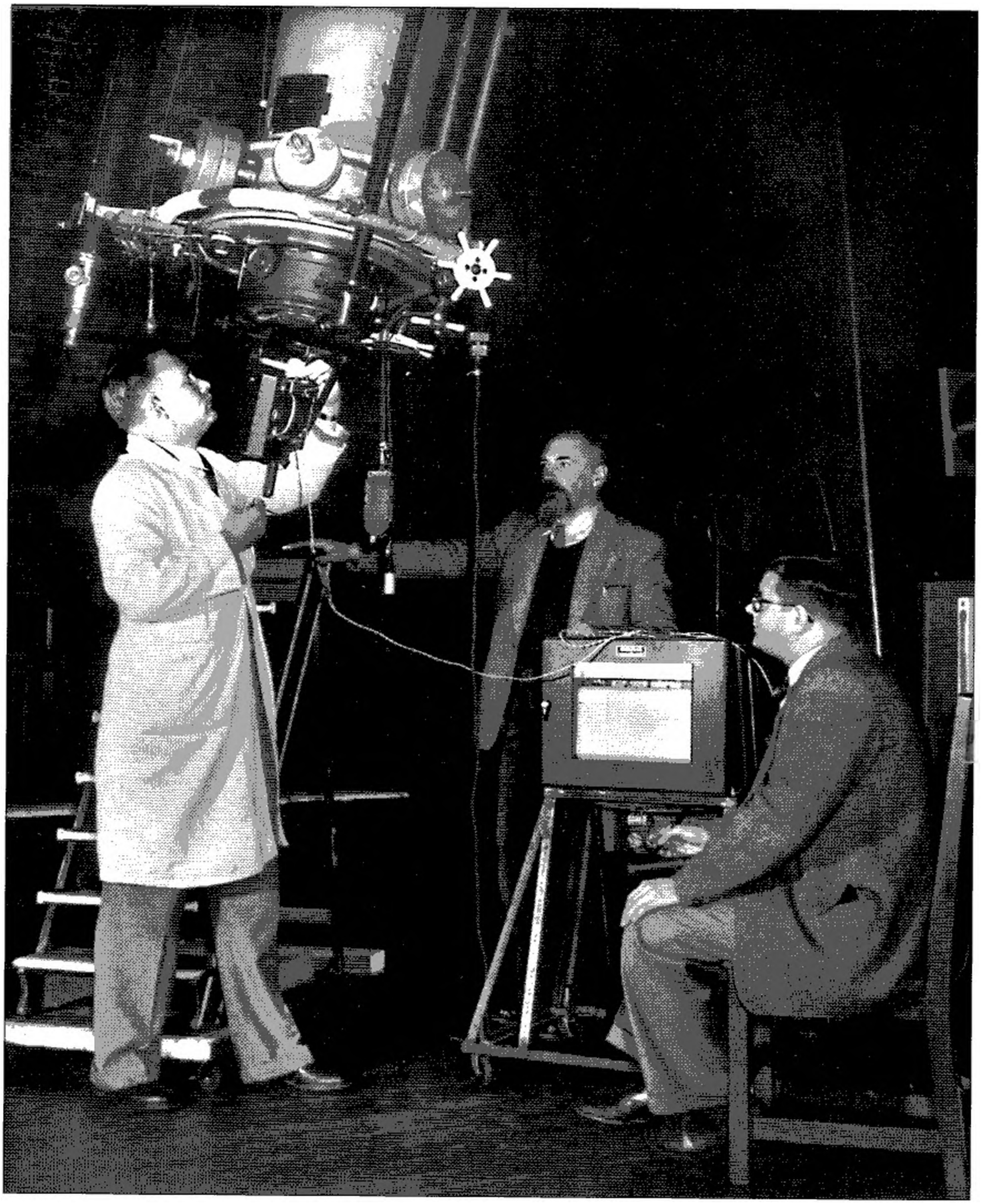


Fig. 92: *Dr Finsen, Dr van den Bos and Joe Churms photographing Mars with a cine camera on the $26^{1/2}$-inch telescope. (E & P Finsen)*

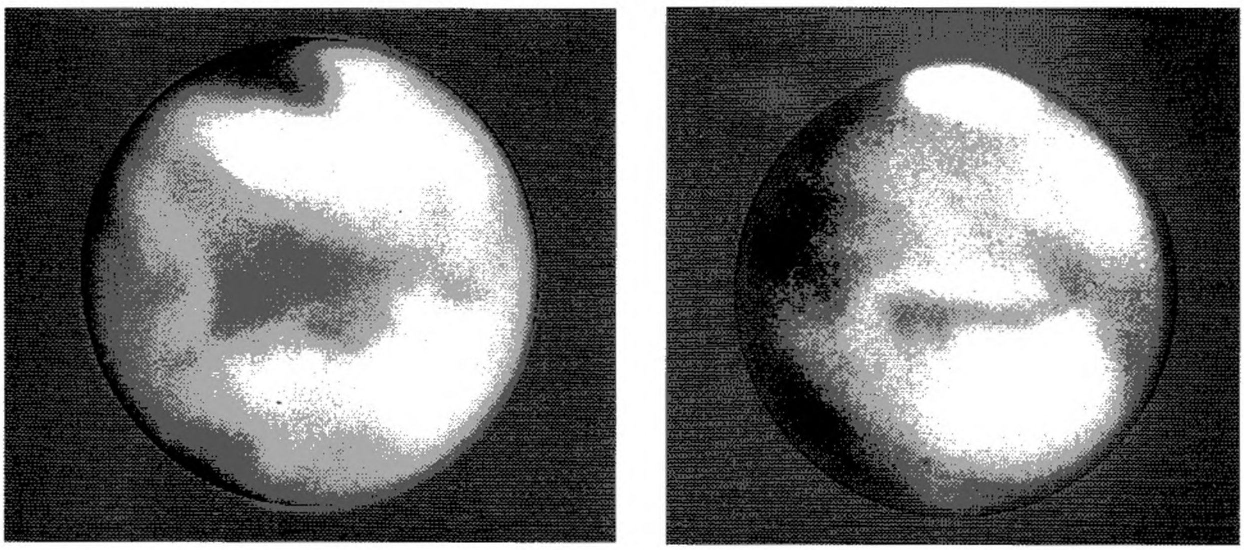


Fig. 93: *Two examples of the photographs of Mars taken by Finsen in 1956. The picture on the right shows the polar ice cap (originals in colour) (Planetarium, Johannesburg)*

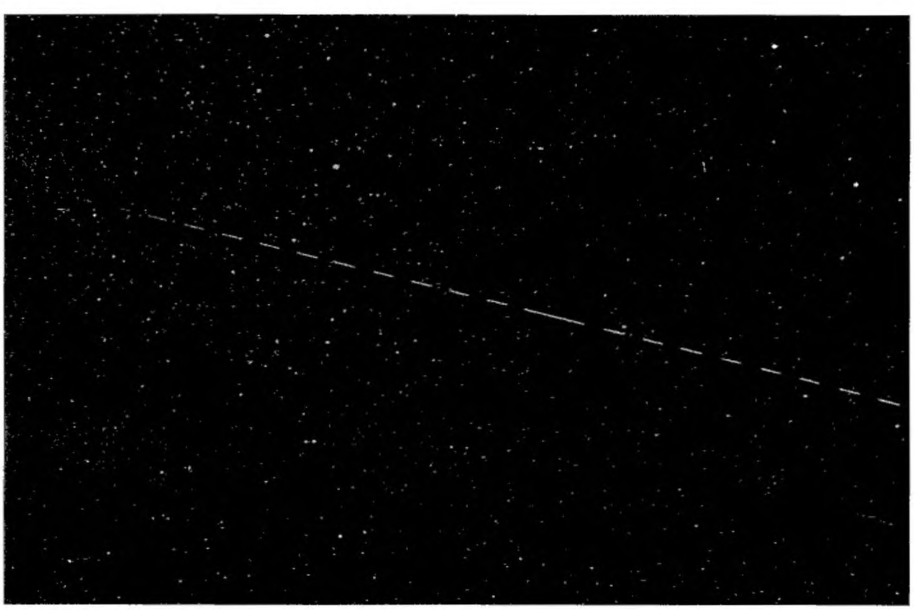


Fig. 94: *Sunlight reflected from the Sputnik 1 rocket casing in low earth orbit after being launched in November 1957 (WS Finsen)*

Fig. 95: *Bill Finsen made this model to explain the behaviour of orbiting satellites. WS Finsen, with J Churms and JA Bruwer (CSIR Archives)*

And then without fanfare the Russians put Sputnik 1 in orbit on 4 October 1957. The special tracking stations planned for South Africa were not yet in operation. The Moonwatch teams were still not equipped with suitable instruments and all they could do was to bring out their binoculars and small telescopes hoping to see the small satellite.

While it lasted, the NITR were able to pick-up the radio signal from Sputnik 1 which made it possible for Dr Fejer of that organisation to calculate a reliable orbit. The satellite itself was too small to be seen even with the help of binoculars but the launch rocket which accompanied it for some time was periodically visible, sometimes even to the naked eye. Fig 94 shows a photograph taken by Bill Finsen of the rocket path on the evening of 1 November 1957. The intermittent visibility was due to the rocket tumbling and reflecting the late evening sun erratically.

The Russians gave out some rather vague and unreliable information on the expected path of the satellite. The American organisation had been taken by surprise and was not able to supply useful predictions of the satellite's movement. It soon became evident that observers would have to depend largely on their own sightings to predict future appearances.

The staff of the Union Observatory threw themselves energetically into the task of following the satellite. They spent their days computing possible orbits whilst the evenings and, later on, the early mornings were spent trying to catch sight of the satellite. The South African observations soon proved to be invaluable particularly as sightings from other parts of the world were scarce.

A simple model was made at the Observatory to show how the satellite was encircling the earth which was very helpful in explaining what was happening to the press (fig 95). It also proved useful in predicting when and where the satellite might next become visible.

Before the first American satellite was launched the Moonwatch teams had been provided with

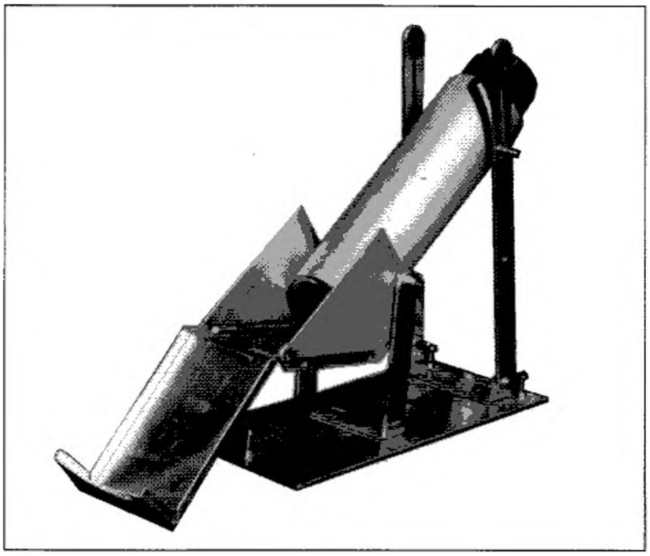


Fig. 96: *One of the moonwatch telescopes supplied to teams around the world (CSIR Archives)*

what was considered suitable viewing equipment (fig 96). In addition the Cape Town and Bloemfontein teams had been supplied with special higher magnification telescopes (apogee telescopes). These instruments were not issued to the Johannesburg and Pretoria teams as it was believed that they would be too far north to see the satellite.

The first American satellite, Explorer 1, was launched on 1 February 1958. This was only a tenth of the size of Sputnik and thus all the more difficult to observe. At first no one was able to locate it but on 8 February The Cape Town team made the first sighting using their apogee telescopes. It soon became quite clear that such small objects would not be visible using the standard telescopes supplied to the Moonwatch teams and the Union Observatory resorted to their conventional astronomical equipment. Using the Cape observations Finsen made regular predictions and on 13 February MD Overbeek was able to observe the satellite from his home using a 12-inch reflector. Three further observations were made on 20 February confirming the local predictions to within 23,5 seconds and one minute of arc in altitude. Vanguard 1 the second American satellite was even smaller than Explorer being only 160 mm in diameter and one fifth the weight. The Russians could not resist calling it the 'grapefruit'.

As there were difficulties in finding sufficient observers in Bloemfontein five of their apogee telescopes were sent to Johannesburg and five to Pretoria. These instruments made it possible for Finsen to make increasingly accurate predictions. Fig 97 shows the Johannesburg team with their Apogee telescopes preparing for an evening watch.

Initially when a satellite came into view all five telescopes would follow its movement. Then, at regular intervals, each of the team in turn would stop and record the time, azimuth and elevation of the satellite at that instant. In this way the co-ordinates of five positions of the satellite would be registered and these were then used to determine its orbit.

The Americans had set up photographic tracking stations around the world and one of these was erected at Olifantsfontein. Their equipment was only capable of capturing pictures of satellites when pointed precisely and the predictions provided by the Americans were generally not sufficiently accurate to achieve this. Consequently none of the stations succeeded in taking pictures until 18 March when the first image was successfully recorded at Olifantsfontein using Union Observatory predictions.

By 16 April 1958 the number of observations of the first American satellite reported to the Satellite Management Committee was as follows: USA 45, South Africa 33, Japan 5, Australia 2.

Eventually the observation teams dwindled down to a hard core and Johannesburg and Pretoria

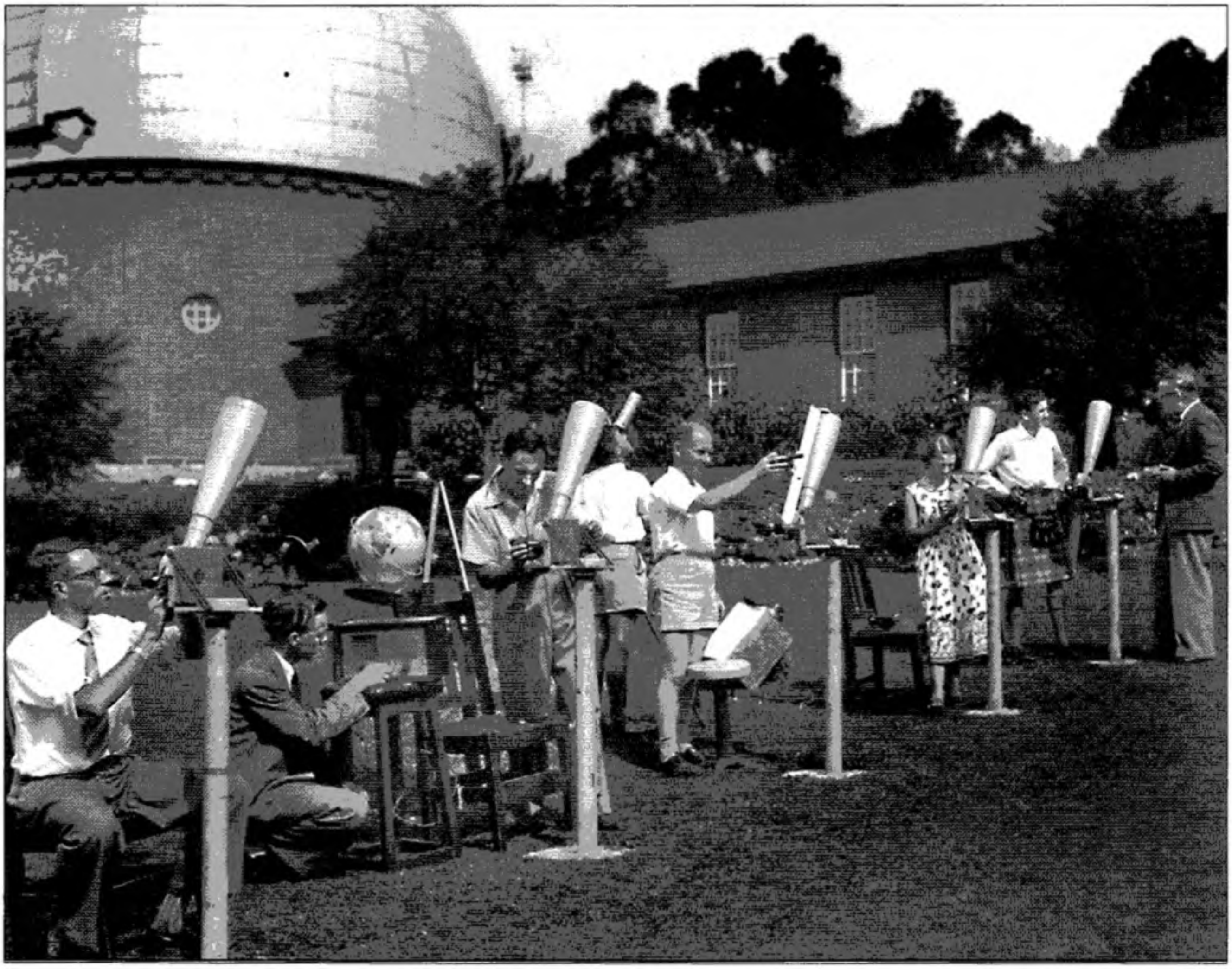


Fig. 97: *The five Apogee telescopes supplied to the Union Observatory with some of the Moonwatch team. From L-R: IRW Brickett, Dr CN Williams, J Vollmer, N van Toechen Delen, Mrs & Mr Johnston, WS Finsen (CSIR Archives)*

pooled their results to simplify the reporting system. Finsen had developed a remarkable ability to produce accurate predictions without the assistance of electronic computers. These reliable predictions combined with good observations resulted in even better observations and predictions.

The Olifantsfontein camera team repeated their early success and captured far more images than any other station. This exceptional performance was firmly based on the Johannesburg-Pretoria observations and Dr Finsen's predictions.

When Explorer 4 was launched on 26 July 1958 it could not be located by any of the teams. Jan Hers, using rough observations taken by the newly installed Minitrack station, was able to predict the path with sufficient accuracy for the Pretoria team to become the first in the world to see the new satellite.

The Astronomer-in-charge of the Olifantsfontein Satellite Tracking Station, Robert Cameron, wrote congratulating Dr CN Williams and his Johannesburg Moonwatch team as follows:

> The amazing world record number of turnouts for Moonwatch sessions, held by the Johannesburg team, combined with the large number and high reliability of the observations deserves the highest commendation as a very important contribution to the International Geophysical Year.

The remarkably accurate predictions made by Dr Finsen earned him the name 'The South African Witchdoctor'.

Dr Finsen was appointed Union Astronomer in 1957 but according to Overbeek[48] he had already taken up many of the public relations and administrative duties long before this as van den Bos was deeply engaged in his double star work. In 1961 the name changed to the Republic Observatory and Finsen became the first and only Republic Astronomer.

Bill Finsen was very much a hands-on operator who liked to do things himself. He was a workaholic and did not like to be disturbed once he became immersed in a project in his upstairs workshop in Innes House. There was at the same time a more sociable side to his character which showed during his regular appearances with Arthur Bleksley and Eric Rosenthal on the SABC radio quiz programme called 'the Three Wise Men'.

It is interesting to hear his opinion of the Herbert Baker Library building at the Observatory. In his recollections[25] he makes the following remarks: 'It wasn't a very good building: it had no passage and you had to walk out on the open veranda to go from office to office, which meant of course that you had a very good idea of what the weather was doing.'

8.4 The Republic Observatory

In 1961 when South Africa became a republic the Union Observatory was renamed the Republic Observatory and Dr Finsen became the first and only Republic Astronomer.

Dr Finsen retired in 1965 but continued working as a guest astronomer mostly by applying his interferometer to the measurement of close double stars. In 1967 The Astronomical Society of Southern Africa awarded him the Gill medal.

Fig. 98: *Bill Finsen clowning with Margaret Ingles (left) and Adele Lezard at the SABC studios (E & P Finsen)*

Fig. 99: *The view looking southwards from the Observatory early in the 20th cent showing the quantities of smoke produced by the mine boilers. Note the Ellis Park sports fields in the middle distance with the Ellis Park Lake where the Standard Bank Stadium was later built (SAAO)*

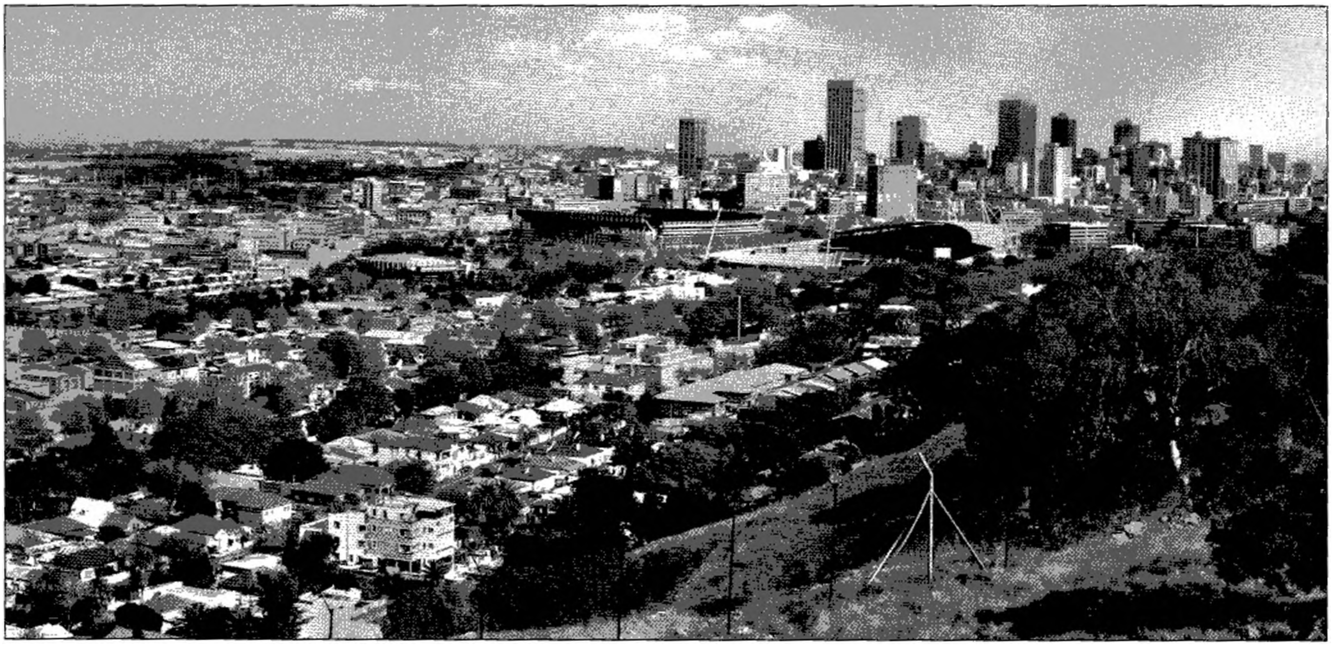


Fig. 100: *A similar view captured in 2006 (A Meyer)*

Jan Hers (b 1915) Acting Director Republic Observatory 1965-1971

Chapter 9

Jan Hers was born in Hilversum (Netherlands) in 1915. His father had followed a long family line of medical doctors but Jan's interests lay in things mechanical and he had no intention of continuing the family tradition. Unfortunately his early life and particularly his schooling was disrupted by the divorce of his parents. His mother and grandmother decided to immigrate to South Africa where they had several relatives. They eventually settled in Potchefstroom where Jan attended the Gimnasium Hoërskool. In spite of the inevitable disruptions and having to learn Afrikaans and English he soon caught up with his peers and reached and remained the top of his class.

In 1933 they moved to Johannesburg so that Jan could study electrical engineering at the University of the Witwatersrand. He chose the light current degree option and by the time he reached his final year he was one of only two candidates in this category. His final year project was a study of the effect of broadcasting equalisers on telephone landlines which had been proposed by W Hilarius (the Chief Engineer of the African Broadcasting Company).

On graduating in 1937 he joined the newly formed South African Broadcasting Corporation at a starting salary of £20/month. For ten years he worked in the recording section which meant that his services were often required at odd hours of the day which left him with time to develop other equipment between recording sessions.

During and after WWII global demand for space in the radio spectrum increased rapidly and attempts were made to squeeze more and more stations into the available bandwidth. This in turn required strict transmitter frequency control so that stations on adjacent channels would not interfere with each other.

Even after the war imported electronic equipment was not readily obtainable and Jan was asked to develop measuring equipment to check the accuracy of the SABC transmitter frequencies. He designed and built a promising instrument based on a stable 100 kHz crystal oscillator and was then faced with the task of checking its frequency accuracy. Frequency and time are directly related to each other and the usual method used was to count the number of complete cycles generated during an accurately known period of time. As the Observatory was delivering time signals to the SABC it was a simple matter to use these for his frequency checks. He discovered that the equipment he had built was superior to the Observatory clocks and he soon needed to interact with the astronomers to try to resolve the discrepancies. Jan became increasingly interested in timekeeping and eventually accepted a post (at a lesser salary) at the Observatory to develop improved timekeeping standards.

To place Jan's contribution to timekeeping at the Observatory in perspective it is helpful to go back to the beginnings of the science in the Transvaal.

9.1 Timekeeping in the Transvaal

In the early days timekeeping was probably of little interest to the predominantly farming community but for anyone owning a clock or watch it must have been almost impossible to maintain correct time before the telegraph line was installed between Pretoria and Natal in 1879.

The Royal Observatory in Cape Town provided accurate time standards based on astronomical observations primarily for the benefit of passing ships. In addition correct time was transmitted to other parts of the country by telegraph. From Gill's remarks at the opening of the Johannesburg Observatory it seems that the telegraph service was not very reliable and he felt that it would be desirable to establish independent time standards in Johannesburg. In the annual report for 1905[89] Innes stated the following: 'Several requests from public bodies that the Observatory should supply exact standard time have been received. In conjunction with His Majesty's Astronomer at the Cape of Good Hope-Sir David Gill, K.C.B- an estimate of the cost of the necessary apparatus was drawn up and submitted, but in the present condition of the finances, the Government was not prepared to make the necessary provision.'

Whilst the Observatory remained primarily a Meteorological station they did not require precise time. Jan Hers was told that the staff used to check their clocks by the time on Markham's clock in Eloff St (fig 101)[21].

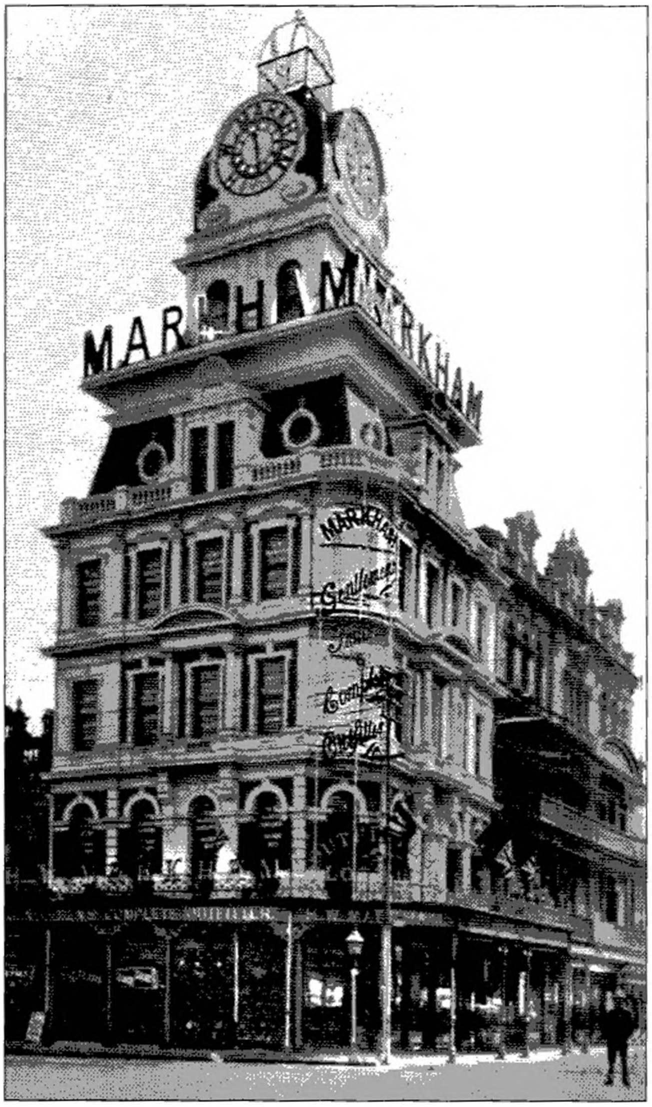


Fig. 101: *At the beginning of the 20th Century many Johannesburgers, including the staff of the Meteorological Station, depended on the prominent clock in the tower of Markham's Building (built on the corner of Eloff and Pritchard Streets in 1895) for correct time*

It is not clear what circumstances in 1908 prompted the decision to establish an independent time-keeping service at the Johannesburg Observatory but we do know that the Public Works Department (PWD) then supplied them with a used Dent pendulum clock[25]. Edward John Dent was a partner in a company that manufactured precision clocks including astronomical clocks and which built the turret clock commonly known as Big Ben at the Houses of Parliament in London[57]. The clock supplied to the Observatory, manufactured in about 1880, was capable of maintaining correct time to within 0,1 seconds per day. It was kept in time by astronomical observations using the $2^{5/8}$-inch Bamberg telescope.

At this stage the observatory was still largely devoted to meteorology and the astronomical work that they were doing did not require a high degree of time precision.

Around 1912 a new clock was ordered from Clemens Riefler in Munich[25]. This more sophisticated instrument was capable of maintaining a higher degree of accuracy and having more than one clock increased the confidence which could be placed on their combined timekeeping.

In 1912 the time-service was extended to Natal. At major ports around the world special arrangements were made to provide accurate time for shipping. For ships in harbour a time signal was provided by means of a large black ball mounted at the top of a mast and visible over a wide area (fig 103). At precisely one o'clock the ball was released and in dropping gave a clear time signal. The release was achieved electrically and from 1912 the Durban Bluff time-ball was controlled directly by the time signal from the Johannesburg Observatory[75 (1912)].

In 1913 and 1914 two further Riefler clocks were purchased, the first to back up the existing standard time clocks and the second to maintain sidereal time[75](1913, 1914). Having two standard time clocks made it possible to compare their readings to provide a more dependable time reference. At this stage the

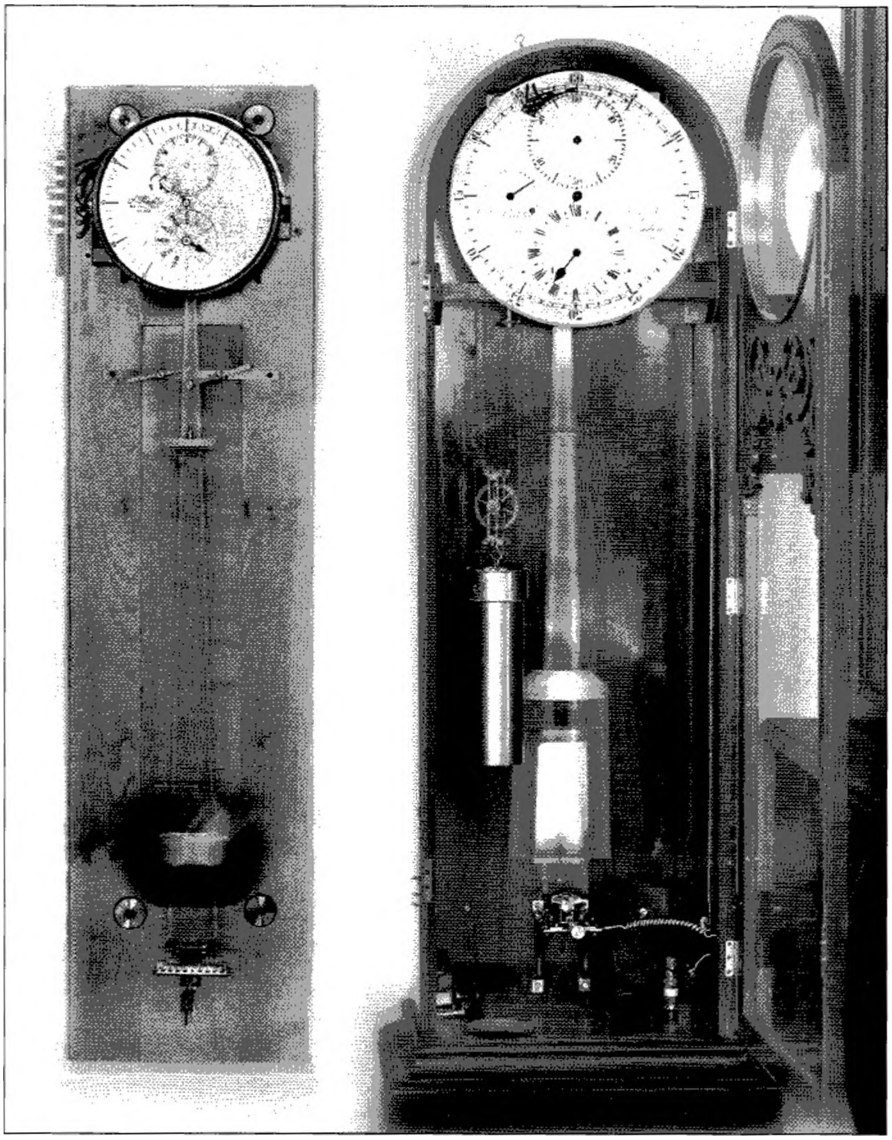


Fig. 102: *Two of the early pendulum clocks used at the Johannesburg Observatory. Riefler on the left, Herbert Brockley on the right (CSIR Archives)*

Observatory was attempting to maintain a time standard accurate to within ±0,1 sec/day.

The familiar practice of making time corrections to a clock by moving the hands was not acceptable for a time standard as this would introduce unacceptable discontinuities and was in any case not practicable when maintaining precise times. Clocks for maintaining standard time were generally corrected by varying their rate to either catch-up to or slow down to the correct time. In the case of pendulum clocks the rate was changed by adding or removing small weights to a platform situated about halfway along the length of the pendulum.

In 1923 the French radio station at Bordeaux and in 1928 the British Post Office station at Rugby began broadcasting accurate time signals on long wave (about 20 km or 15 kHz). Using very powerful transmitters and large aerials they could deliver an

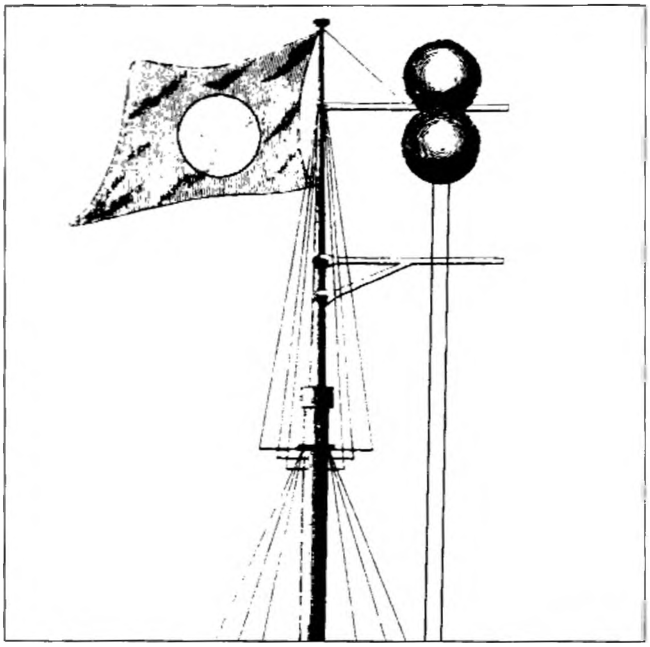


Fig. 103: *Time Balls were erected in prominent positions overlooking harbours to provide accurate time signals for shipping. The Durban time balls were released telegraphically from the Johannesburg Observatory*

acceptable signal at any hour of the day or night anywhere in the world. The Observatory soon recognised that they could provide a much more consistent time service based on this information than they could hope to achieve by astronomical means. They acquired Marconi equipment for receiving these signals but Finsen was not satisfied with the performance and built his own receiver (fig 87). He was able to pick up these time signals regularly and thus keep the Observatory clocks in line with European time standards. After 1924 no further attempts were made to confirm time astronomically. The receiver with its aerial situated at the top of the hill was often damaged by lightning.

The long-wave time signals were sent as interruptions of the radio carrier wave in the same way as telegraph signals were transmitted. Instead of sending 60 such pulses every minute as one might expect the wave was interrupted 61 times/minute[23]. By locating the pulse that corresponded with the seconds of the local clock it was possible to determine its time error to the nearest 1/60 of a second in much the same way as with the scale on a Vernier calliper. The method was generally known as the rhythmic time signal system. A deduction of 0,027 second was applied to correct for the transit time for radio waves travelling over the intervening distance.

9.1.1 Radio time signals

From the 1920's onwards broadcast radio time signals were to become the most dependable means of checking time. Bill Finsen used to tell the apocryphal story that the SABC synchronised their time signals by opening the studio window just before the hour so that the announcer could hear the Post Office clock striking. This casual arrangement would probably have been quite adequate for the needs of most listeners were it not for the fact that the Post Office was said to set their clock by the pips heard on the radio[25].

In 1927 the Dent clock was equipped to deliver the familiar pips to the African Broadcasting Company studios at 13:00, 17:00 and 20:00 hrs[23]. In the beginning the signal consisted of only 5 pips[49] changing to 6 sometime later. The time service was continued by the SABC in 1937

In 1939 at the start of WWII Finsen warned the current director, H E Wood, that he could not guarantee continuous reception of the time signals with the existing equipment which by that time had become obsolete. With the approach of WWII this gave rise to serious concern as it was likely that the demand for accurate timekeeping would increase under wartime conditions. Wood asked the Chief Engineer of the Post Office to inspect the equipment and to advise them on what should be done. He agreed that an improved instrument was urgently required and Wood eventually purchased a suitable Marconi receiver which improved reception and reliability but still did not provide an ideal solution. The problem was solved when the United States National Bureaux of Standards began transmitting continuous accurate time signals on short wave (station WWV in Washington and WWVH in Hawaii)[23].

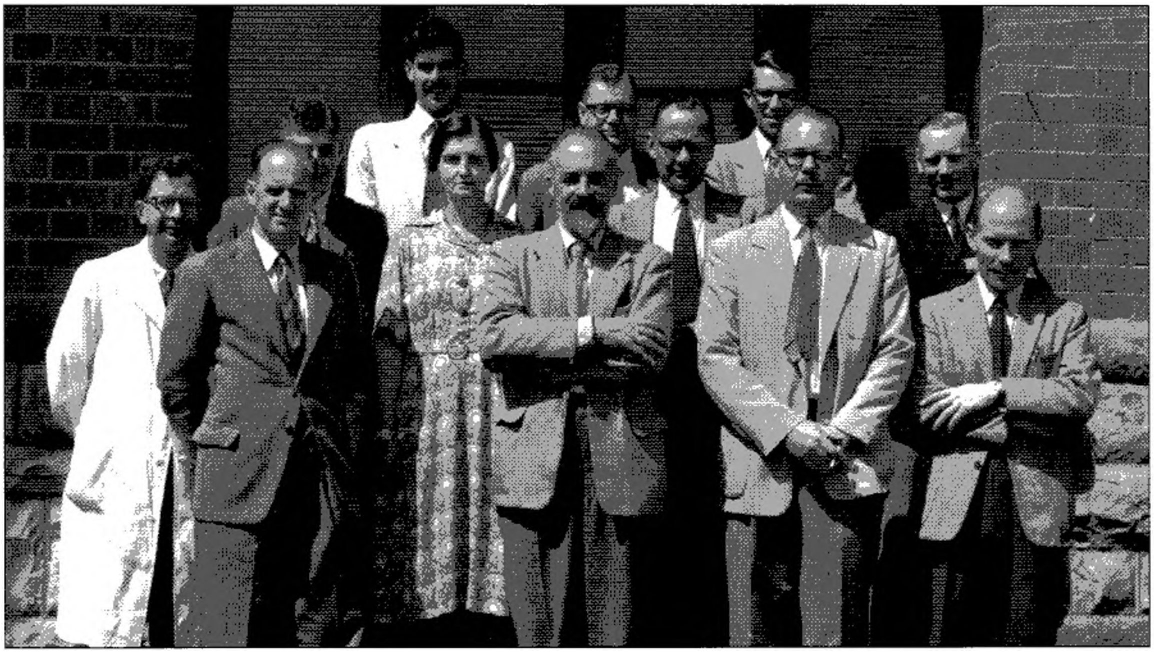


Fig. 104: *The staff of the observatory in the mid 1950s: Front row: J Hers, WH van den Bos, WS Finsen, N van Toechen Delen. Middle row: P Seligman, FC Sherry, Miss DM Howe, JA Bruwer, JH Botham. Back row: MH O'Driscoll, J Churms, RW Brickett (CSIR Archives)*

9.1.2 The Observatory quartz clocks

Jan Hers joined the observatory staff on 1 November 1946 to construct quartz clocks of high stability and accuracy for their time service. Fig 106 shows two clocks made by Jan Hers who is seated at the controls of the Hallicrafters SX 28 receiver. Office space at the Observatory was at such a premium that Jan's equipment had to be housed on the veranda of the Herbert Baker Library which had been boarded-up to keep out the weather. The first of Hers's clocks (Q1) can be seen in fig 105 and the second (Q2), can be seen on the left hand side of fig 106. Q1 was controlled by a specially cut quartz crystal (GT) supplied by the British Post Office. Q2 initially used a commercial 100 kHz crystal and was equipped with a sidereal time converter. Standard time and sidereal time were displayed separately on the two clocks visible in fig 106. Q2 had standby batteries and charging equipment to ensure continuos operation during mains failures. At this stage the Observatory was able to maintain its time standard accurate to within 1millisecond/day (1 part in 10^8)[23].

In 1955 the British Post Office offered to supply the Observatory with an Essen ring crystal with much higher stability than the standard GT cut crystals. The crystal was suspended by fragile silk threads and the BPO required that it should be collected and carried by hand to its destination. The Observatory could not afford to send Hers to England but Wim van den Bos's son, Willem, who was in the South African Air Force heard that there were military flights (Dakota) which could be used by civil servants. Jan enjoyed the 5 day journey (each way) stopping over at fascinating spots dotted across Africa. Fortunately the crystal arrived unharmed and provided a new time standard which remained stable to within 2 parts in 10^9 [23]. This clock remained the basis for the Observatory timekeeping until the caesium clock arrived in 1966.

Fig. 105: *Jan Hers with the quartz clock (Q1) he made for the Union Observatory ca 1950 (CSIR Archives)*

Up until this time the Observatory time standards had been used mostly by themselves and to provide radio broadcasting time signals. The new quartz clocks provided a hundred fold improvement in accuracy and offered continuous time information in a readily accessible form.

As the time standard improved and became more widely known new clients began to emerge. One of these was the road traffic authorities who were required to certify the accuracy of the stop watches used for speed trapping. In the mid 1950's the Observatory was checking and certifying over 200 stop watches each year[75(1955)].

9.1.3 Continuous time service by radio

It did not take long for surveyors, geophysicists and amateur astronomers to press for constant access to this new standard. The decision was made to provide continuous time signals by radio. In May 1949 the SABC made one of their low power high frequency transmitters available to broadcast the observatory time signals continuously during those hours when it was not required for normal broadcasts. Mechanical contacts were fitted to Q2 to generate the call sign and the hour and minute signals which were conveyed by landline to the SABC. Soon thereafter the Observatory built their own 100 Watt transmitter which broadcast the time signal 24 hours a day on a frequency of 5 MHz This station was given the call sign of ZUO (Union Observatory)[23 42].

Arrangements had been made to avoid the effects of normal mains failures on the time standards and in 1955 a diesel standby generator was installed to provide power in case of prolonged failures. These precautions applied also to the ZUO transmitter so that field workers could depend on continuous time information under all circumstances.

Subsequently the Post Office undertook to broadcast the Observatory time signal from their radio station at Olifantsfontein using a transmitter having a power of 4 kW. The Observatory transmitter was modified to transmit the same information on 10 MHz[23].

Surveyors working in the field had a need for time signals during the night. Unfortunately frequencies in the region of 5 MHz to 10 MHz were unsuitable for transmissions over distances lying between a few tens of kilometres and a few hundred kilometres during the hours of darkness. This problem was solved by making use of the SABC FM broadcast-

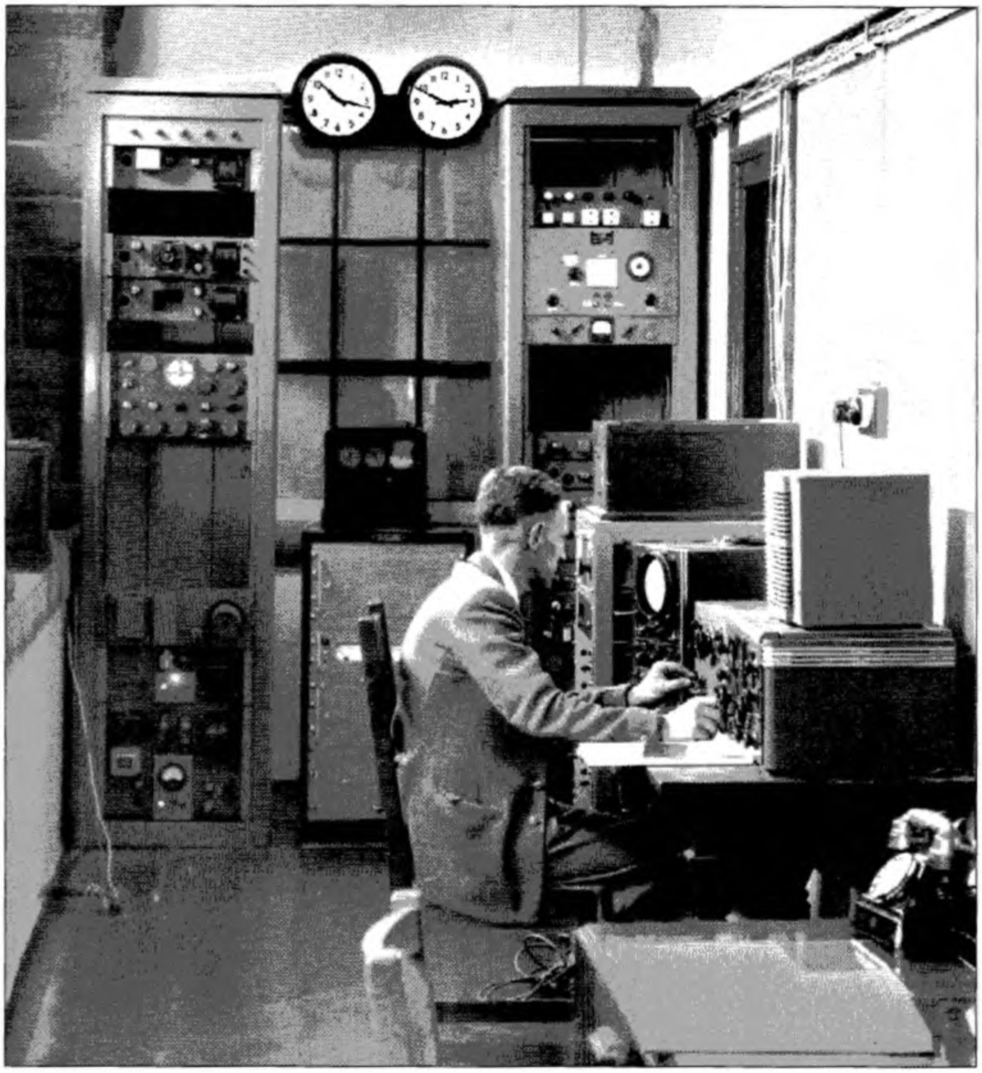


Fig. 106: *The Time Section of the Observatory was situated on the stoep of the Herbert Baker Library building which had been enclosed to excluded the weather. Hers' second quartz clock (Q2) can be seen on the left (note the '50s short back and sides haircut) (Jan Hers)*

ing network which offered reliable coverage over the whole country. During the day the SABC FM network broadcast on several channels. Only one of these persisted throughout the night leaving dormant channels available to deliver the Observatory time signals[23].

Before 1955, when station LOL was established in Buenos Aires, ZUO was the only time standard available in the southern hemisphere and South Africa remains the sole provider of accurate time in Africa.

From 1 January 1961, in conformance with an international agreement, ZUO time signals were held within 1 millisecond of the high-frequency transmissions of WWV. Hers developed a continuous recorder showing the phase difference between the long-wave transmissions from Rugby and some American stations. This made it possible to maintain the Observatory quartz time standard to within ±5 parts in 10^{23} of the original signals[75(1961)].

In 1964 the quartz clocks were moved to the basement of the newly completed office block.

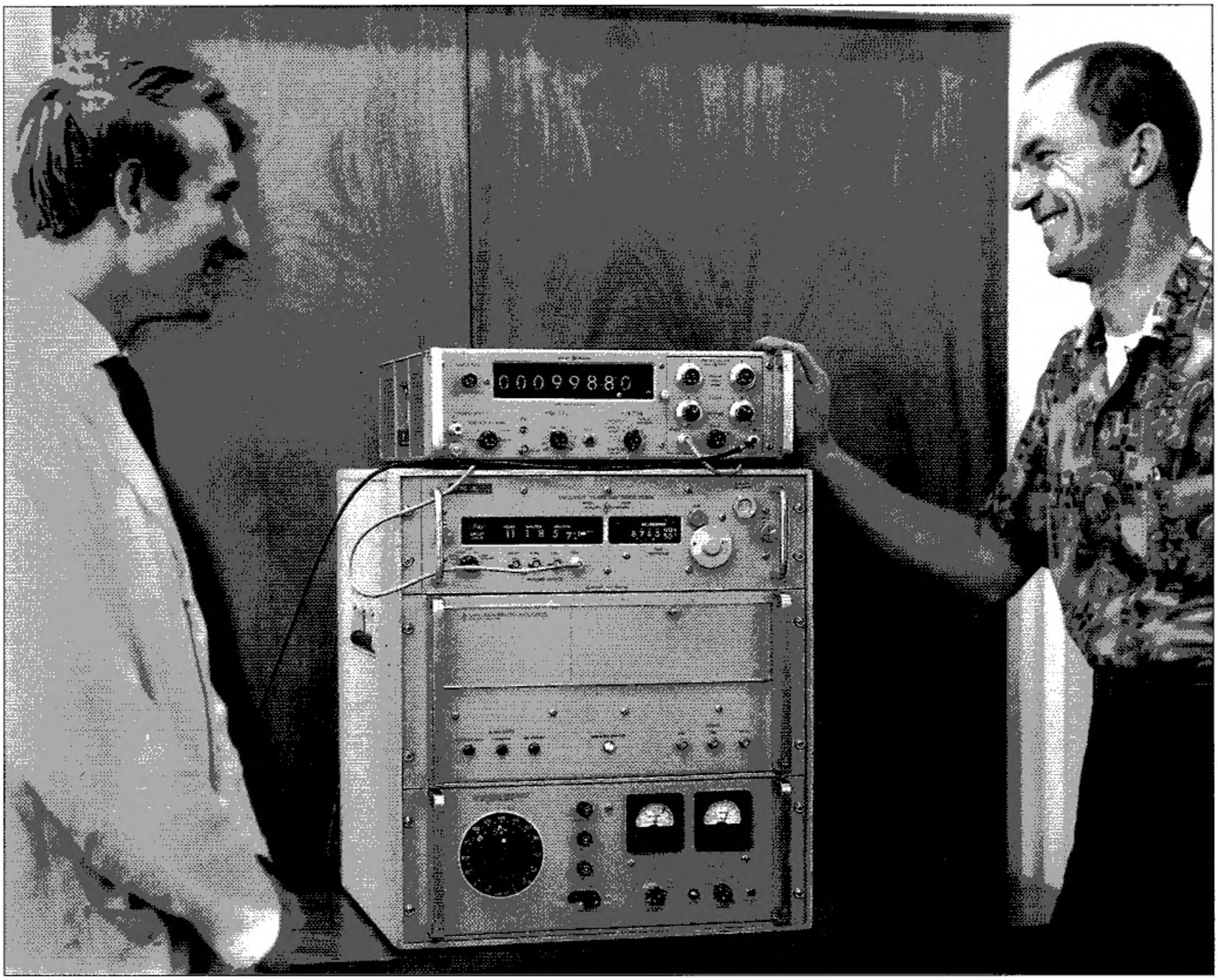


Fig. 107: *CD de Villiers standing to the right of the Observatory Caesium clock ca 1967- the man on the left was from the US Naval Observatory (CSIR Archives)*

The international time standard is now based on the natural period of vibration of the caesium atom (the basis of the caesium clock). Such clocks can achieve an unprecedented dependability of ±1 second in 30 000 years (1 part in 10^{12}) In 1966 a caesium clock was installed at the Observatory and this was used to standardise the quartz clocks. The irregular rotation of the earth noted by Innes in 1925 is now an accepted fact and the caesium clock has replaced the period of rotation of the earth as the standard measure of time[42].

Jan Hers was assisted in the time service division by Ron Lake, Danie Smuts and Chris de Villiers.

It is interesting to relate the accuracy of the successive Observatory clocks to more familiar timepieces as follows:

	Typical accuracy	
Wound clocks and watches	1 min/week	1 part in 10^4
Early Observatory pendulum clocks	0,1 sec/day	1 part in 10^6
Later Observatory quartz controlled clocks	1 millisec/day	1 part in 10^8
Modern domestic quartz clocks & watches	1 minute/year	2 parts in 10^6
(almost as good as the early Obervatory pendulum clocks)		
Caesium clock	1 sec in 30 000 yrs	1 part in 10^{12}

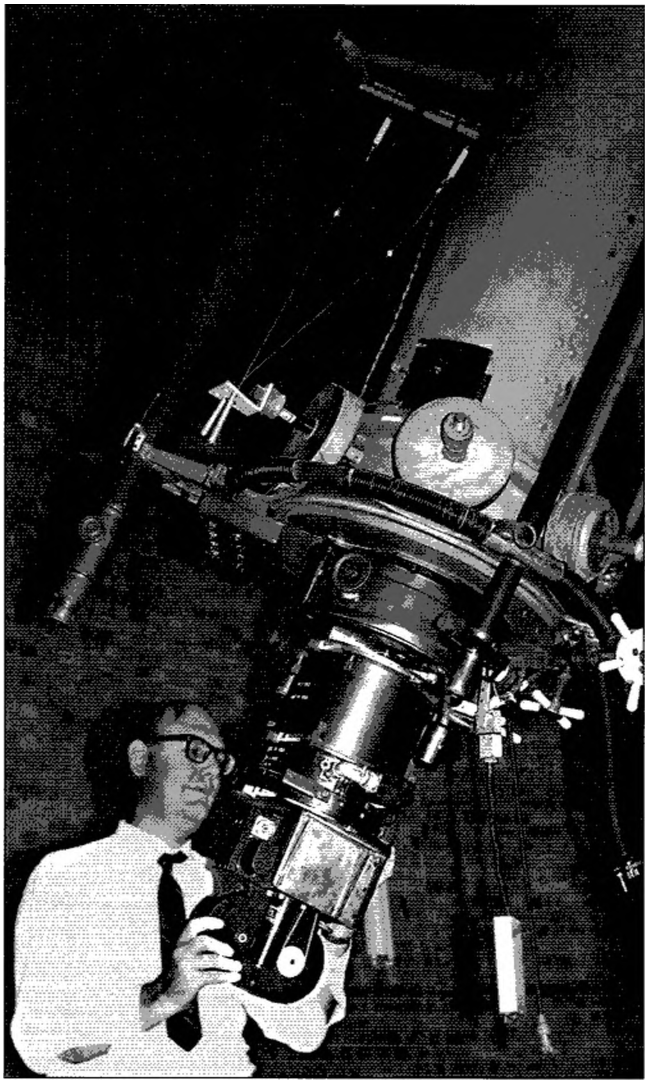


Fig. 108: *Greg Roberts using a special 35mm camera to record images for the International Planetary Patrol Program (SAAO)*

Before 1964 the Observatory had been the responsibility of the Government Department of Arts, Science and Technology. It was then placed under the control of the Council for Scientific and Industrial Research (CSIR) and when WS Finsen was appointed as Union Astronomer Jan Hers was made Assistant Union Astronomer. When Finsen retired in 1965 no successor was named but Hers was appointed acting director and the Republic Observatory functioned under his direction until it was officially closed in 1971.

Dr van den Bos (as a guest astronomer since by then he had retired) continued micrometer measures of double stars together with G Knipe, JL Newburg, MA Klerk and P Hauman. Planetary observations and photometric work continued in the hands of G Knipe, PNJ Wisse, Mrs M Wisse, G Roberts and JA Bruwer.

9.2 The NASA International Planetary Patrol Programme

In 1969 NASA funded the International Planetary Patrol Program. Lowell Observatory controlled the programme and sub-contracted the photographing of Mars and Jupiter at hourly intervals to several observatories including the Republic Observatory. The pictures were taken through red, green and blue colour filters and were recorded on a special 35 mm camera on loan from Lowell Observatory. This camera was used on the $26^{1/2}$-inch telescope as well as on the 20-inch Boller and Chivens reflector for a short period to record Venus.

Greg Roberts was recruited principally to undertake this project. Because of the continuous night work he was assisted successively by Geoffrey Smith, Pierre Hauman, Herbert Jaske and Joseph Janetta, Johannes Dirker and Gerhard Grabner.

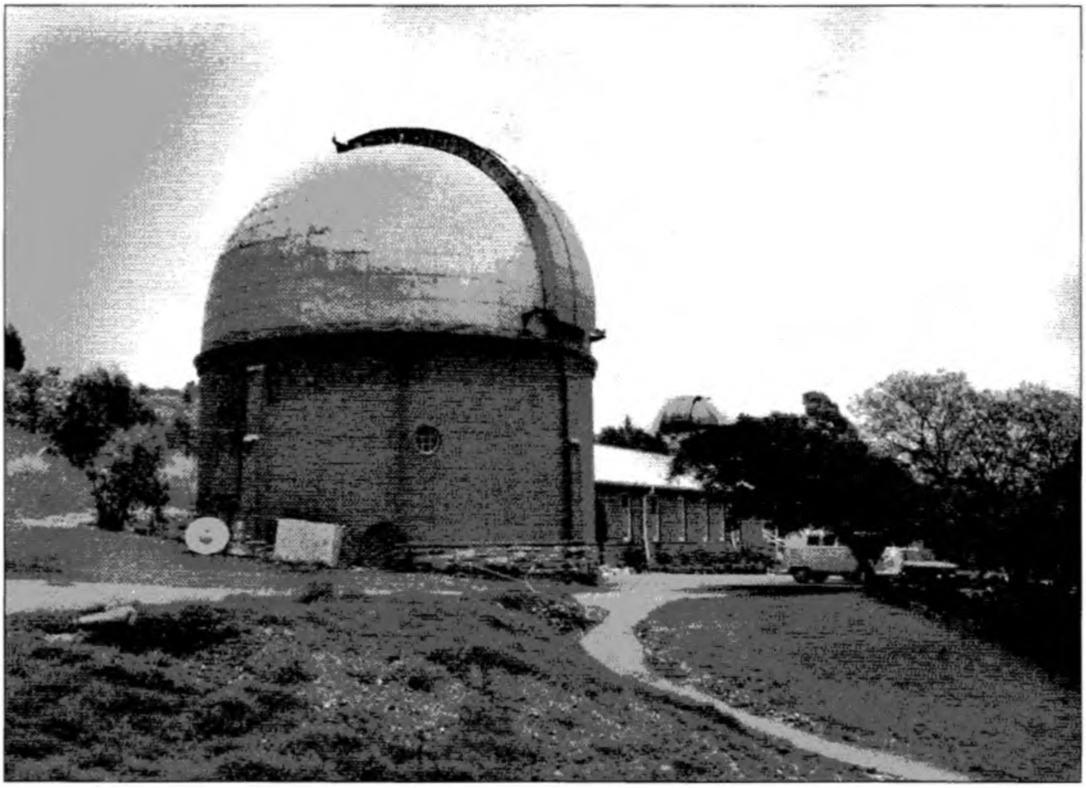


Fig. 109: *A view of the Republic Observatory sometime in the late 1960s (Greg Roberts)*

During the time of the Mariner flyby of Mars the Republic Observatory was best placed for photographing Mars. At the time the periodic dust storms on the planet were severe and the pictures taken every night in Johannesburg were carried by commercial airline cabin crew for prompt delivery to Lowell Observatory. The camera on Mariner could thus be aimed at favourable locations avoiding unfruitful records that would otherwise have drained the satellites severely limited resources.

It was originally intended to share the 26$^{1/2}$-inch telescope with the double star observers, Van den Bos and De Klerk. In practice it took so long to mount and remove the camera and then reposition the telescope that the double star programme was shelved for the five-year duration of this contract.

The images secured at this time were superior to those taken by Finsen in 1954 and were considered to be amongst the best achieved by any of the participants in the programme.

Roberts also tracked Apollo 11 on its way to the moon. He photographed the spacecraft 200 000 miles away and BELLCOM included the picture in a publication on the tracking of the mission. Greg Roberts remained for the full duration of the contract and transferred to the South African Astronomical Observatory (SAAO) in Cape Town in 1974.

9.3 The 74 inch reflector disc

In 1949 the British Astronomer Royal, Sir Harold Spencer Jones, visited the Union Observatory and told them that Pilkington Brothers intended casting a 74 inch disc for a reflector telescope in Australia. He made the point that they would probably be

Fig. 110: *The staff of the Republic Observatory ca 1970: Front row from l-r: PNJ Wisse, M Wisse, AME Hey (secretary), EJ Lake (librarian), GFG Knipe. Second row: JA Bruwer, J Newburg (dark jacket and spectacles), J Hers, MA de Klerk (white Jacket). Third row: R Lake (dark jacket), DJ Smuts (bow tie), G Roberts (with spectacles), Back row: Straka, Jan Hoevers, HF Shultze (with spectacles), NC Roux (Jan Hers)*

willing to cast a second one at a favourable price. Dr van den Bos drew up a motivation for the purchase of this disc indicating that the required £6 000 (which rose to £9 000 before it was finished) was very attractive[23]. To everyone's surprise the Treasury accepted the proposal and the order was placed with Pilkingtons.

The disc was not delivered to South Africa as it would have meant returning it to the UK for finishing when the complete telescope could be ordered. The Royal Greenwich Observatory agreed to store the disc until it was required.

It had been generally believed that reflector telescopes were not suitable for double star work. However after Dr van den Bos had spent some time using the 82-inch reflector at the McDonald Observatory in the USA he found that it was eminently suitable for double star measures and obser-

Fig. 111: *Removing the Boller and Chivens telescope for re-installation at the SAAO Observatory in Sutherland (Greg Roberts)*

vations. His report back on his return to Johannesburg made the prospect of having a 74-inch reflector telescope much more attractive.

It was originally intended that this large telescope would be installed at the Hartebeespoort annexe but by the mid-1960s the area had developed considerably and Jan Hers (by then acting director of the Republic Observatory) began to look for alternative sites. He consulted the Weather Bureau seeking sites having a clear atmosphere with a minimum number of cloudy days and from the information received compiled a preliminary report which he circulated to members of the CSIR Astronomy Committee.

By that time the CSIR had decided to combine forces with the Science Research Council of Great Britain and to centralise the best telescopes in the country at the South African Astronomical Observatory at Sutherland in the Karoo.

Hers's report recommended investigating other sites and in the circumstances was not welcomed. The chairman of the committee had all copies of the report withdrawn and the situation became rather unpleasant for all concerned. Hers's work on this subject was summarised in a paper he presented at the fourth South African National Survey Conference[18].

9.4 Closing of the Republic Observatory

The Republic Observatory was officially closed in 1971 and some of its equipment was moved to Sutherland but the $26^{1/2}$-inch Grubb refractor has remained in Johannesburg as it would have been expensive to move and re-house in the Cape. Astronomical observations using the $26^{1/2}$-inch telescope continued into the 1980s. The Time Service was transferred to the National Physical Research Laboratory in Pretoria.

The CSIR was severely criticised by astronomers around the world for closing down the Republic Observatory. The widely recognised double star work that had been done there was terminated and has not been continued at Sutherland. In fact since the closure of the Republic Observatory little further work on double stars has been pursued anywhere in the world.

Other astronomers at the Johannesburg Observatory

Chapter 10

10.1 WN Worssell

Worssell joined the staff in 1909 after having started his working life in the Post Office. He was a keen amateur astronomer and this together with his knowledge of telegraphy would have made him a natural choice for the Transvaal Meteorological station. He brought with him a 4 inch telescope which was housed at the Observatory throughout his working life.

He spent much of his time looking after the time service but was also involved in other activities. He tried to enlist in 1915 but was rejected due to his myopia. He was not married and he retired in November 1936 after 27 years of service (see figs 83 & 84).

10.2 EL Johnson

Johnson was an astronomer at the Union Observatory from 1914 until 1950 living on the property with his family for most of that time. The following was compiled from information supplied by his daughter, Mrs Pamela Sorgentini[59].

Johnson was born in Bloemfontein where his father was a medical doctor in government service. He matriculated at Grey College and together with his brother started his working life on a mine. When his brother was tragically killed by a cocopan (small rail wagon for carrying ore) he applied for a job as a learner astronomer at the Union Observatory and started there in 1914. After the beginning of WWI he volunteered to serve in South West Africa (now Namibia). He fell ill on active service and was returned home but after recovering he moved to England where he joined the Royal Flying Corps to become a bomber pilot (fig 112).

Fig. 112: *EL Johnson served with the Royal Flying Corps as a bomber pilot in World War I (P Sorgentini)*

After the war he returned to work at the Observatory and in 1922 married Aisleen Devenish. At first they lived in a rented house in Yeoville where his daughter Pamela was born. As he was expected to work at night he requested accommodation on site and was allocated a small two-roomed wood and corrugated iron hut alongside the library having neither running water nor sewerage (fig 113 and block 1 of fig 137). They had to heat water and cook on a Primus stove and it was very cold in winter. Their second child, Keith William (fig 113 & 117), was born here and Johnson made a cradle for the new arrival from wood salvaged from the packing cases for the 26½-inch telescope.

Fig. 113: *The two roomed wood and iron hut seen in the background was home to the Johnson family for several years (P Sorgentini)*

The four Johnsons continued to live here until 1927 when Innes retired. At that stage Wood moved into the double storey house and the Johnsons were allocated the Boulton and Paul pre-fabricated house. At about this time Johnson's mother came to live with them and produced the watercolour of the observatory reproduced in monochrome in fig 114.

Johnson contributed to the sky-mapping project and one of his charts can be seen in fig 38. Whilst photographing map regions in 52° south declination Johnson discovered a faint comet visible from January 7 until February 24, 1935. It was officially named Johnson's comet 1935 I (to indicate that it was the first comet discovered in 1935) and can be seen in fig 115. He discovered a second comet (1948 III) and several minor planets (asteroids) whilst mapping the southern sky. He worked with Wood to produce the southern hemisphere star maps.

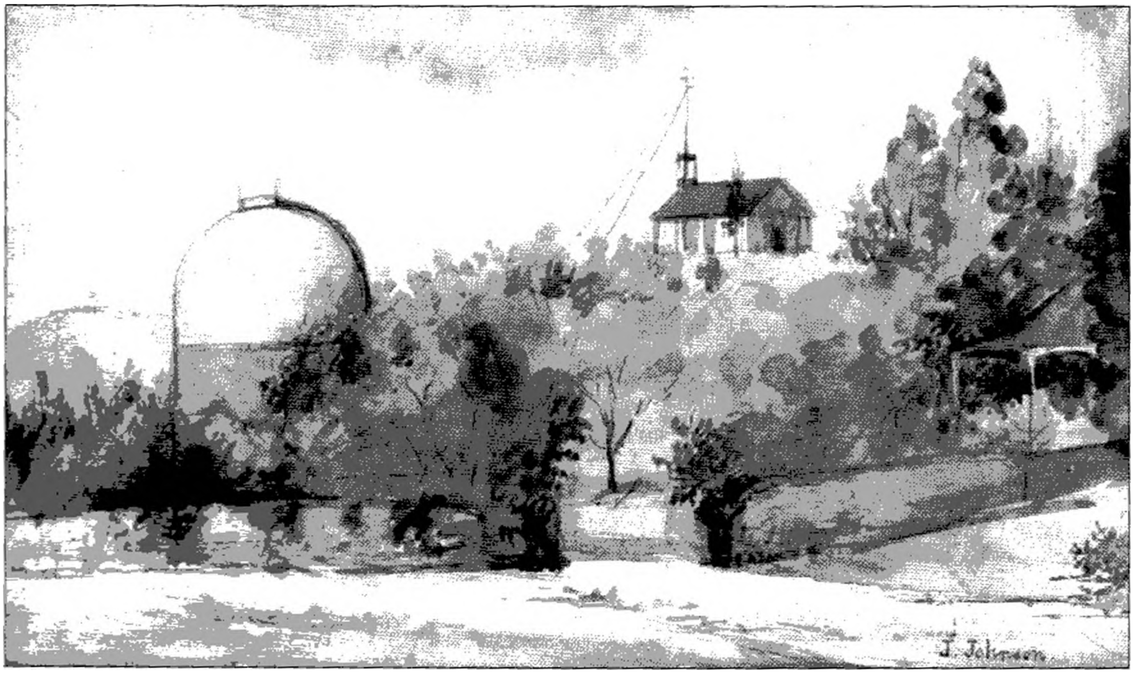


Fig. 114: *EL Johnson's mother, Mrs Joan Johnson, painted this watercolour of the observatory in the early '30s (P Sorgentini)*

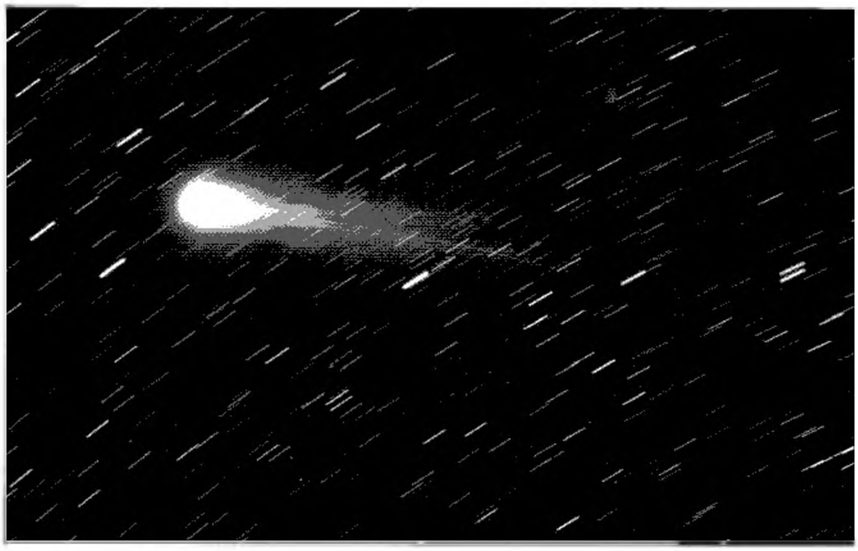


Fig. 115: *Johnson's Comet 1935 I (P Sorgentini)*

In 1948 his daughter, Pamela, married Italo Sorgentini and the wedding reception was held at the observatory (fig 116). Hearing Mrs Sorgentini speak about life at the observatory it became clear that assistant astronomers were not paid very much and that life for her mother was a struggle until she was later able to take on a job as a saleslady in a fashionable city boutique.

Fig. 116: *Pamela Johnson's wedding reception was held at the observatory in 1948 (P Sorgentini)*

Fig. 117: *Keith Johnson and Willem van den Bos with the guy they made in the mid '30s (P Sorgentini)*

Johnson enjoyed a round of golf at the Observatory Golf Course each evening after work and reduced his handicap to 12. The family counted on him to bring home the turkey which was the prize offered each year to the winner of the Christmas golf tournament.

He obviously made a good impression on Mrs Wood who describes him as follows: 'Mr Johnson was always a good mixer with a social charm that gave him a welcome everywhere. I never remember seeing him ruffled or perturbed although he could – and did – air his grievances on occasion'.[65]

He retired in December 1951 but remained active as a part time worker.

10.3 Cyril Jackson (fig 83)

Jackson is thought to have joined the professional staff in December 1926. He and his family moved into the wood and iron hut when Johnson moved to the Boulton and Paul house in 1927. They used to refer to the dwelling as the shack but it must have been considerably upgraded at some stage as his son Paul Jackson remembers that it had water, electric light and sewerage in the 1930's.

Cyril Jackson discovered Comet 1936 IV and rediscovered Comet 1925 II (Schwassmann-Wachmann 1). He discovered and named more minor planets (72) than any of his colleagues at the Johannesburg Observatory (see section 4.2). Jackson volunteered for active service at the beginning of WWII. On his return in 1945 he became Dr Alden's successor at the Yale Southern Station on the University of the Witwatersrand campus[75 (1945)]. When the Yale telescope was moved to Canberra, Australia Jackson and his family followed the instrument. He subsequently moved on to the Yale Argentinean observatory but returned to this country after retirement. He was married and had two sons and a daughter.

10.4 JA Bruwer

Bruwer joined the professional staff immediately after he graduated from Stellenbosch University in July 1938 and remained until he retired in the late 1978. Bruwer had a particular interest in minor planets and was the discoverer of several new ones. He lived in the Boulton and Paul prefabricated house for several years after the Johnsons had retired. Bruwer remained at the Observatory as Acting Director and to complete his personal research into minor planets long after most of his colleagues had left (see fig 110).

Amateur astronomers at the Observatory

Chapter 11

The first director of the Johannesburg Observatory, RTA Innes, started his astronomical career as an amateur. Franklin-Adams, although he never worked at the Observatory, was another amateur who influenced the Observatory's early development. The annual reports for 1927 and 1928[75] mention the observations and timing of occultations done by two amateurs, Dr J Moir of Auckland Park and GE Ensor, of Pretoria.

In the late 1940s the amateur WP Hirst took on the exacting and arduous tasks of determining the orbits of minor planets using observational data collected by the Observatory. EL Johnson had discovered several asteroids in 1948 but never determined their orbits and consequently was not invited by the Astronomical Union to name his discoveries. Hirst provided the information for one of these asteroids which was finally given the name 5038 Overbeek to honour another respected amateur, Danie Overbeek. The asteroid 4094 Bennett was named after the South African amateur who also discovered the very prominent Comet Bennett 1970[49].

In 1952 Joe Churms helped a small group of amateurs to learn the rudiments of positional astronomy. Finsen, who had also started his career as an amateur, decided to establish a group of amateurs known as Union Observatory Associates. These volunteers assisted the staff at the twice-monthly visitors' evenings and were in return allowed the use of the Observatory instruments when the full-time staff did not require them[48].

At the end of each visitors' evening Finsen invited the staff and the UO Associates for refreshments at his house. According to Danie Overbeek these occasions were most stimulating as Finsen had a vast store of facts and anecdotes and his wife laid on a tempting spread. These evenings did much to foster a spirit of belonging amongst the amateurs. The satellite Moonwatch teams whose work was described in section 8.3 were mostly ama teurs.

In the late 1950s JH Botham using the Observatory 9-inch telescope rediscovered the White Spot of Saturn which had first been discovered by another amateur, Bill Hay the British comedian, in 1933[49].

In 1968 when the value of grazing occultations of stars by the moon was first recognised a special group of amateurs formed a team under the direction of Danie Overbeek to make such observations in collaboration with the Observatory staff which continued until 1971. Danie calculated the optimum positions of the individual observing stations, using data from the International Occultation Timing Association and the United States Naval Observatory and arranged for amateurs to make the required observations[49].

Other amateurs whose contributions were recognised in the annual reports were: IRH Brickett, J Vollmer, H C Lagerweij, Mr & Mrs A Johnston, W Bell and C N Williams.

GF Knipe, one of the professionals at the Observatory, required a reflector telescope for the work he was doing on photoelectric photometry. As the Observatory did not have a suitable instrument two amateurs offered the use of their telescopes and he eventually mounted the 12½-inch Tinsley Cassegrain belonging to Christos Papadopoulos on the Franklin-Adams 6/7-inch telescope for this purpose[49].

When the Republic Observatory was finally disbanded the Transvaal Centre of the South African Astronomical Society was offered the use of the Herbert Baker Library building at a nominal rental. At the same time the Franklin-Adams 6/7-inch (still carrying the 12½-inch Papadopoulos Cassegrain telescope) was donated to them and Papadopoulos financed the construction of suitable housing (T1 in fig 137). The dome was removed from position T7 of the new Observatory building and re-erected on the Papadopoulos base for use with the 6/7-inch telescope.

The second telescope erected by amateurs at the Observatory is housed in a building provided by a former chairman JE van Zyl (T2 in fig 137). The family of CR Jacobs, another past chairman, donated the instrument, a 12½-inch Newtonian telescope, and the dome which Jacobs had used as an amateur[49].

Fig. 118: *Robert Innes and Theodore Reunert (on the left) showing visitors the Baker Library (SAAO)*

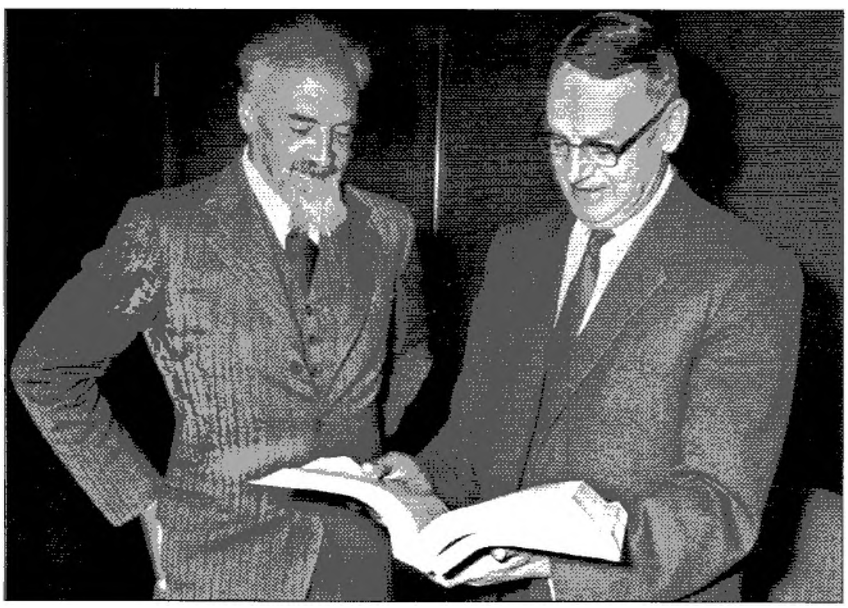


Fig. 119: *Dr van den Bos with Dr S M Naude (CSIR) looking at a copy of the Index Catalog of Visual Double Stars produced by WH van den Bos, HM Jeffers and FM Greeby of Lick Observatory (SAAO)*

The CSIR period

Chapter 12

After 1972 the Observatory site was occupied by the CSIR's National Institute for Telecommunications Research (NITR) and the National Institute for Personnel Research (NIPR) the latter being allocated the Baker house previously occupied by the director.

12.1 The NIPR driver fatigue study

In the early 1980's Mrs Monica van der Nest of the NIPR conducted a survey to assess the extent of fatigue amongst heavy-duty vehicle drivers. 352 professional drivers of all race groups from all parts of South Africa answered the initial questionnaire. It revealed that more than 50% of such drivers had at times continued driving for longer than 8 hours without rest and that 6% had driven for periods of up to 25 hours without a break. 72% acknowledged that they experienced fatigue and 24% reported that this was so severe that they experienced hallucinations. As an example one driver imagined that a cow as big as a house suddenly appeared on the road in front of him and then just as suddenly vanished. Other drivers reported having seen people or approaching vehicles on the road ahead and in many cases had braked or swerved to avoid these imagined obstacles placing themselves and other road users in danger[83].

As a result it was decided to research the effects of stress and fatigue on driver performance under controlled conditions. A simulator called the Dynamic Visual Field Generator (DVFG) was ordered together with an Interdata minicomputer to record the performance of drivers under test. During the experiment the computer stored the following observations:

- Ability to maintain correct tracking, ie how well the subject followed the road.
- Reaction time in response to stimuli such as road signs.
- Reaction time in response to emergencies.
- Extent to which drivers exceeded speed limits
- Physiological factors such as pulse rate, muscle tension and breathing rate.

The study was made on 150 drivers of heavy duty road vehicles employed by the South African Railways. The drivers were divided into three groups - the first group was allowed predetermined rest periods, a second group was allowed to determine their own rest periods whilst the third group was expected to drive continuously for the full 8 hours of the simulated journey.

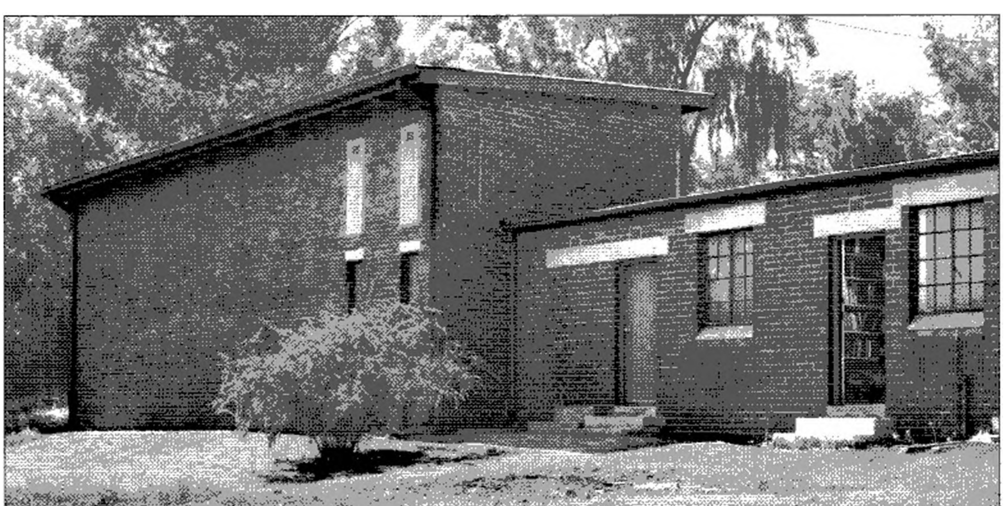


Fig. 120: *The special building for the NIPR motor vehicle driver research programme is on the left. The lower structure on the right provided office accommodation. These now house the SAIEE's historical collection and library (author)*

The elaborate motor vehicle driving simulator (DVFG) was installed in the building situated behind the Director's House (fig 120)[4, 5]. The tall structure on the left enclosed a windowless room measuring approximately 11 meters long, 4 meters wide and 5 meters high. Equipment resembling that shown in fig 122 was installed in this room to project onto a flat horizontal screen a moving image of the road extending from Johannesburg to Durban. The image presented the driver under test with the approaching 64 metres of road which varied in relation to his use of the steering wheel. The driver sat in a special chair (fig 121) fitted with several mechanisms to reproduce the movements of a vehicle including a vibrator which simulated the noise and feel of the engine.

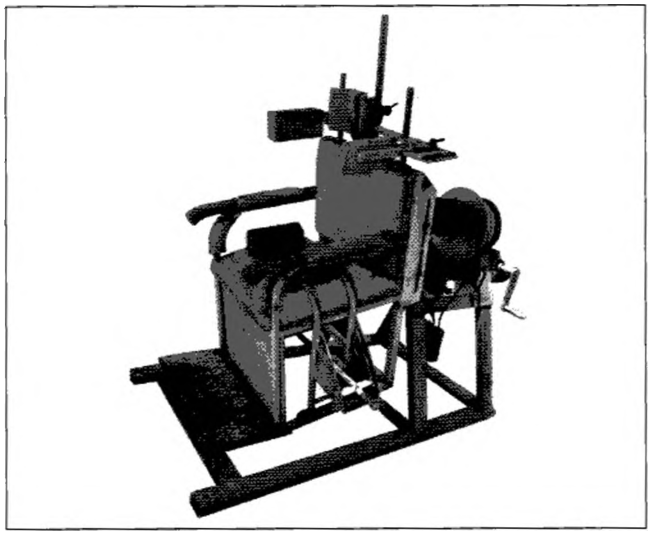


Fig. 121: *The driver's chair used in the simulator (author)*

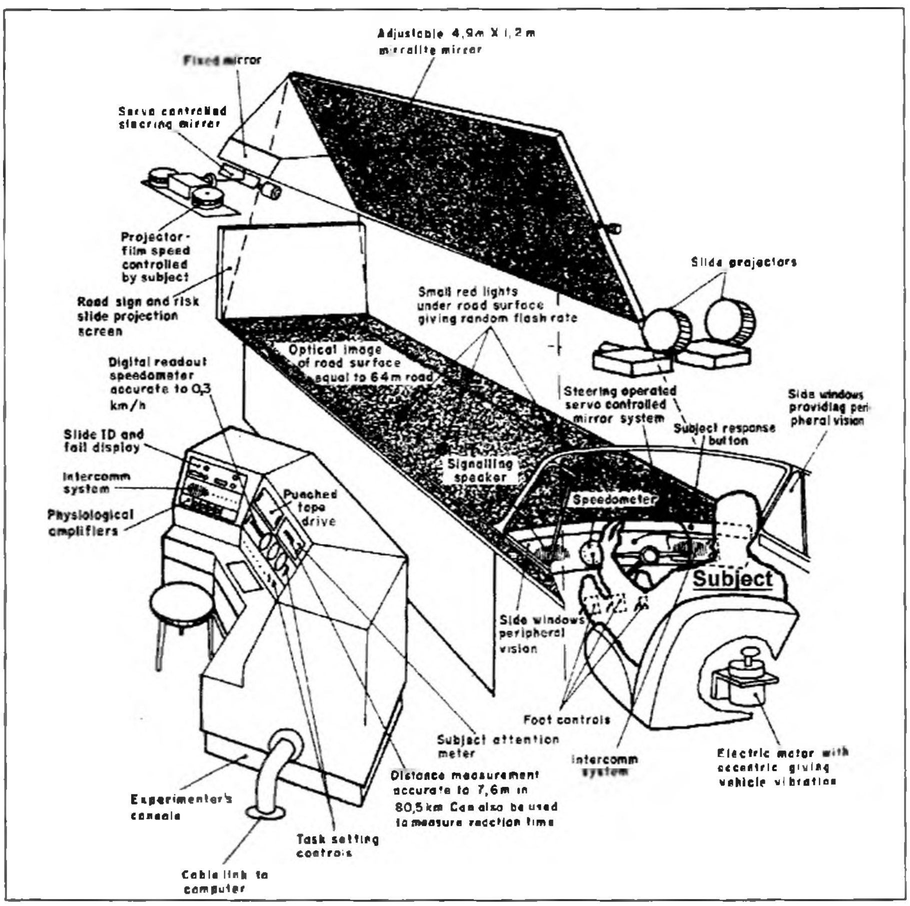


Fig. 122: *The motor vehicle driving simulator used in the NIPR driver research programme (ref 5)*

The behaviour of the simulator and the performance of the driver were controlled and stored by the minicomputer, the forerunner of the microcomputer and the now familiar personal computer (PC). It is interesting to compare the facilities offered by the Interdata 7/16 minicomputer which was used in these experiments with a modern PC. The hardware would have been mounted in a cubicle about the size of a 4-drawer filing cabinet. The internal memory (RAM) was restricted to 48 kbytes and the two floppy discs could each store 250 kbytes (no hard drive). The bulk data was stored on magnetic tape with a capacity of 5,76 Mbytes/reel[4].

Road signs and traffic signals were flashed up on a vertical screen at the end of the horizontal road screen. These increased in brightness to give the driver the impression that he was approaching them from a distance. In addition a total of 14 small red lights were flashed at him in random sequence. Some were placed under the road screen, others to the left and right of the road and visible through his peripheral vision and one that could only be seen through the rear view mirror. The driver was required to respond to these lights by pressing a button on the dashboard.

The whole test occupied at least 8 hours to give sufficient time for fatigue to set in. A system of merits and demerits was used to calculate the driver's performance and the test subjects were financially rewarded in proportion to their score.

12.2 The National Institute for Telecommunications Research (NITR)

This section of the CSIR was established in 1946 to investigate opportunities associated with radio communication in South Africa. As most of the founding staff came from the wartime radar group it is not surprising that they brought with them a special interest in this field. Until 1973 the group was housed at the University of the Witwatersrand and subsequently moved to the Observatory. The NITR staff occupied the newly built office (block 6 in fig 137) to which a third floor and an elevator had been added. At the same time block 4 was built to provide accommodation for a workshop, library, computer and boardroom[50 & 51].

Some remarkable work was done during its time at the University which resulted in the development of several important instruments that were marketed world-wide. The main projects undertaken at the Observatory are briefly described below. It should be appreciated that most of the practical observational work had to be done at field stations but the offices, library and workshop were all centralised at the Observatory.

12.2.1 Ionospheric sounding

In the early years special equipment was designed and developed by Trevor Wadley for measuring the height and density of the ionosphere. This information was required for predictions of the optimum short wave frequencies required for long distance radio communication. Wadley's design for this equipment was highly successful and was repeated at several observing stations in southern Africa.

He subsequently adapted the technique used in the ionospheric sounder for use in a radio receiver design. The result was an instrument superior to competing professional equipment. Racal, a British manufacturing company, produced this receiver under licence from the CSIR and it became standard equipment for the Royal Navy. In the 1960s a transistorised version known as the Barlow-Wadley receiver was manufactured in South Africa and was widely exported[50].

NITR ionospheric sounders were installed at Frankenwald, near Johannesburg, at Tsumeb and at Hermanus and the resulting radio frequency predictions were published regularly in the British journal Wireless World[50].

12.2.2 Rainfall measurements using 8 mm Doppler radar techniques

Useful research was done at the Observatory to determine the drop-size distribution of falling rain. Amongst other applications this information was used to assess the efficacy of attempts to influence rainfall such as cloud seeding.

Fig 123 shows the platform on which two 2,4 m (8 foot) diameter microwave parabolic reflectors were mounted. One of these directed a narrow beam of 8 mm wavelength radiation into the sky. Raindrops falling from an altitude of about 1 km reflected a portion of this electromagnetic energy back to earth which was collected by the second parabolic reflector and delivered to a receiver. The speed of descent of the raindrops was measured using the Doppler effect and from this the droplet size distribution could be calculated. At the start of this project the devices required to generate such extremely short wavelengths were only just emerging and this was one of the earliest applications[50].

The building behind the platform was used to house the equipment. It was constructed in 1913 for the Franklin-Adams 6/7 inch telescope. The pillars that now support the platform were originally used for the rails of a sliding roof similar to that shown in fig 52. The tiled roof was constructed when this project first started.

12.2.3 Lightning research

Most of the early lightning research was confined to flashes between clouds and earth. As these are clearly visible they could be recorded photographically and resulted in a better understanding of lightning phenomena.

In 1968 the NITR decided to study discharges occurring between and within clouds. In this situation most of the flashes are obscured by the clouds resulting in what is often called sheet lightning. Dave Proctor, who was entrusted with this project, found that he could determine the paths taken by such lightning strokes using the radio waves produced by

Fig. 123: *The platform built to support the two 7,3 m diameter micro-wave parabolic reflectors for the NITR rainfall research project. The building now covered with a tiled roof was erected in 1912 to house the Franklin-Adams 6/7-inch telescope - the concrete pillars supported the sliding roof (author)*

the lightning discharges. He established four receiving stations around a central base station as shown in fig 124 (note that the Observatory outstation was erected even before the CSIR took over the site). At each station receivers tuned to 253 MHz responded to the radio energy emitted by the lightning and repeated their input signals to the base station where he used the differing times of arrival to determine the origin of the source (in three dimensions)[52 & 53].

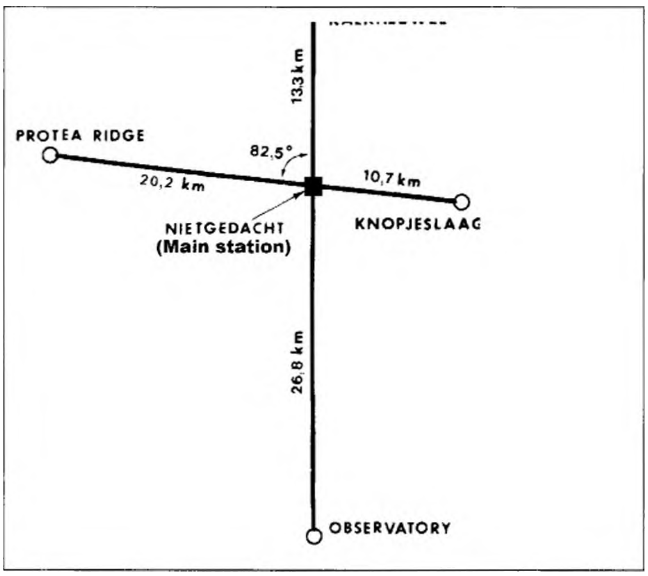


Fig. 124: *Lightning research main and outstations (Nietgedacht is close to the Lion Park) (ref 52)*

He found that each lightning event was made up of numerous impulses which could be identified in the records from each station. By calculating the position of the source of these impulses and plotting each of them on a chart he was able to reveal the track of the constituent lightning flashes. Fig 125 is the result of one such plot – note that the tracks were made up of separate points which were so numerous that they combined to form a clear black path. It is also apparent that the event was made up of several separate discharge paths. This impulse by impulse plotting process was labour intensive and a chart such as fig 125 would have taken almost 6 man-months to prepare[52, 53].

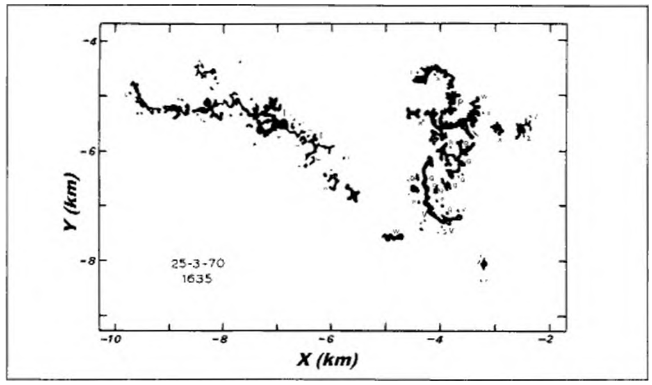


Fig. 125: *Image of intracloud lightning discharges (ref 52)*

Fig 126 shows the microwave antenna (X band) used to convey the lightning signals picked up by means of a separate 253 MHz receiver from the Observatory to the main station at Nietgedacht.

Fig. 126: *Parabolic dish for the radio link from the Observatory to the central lightning observation post shown in fig 124 (author)*

12.2.4 The radio antenna test range

As tests on radio antennas require flat uniform terrain the practical work was carried out at the NITR field station at Paardefontein, 40 km north-east of Pretoria. In the middle 1980s this site proved to be useful for the launching of high-altitude balloons carrying meteorological instruments in collaboration with the French space research centre CNES (Centre National d'Etudes Spatiale). Fig 127 shows the launching of one of these delicate 15 micron polyester film balloons.

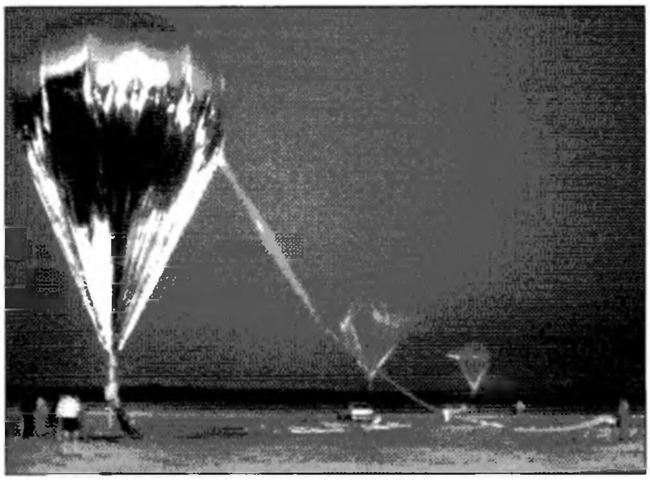


Fig. 127: *A CNES research balloon being launched at the NITR antenna test site at Paardefontein (North of Pretoria) (F Potgieter)*

The launch had to take place at night to minimise the ill effects of wind. The balloons were known by the acronym MIR (Mongolfier Infra-Rouge). In flight the helium used to fill the envelope had to be maintained at a reasonably constant temperature. This was achieved by silvering the top to reduce the absorption of infra-red radiation from the sun and by leaving the underneath clear the gas was warmed at night by the radiation from the earth.

In 1982 one of the balloons launched from Paardefontein circumnavigated the earth several times at an altitude of about 30 km taking 52 days to complete each circuit. The French were naturally happy to have shown that Phineas Fogg's record was quite possible[51].

12.2.5 Satellite remote sensing centre

The NITR had two satellite tracking stations at Hartebeeshoek. A deep space facility was used for radio astronomy and the second for receiving data from the Landsat, Meteosat and CNES satellites. The information thus received has proved invaluable to agriculture, meteorology and other disciplines. An example of one of the computer enhanced images of the earth received at Hartebeeshoek from Meteosat-2 is shown in fig 128[76]. With such clear information on cloud cover meteorologists have been able to improve weather forecasting considerably.

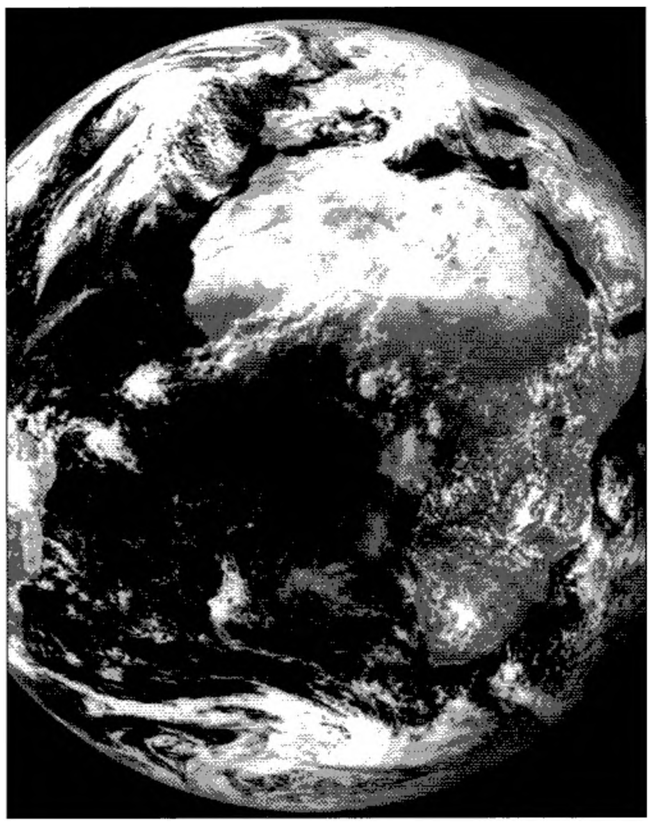


Fig. 128: *Meteosat-2 enhanced image showing cloud cover (ref 76)*

Fig. 129: *An enhanced image of the Vaaldam taken from Landsat. The white shows the level in November 1981 whilst the black shows what it became in 1983 after a severe drought (ref 77)*

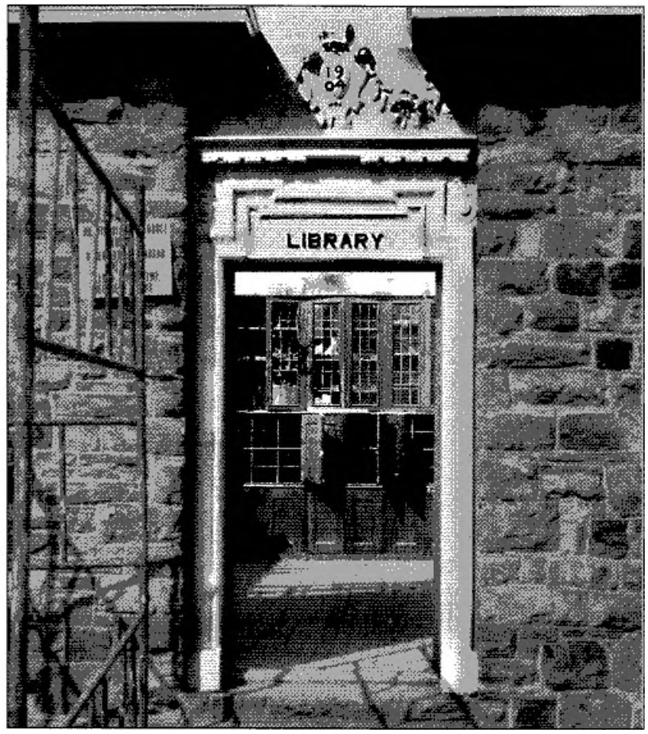


Fig. 130: *Damage to the woodwork of the Baker Library caused by a fire in the early 1980s (SAAO)*

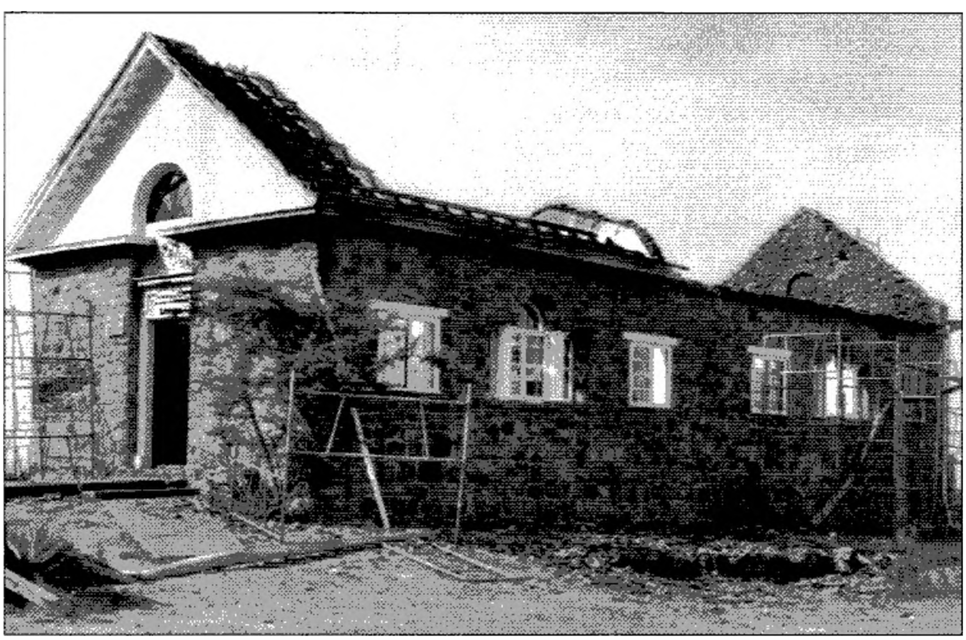


Fig. 131: *The Baker Library building after the fire (SAAO)*

Fig 129 originated from Landsat and shows the level of the Vaal dam at the beginning of November 1981 when the dam was 81% full (shown in white) compared with the subsequent level at the end of June 1983 (shown in black) after a prolonged drought when it fell to 24% of full capacity. Computer enhancement plays an important part in producing such graphic material providing much valuable information not easily available by other means[77].

12.3 The Baker Library fire

In the early 1980s the CSIR had arranged for the Baker Library to be re-painted. Whilst work was in progress a fire started which destroyed the roof and much of the interior woodwork (figs 130-132). Fortunately the robust shell of the building was not severely damaged and could be restored as far as possible to its original condition. Most of the original woodwork was lost including the cupola on the east side of the roof which had to be completely replaced. The replacement cupola only lasted until 1999 when it collapsed and has since been rebuilt.

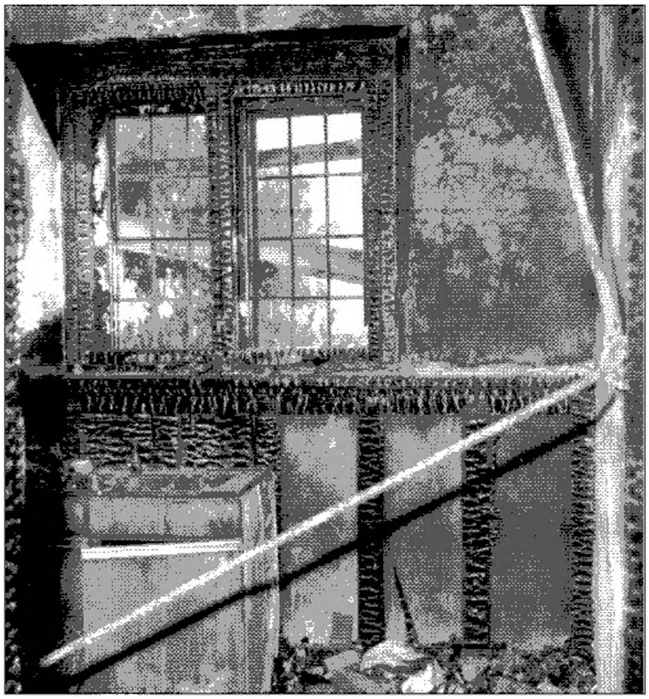


Fig. 132: *Fire damage to one of the small rooms in the Baker Library*

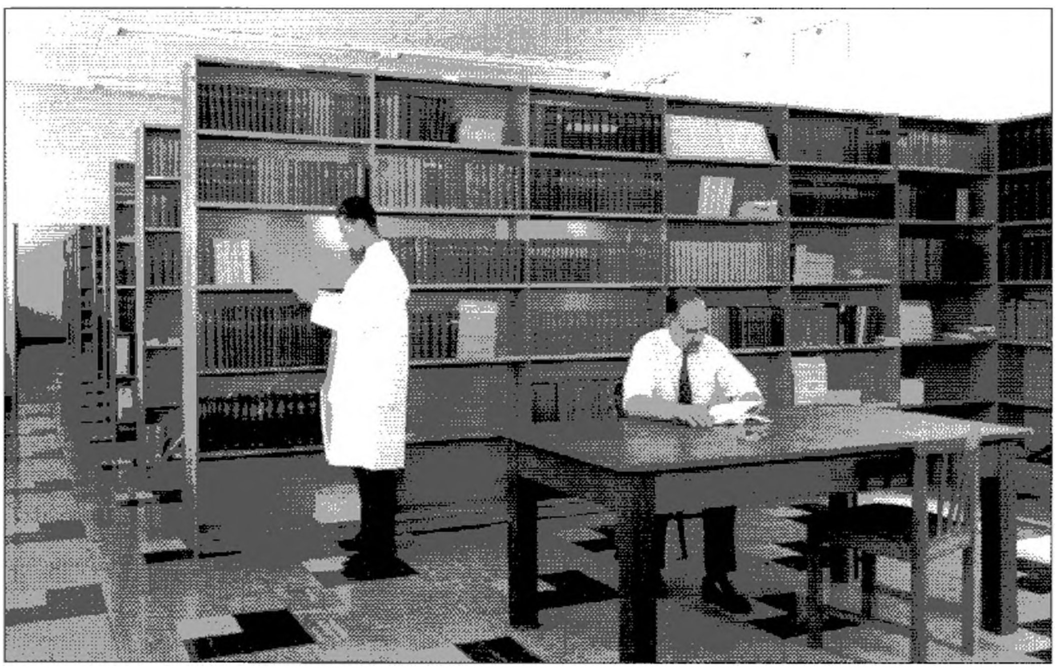


Fig. 133: *NC Roux and Jan Hers in the library in the new building ca 1965 (SAAO)*

The Associated Scientific and Technical Societies (AS & TS)[66]

Chapter 13

The rapid growth of the mining industry in Kimberley and the Transvaal attracted numerous scientific and technical personnel. Towards the end of the 19th century most of these were domiciled on the Witwatersrand particularly in Johannesburg.

These specialists soon came together and formed associations to help each other and to share experiences. The first of these was the South African Association of Engineers and Architects founded in 1892 followed by the Chemical and Metallurgical Society in 1894 and the Geological Society of South Africa in 1895.

The South African war drove most of these professionals to Cape Town where in 1902 they formed the South African Association for the Advancement of Science (S_2A_3) and provided the stimulus for a visit of the British Association for the advancement of Science in 1905.

When peace returned industry gradually recovered and the technical specialists returned to the Witwatersrand. Several more technical societies were formed and the limited meeting facilities offered by the Chamber of Mines and the Transvaal Technical College could no longer cope with all their activities.

World War I followed and an Industrial Research Committee was formed to co-ordinate the war efforts of the individual disciplines. This group succeeded in producing, locally, many essential items previously imported. At the end of the war it became evident that this co-operative effort could also bring benefits during peacetime.

In 1920 it was decided to bring the scientific and technical societies together in a more structured relationship called the Associated Scientific and Technical Societies (AS & TS). The building previously occupied by the Johannesburg Club at 100 Fox St (fig 134) was purchased for £22 500 with funds loaned by the Chamber of Mines. It was named Kelvin House and provided accommodation for their secretarial services and a central facility where member societies could hold their meetings.

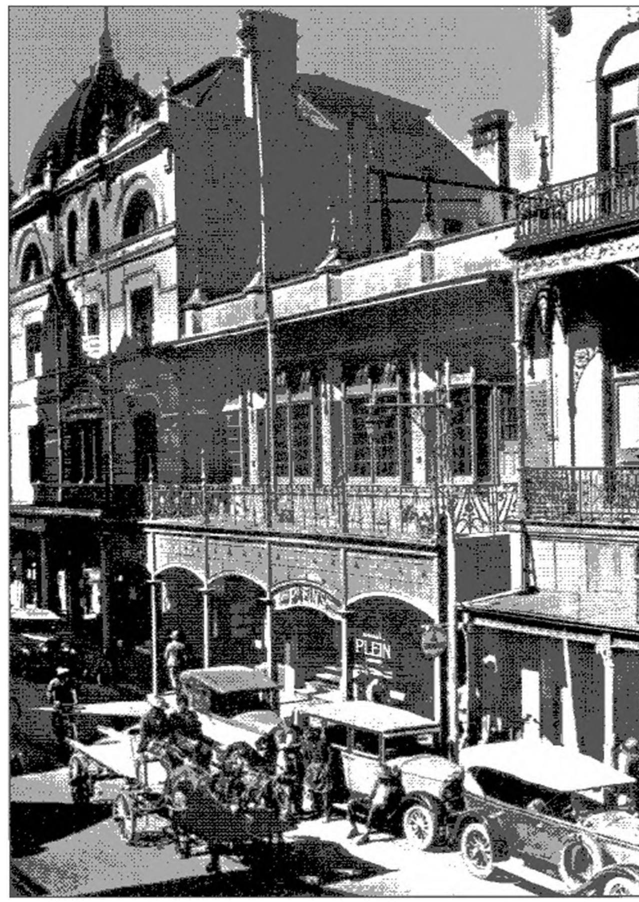


Fig. 134: *The first Kelvin House, home of the Associated Scientific and Technical Societies from 1929 – 1937, was at 100 Fox Street (previously the Johannesburg Club) (AS & TS)*

During the general strike of 1922 members of the AS & TS kept the Johannesburg Power Station running to prevent the city from being plunged into darkness and to maintain essential services.

In July 1924 the AS & TS opened the first regular radio broadcasting station in Africa. This bold action needs to be viewed against similar activities abroad – eg the British Broadcasting Company had only just started broadcasting in November 1922. This remarkable initiative seems to have been largely driven by Dr AJ Orenstein of the Witwatersrand branch of the British Medical Association. Dr Orenstein had started his career combating yellow fever in the Panama Canal zone. He was persuaded to move to South Africa to join Rand Mines to combat pneumonia which was taking the lives of many miners working on the gold mines. The AS & T Broadcasting Company had its studios and transmitter in Stuttafords Buildings in the centre of Johannesburg. The venture was a great success with the public but unfortunately many listeners did not pay their licence fees and the company was unable to meet its expenses forcing closure in January 1927.

In 1931 an extra floor was built on to the Fox St premises to cope with increasing demands for space. With the growth of the mining industry the number of societies and their membership increased steadily and eventually it became evident that a significant increase in the size of their premises would be required.

In 1937 the AS & TS sold the Fox St premises and erected a new 8 storey building on the corner of Marshall and Hollard Streets designed to meet their needs (fig 135). These new premises were also named Kelvin House and accommodated the societies comfortably until the early 1960s. At that stage their neighbour, General Mining, decided to rebuild their premises and persuaded the AS & TS to refurbish Kelvin House to fit in with their new look. Much of the interior, particularly the meeting chambers, was completely remodelled. Kelvin House not only provided secretarial facilities and meeting chambers for the various societies but also a restaurant and pub which were widely patronised as it was conveniently situated in the business centre of Johannesburg.

In the late 1980's the CSIR offered the Observatory site for sale and the AS & TS saw this as an opportunity to leave the noisy, overcrowded city and move to premises which had been closely associated with scientific endeavour for most of the century. With some wrangling they were eventually able to sell Kelvin House and buy the Observatory site with sufficient left over to pay for the building alterations needed to accommodate everyone

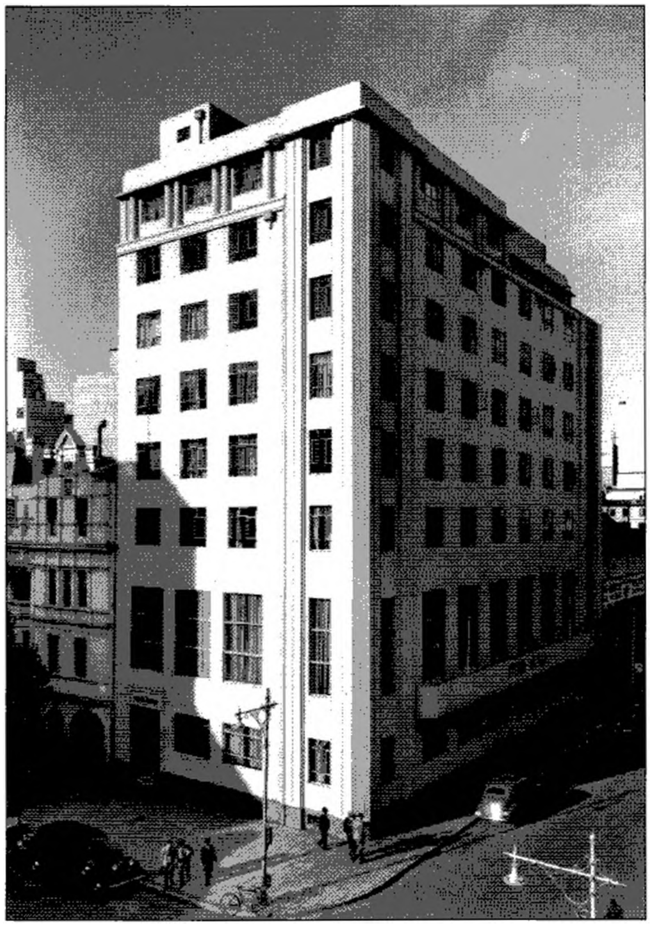


Fig. 135: *The second Kelvin House on the corner of Marshall and Hollard Streets soon after it had been built in 1937 (AS & TS)*

comfortably. At the same time they were also able to clear their outstanding debts with the Chamber of Mines.

The AS & TS moved to Observatory in 1990 and converted the workshop area (fig 137 block 4) built by the NITR into offices which they occupied themselves. The NITR Library was converted into meeting rooms and the remainder of the building was sub-let to constituent societies. Unfortunately many of them have since moved elsewhere and this part of the building has been revamped to make it suitable for small conference facilities.

The South African Institute of Electrical Engineers (SAIEE)

Chapter 14

At the turn of the 20th century mining was the largest industrial activity and most of the early mines produced their own power using steam and other prime movers to drive machinery such as hoists, stamp mills etc. Electrical engineering was viewed with some suspicion by most mining people who confined its application to lighting and signalling but in spite of this progress was already evident in the 1890's.

Prospectors, gold diggers and other colourful characters initiated the whole mining process but once the surface workings had been exploited they could not continue much further without the help of engineers and technologists. Geologists, mining engineers, metallurgists and mechanical engineers were in the forefront but these were followed by electrical engineers and by the 1890's there was a considerable number working on the Rand.

To quote one of the electrical pioneers who arrived in Johannesburg in 1896

'it did not take long for birds of a feather to flock together ... the accepted method of meeting friends and colleagues was to blow in to a friendly bar where one's friends were in the habit of calling on like quest, particularly at week ends. By means of two or three glasses and a couple of sandwiches and a few cloves (sic) some graphs would doubtless be drawn on the mahogany to illustrate what happened to the power supply to shut the mill down.'

Three large technical societies had already been established on the Reef. The South African Association of Engineers and Architects (1892), the Chemical and Metallurgical Society (1894) and the Geological Society (1895).

To quote again from the same source:

'These pioneer societies were real live bodies in 1896, with good membership rolls and excellent attendances. Nearly all the members were under thirty years of age, and many bore the indefinable, yet unmistakable, stamp of public school and university. Attendance at meetings, especially those held in the evening, was quite an event for members domiciled, even a very little way, out of the town. For those wide afield, it usually meant a long walk or drive in a crazy mule-drawn vehicle from the mine to some halt on the NZASM "Rand Tram" line. Then a wait for the belated train, which finally discharged its passengers often in a cloud of thick red dust at Park Halt long after the scheduled time. One had the choice of tramping up town ankle deep in dust or engaging what had once been a respectable "Victoria." There were other minor inconveniences and excitements of the trip, and it was sometimes a wise precaution to bring one's revolver in a convenient pocket. Usually the return journey had to be resumed on the following day, but none the less the attendances were excellent and much higher, proportionately, than they are to-day.'

14.1 The South African Society of Electrical Engineers

On 15 May 1897 22 electrical engineers got together to form the Society of Electrical Engineers (SASEE). At their second meeting in August 1897 they were able to muster 50 foundation members.

Sir James Sivewright, KCMG, MIEE accepted the office of President of the SASEE. Sivewright became a Telegraph Engineer under Sir William Preece, Chief Engineer of the British Post Office and had came to the Cape in 1877 to assist the Manager of Telegraphs. Through his friendship with Cecil Rhodes he became the Member of Parliament for Griqualand West and was given a cabinet position in the Cape Parliament in 1890. A street in New Doornfontein, Johannesburg, was named after him.

The Chamber of Mines formally recognised the Society and placed its Council Chamber at its disposal for meetings. By 1899 the membership had risen to 80 and there was a joyous smoking concert held at the North Western Hotel at which 250 people had a memorable night, even for those Bohemian times.

The Anglo-Boer war dealt a severe blow to the SASEE. Most of its members were dispersed elsewhere and in spite of efforts made to re-assemble the society after the war no further meetings were held.

14.2 Post Anglo-Boer War Developments

The easy gold available to the early shallow mines soon ran out and they had to work at ever-deeper levels. Steam powered hoists located on the surface could raise the ore mined from considerable depths but eventually reached the limit imposed by the weight and strength of their winding ropes. To reach deeper levels it became necessary to operate secondary hoists underground and these could no longer be driven by steam engines. Electric power provided the only economical alternative.

In 1907 A M Robeson, the Consulting Mechanical Engineer to the Central Mining/Rand Mines Group, persuaded management to carry out the complete electrification of all mines in their group. For the first time a clear signal was given that electrical power had come of age and was worthy of taking its place alongside the other heavy engineering disciplines.

Government statistics recorded that the total capacity of electric motors on the Witwatersrand in 1905 was 20 000 horse-power (15 000 kW). By 1909 this had grown to 400 000 (300 000 kW). Much larger power stations had to be provided and these had to be designed by experts to achieve maximum economy. The electrical engineer had really arrived.

14.3 Formation of the South African Institute of Electrical Engineers

In February 1909 several engineers came together to form a new association and in June they called a General Meeting of the South African Institute of Electrical Engineers at the Grand National Hotel in Johannesburg which was attended by 117 Foundation Members. The first Annual General Meeting followed in November 1909 where the constitution was adopted and members of the first council were elected.

14.4 Premises of the SAIEE

Meetings were held in the Lecture Theatre of the Transvaal University College which later became known as the South Africa School of Mines.

In 1920 ten scientific and technical societies including the SAIEE came together to form the umbrella body known as the Associated Scientific & Technical Societies (AS & TS) which offered member societies, amongst other things, premises and secretarial services. The old Johannesburg Club at 100 Fox St (fig 134) was purchased and in 1930 the building was named Kelvin House. This served as home to the SAIEE and other constituent bodies until 1937 when its accommodation became stretched to the limit.

A new 8 storey building was purchased in Hollard St (fig 135). The name Kelvin House was transferred to the new building and remained the home of the Association, including the SAIEE, until 1989 when the AS & TS moved to Observatory.

In 1990 the SAIEE purchased the northeastern portion of the observatory site including the director's house and the buildings immediately behind it. The SAIEE administrative offices are housed in the house that has now generally become known as Innes House. Since its beginnings there has been a steady growth in Institute membership which now stands at over 5 000 (2005).

Amongst their several specialist sections the Institute supports an Historical Section which is attempting to preserve the heritage of the profession. South Africa was amongst the earliest nations to exploit electricity and the group has assembled a significant collection of artefacts in preparation for a future museum of Science and Technology. Part of this collection is housed in what was previously the NIPR simulator room (fig 120).

The Historical Section has also collected a wide range of early books and periodicals for their library which is rapidly becoming a valuable resource for historical research. Revealing our rich and interesting past is stimulating and inspirational and the Institute therefore encourages the publication of historical reviews – this book is a product of that policy.

The future of the Johannesburg Observatory – SAASTA

Chapter 15

On the 100th anniversary of the founding of the Transvaal Meteorological Department in Johannesburg the AS & TS transferred the management of the Observatory to the South African Agency for Science and Technology Advancement (SAASTA). SAASTA is an operational business unit of the National Research Foundation (NRF) tasked with the promotion of Science, Engineering and Technology (SET) in South Africa. The Observatory Science and Technology Site, as this historic landmark is now known, will be dedicated to the promotion of science, engineering and technology. SAASTA's mission is to increase both the number and competence of people qualified in mathematics and science in South Africa.

The Observatory Site is now part of the NRF family which includes national facilities such as the South African Astronomical Observatory (home of the state-of-the-art Southern African Large Telescope inaugurated by President Thabo Mbeki in November 2005), the Hartebeesthoek Radio Astronomy Observatory, and the Hermanus Magnetic Observatory.

The Observatory lends itself to science awareness activities as the many popular science fairs and exhibitions presented in recent years have demonstrated. SAASTA will build on this to develop an integrated centre providing a unique science and education experience for visitors.

There has also been a strong demand from educators and the public for more frequent activities at the Observatory. One such activity is that of the Astronomical Society of Southern Africa whose members use two telescopes for professional purposes and for monthly public viewing. The Society regularly presents courses on telescope building and driving as well as various other programmes for the public at the Observatory. This type of activity will be encouraged as it fits in well with SAASTA's objectives for the use of the site.

Before the site can be developed into a thriving hub of science activity several serious challenges have to be faced. Due mostly to changing ownership many of the buildings have deteriorated and some will require restoration. Security on the site is inadequate.

SAASTA appointed the Holm Jordaan Group of architects early in 2006 to evaluate the site and to propose ways of developing it into an integrated centre for science awareness and education. Their concept includes the conversion of buildings to suit new requirements, the restoration of structures of historical value, the upgrading of roads, parking, maintenance and support areas, as well as landscaping of the site. This will all be done in phases aiming at an integrated national resource for hands-on learning to raise awareness of the impact of science and technology on the lives of South Africans.

As a first step adequate research and preparation of documentation relating to all the facilities have been undertaken so that this heritage site can be developed in a responsible and sustainable manner. The South African Heritage Resource Agency will be involved in identifying buildings that need to be restored, reused or redesigned to give the site a new lease of life.

The first phase of development will start in the second half of 2006 with the conversion of the northern office block (built in the 1960s) into a centre for learning and teaching with interactive indoor and outdoor exhibits. According to the architects, the hands-on learning facility will reflect the excitement and accessibility of science to learners and the community at large. The design will invite people to explore and become involved in the exhibits.

The refurbished building will house facilities such as science and computer laboratories, offices and a media centre to stimulate debate, communicate science in fun and exciting ways and to promote careers in science.

A unique and innovative feature will be the 'Infinity Room', a space with no corners or points of reference. According to the designer this will impart a fascinating experience like 'flying in a cloud'. Constructed in an enclosed courtyard the exhibit space will provide open and flexible areas suitable for housing large items. Ramps will ensure access to all exhibits for the disabled.

The themes of the exhibits will initially focus on the astronomical and earth sciences, as well as engineering.

The sustainable use of resources will be a feature of the building design. This will not only ensure that the building makes use of state of the art technology, but will also serve to demonstrate environmental awareness and provide visitors with hands-on experience of these technologies. Features included in the design are shading, heat transfer, solar water heating, photovoltaic cells, energy efficient lighting and curbing of light pollution especially in relation to viewing the night sky through telescopes. Energy efficient climate control, water saving devices, technology for the re-use of grey water, rain water harvesting, and water wise landscaping will be displayed.

The second phase will include the redesign of the entrance to the site, perimeter fencing, roads and parking areas, and the historic building that houses the 26½-inch telescope and lecture hall. Priority will be given to revamping the roads and parking areas as the site will have to cater for both public and school visits.

Possible phases for redevelopment of the site will be the refurbishing of the southern office block, creating space for outside role players, a tuck shop and canteen, and overnight accommodation for learners. All historical buildings, such as the library and guest house will be restored and put to use in line with their original purpose.

In the longer term, the plans for the site include exciting projects such as a travelling science and technology exhibition for outreach purposes a camera obscura; science theatre; a conference facility; a shop selling science-related items; and a restaurant with a science theme.

SAASTA believes the Observatory Science and Technology Site will in the long term not be seen as an isolated site but will eventually become part of a bigger plan - a science tourism route in Gauteng. This will encompass the Sci-Bono Discovery Centre in Newtown, the Origins Centre at the University of the Witwatersrand, the Johannesburg Planetarium, Maropeng and Sterkfontein in the Cradle of Humankind.

With its new vision for the Observatory Science and Technology Site SAASTA will be conforming to the wishes expressed more than 100 years ago by the owners of the original farm, the Bezuidenhout family, to use the site for astronomy and related scientific activities. It will at the same time be fulfilling its mandate to promote understanding, appreciation and engagement with science, engineering and technology amongst all South Africans.

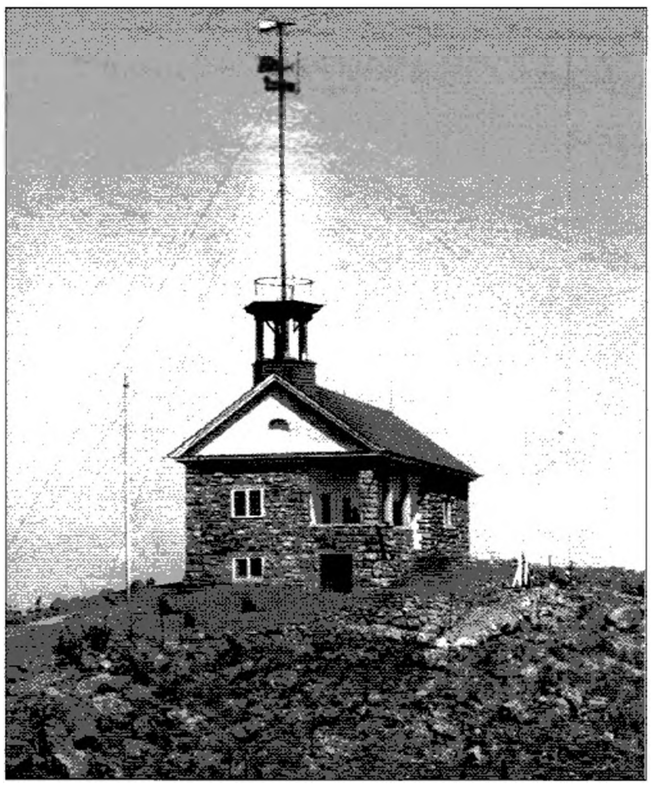


Fig. 136: *An early photograph of the Baker Library building showing the wind velocity and direction sensing instruments at the top of the mast (SAAO)*

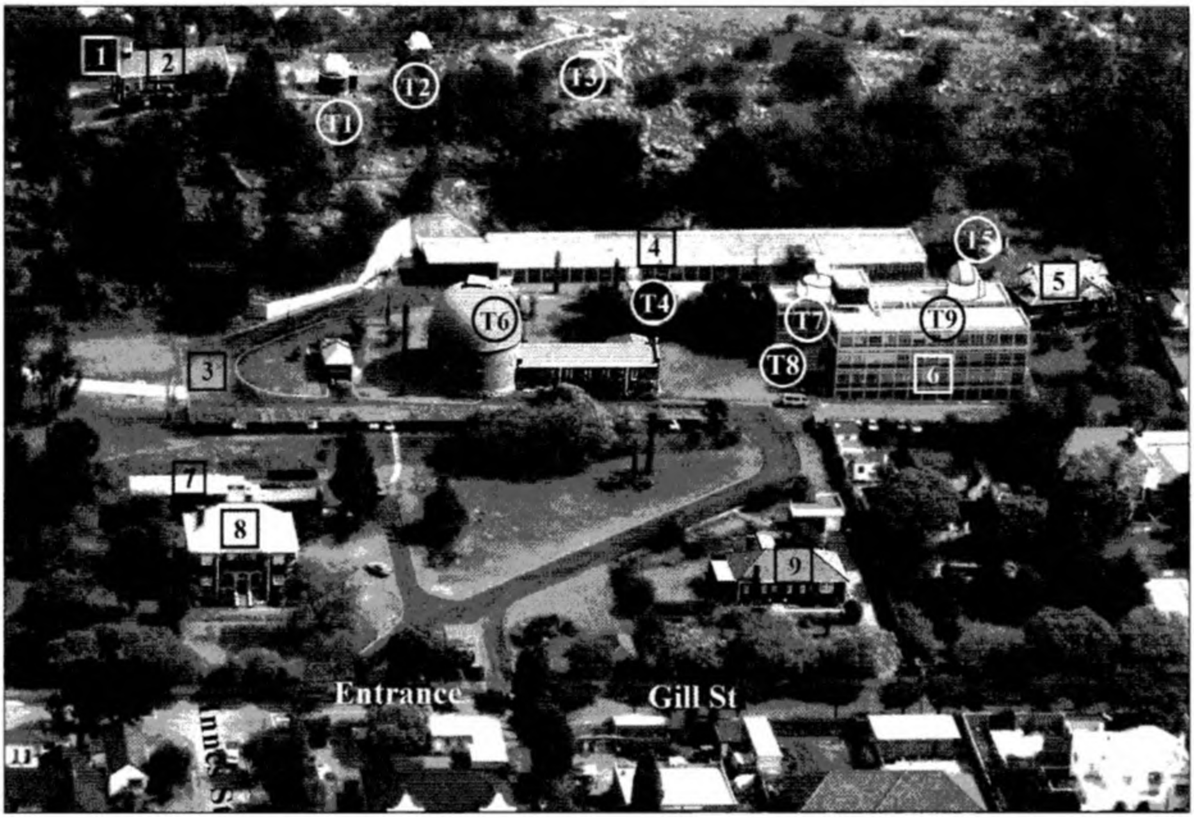


Fig. 137: *Aerial view of the Johannesburg Observatory taken in the early 1990s (AS & TS)*

Key to features:

1 Site of early staff house.
2 Herbert Baker Library.
3 Site of van den Bos asbestos/cement prefabricated house (demolished).
4 AS & TS office block (previously NITR workshops).
5 Boulton & Paul Wood/Iron prefabricated staff house (1903).
6 New Office block (1964).
7 NIPR Driver fatigue study building (now SAIEE museum and library)
8 Director's house (now known as Innes House and home of the SAIEE).
9 Assistant Director's house.

Telescope Positions:

T1 C Papadopoulos structure (Astronomical Society) with dome from site T7 and now housing the Franklin-Adams 6/7-inch Cooke photo/visual telescope.
T2 C R Jacobs Dome (Astronomical Society).
T3 Original housing for the Franklin-Adams 6/7-inch Cooke photo/visual telescope.
T4 Original position of the Leiden Telescope (16/16-inch Rockefeller photographic reflector).
T5 Original location of the 9-inch Grubb refractor (now demolished).
T6 $26^{1/2}$-inch Grubb refractor.
T7 20-inch Boller & Chivens reflector, transferred to Sutherland (dome transferred to site T1 when the Observatory was closed down).
T8 Franklin-Adams 10-inch camera (transferred to Hartebeespoort; site now covered by later building).
T9 Franklin-Adams 6/7-inch photo/visual Cooke transferred to this site in 1966 and moved to T1 in1975.

NB the positions shown for demolished structures are approximate.

Appendix 1 Theodore Reunert[80, 91]

Reunert (fig 3 and 118) was born in Leeds in 1856 having a German father and English mother. Both parents were teachers and from them he inherited a desire to promote education and a profound appreciation of the best in literature and art.

He served an apprenticeship as a mechanical engineer in Leeds and received his technical education at the Yorkshire College of Science (now Leeds University).

He immigrated to South Africa in 1879 and spent 10 years practising in Kimberley. He then moved to Johannesburg and became a partner in what became the well-known engineering business Reunert and Lenz.

Reunert was active in promoting education in Johannesburg and was awarded an Honorary Degree of Doctor of Literature by the University of the Witwatersrand for his part in establishing that institution[91].

In 1902 he was one of the founders of the South African Association for the Advancement of Science (S_2A_3) and was elected president in 1905, the year the Observatory was officially opened.

Reunert died in Durban in 1943.

Appendix 2 Distinguished guests attending the opening ceremony on 7 January 1905[78]

George Goch (Mayor of Johannesburg)

Sir David Gill (His Majesty's Astronomer at the Cape of Good Hope)

Theodore Reunert (President of the South African Association for the Advancement of Science)

Dr EHM Showers (Commissioner of Police)

Turner (Medical Officer of Health for the Colony)

G Albu	Dr Corstorphine	Dr Porter
JW Bell	W Cullen	JW Quinn
E Brakhan	Mr Easton	FS Smith
WA Caldecott	M Franke	J Thompson
C Chudleigh	Mr Johnson	Mr E William
RE Connelley	WF Lance	JR Williams
AF Crosse	H Pimm	Mr van den Berg

Appendix 3 The meteorological equipment at the Transvaal Observatory in 1906

The observatory was equipped with several sophisticated instruments such as recording barometers, Campbell-Stokes sunshine recorders, anemo-meters and both earth and radiation thermometers. Evaporation was measured by means of a Symons evaporimeter (fig 13) which was an open tank with a surface area of 1,8 m by 1,8 m filled with water to a depth of 600 mm. The drop in water level with time provided a measure of the evaporation rate. A seismograph was located in the basement to allow direct contact with bedrock (fig 18) - access was through the low-level door that can be seen in fig 13.

A standard Royal Meteorological Society Stevenson screen housing maximum and minimum thermometers was mounted at the top of the hill (fig 12). Close to it a hut with louvered walls 3 m long, 2 m wide and between 1,5 m and 2 m high was built to house the platinum air temperature thermometer, thermographs and hygrographs (figs 12 & 15). A double roof tempered the effect of the sun and canvas blinds were placed inside the louvered walls to prevent driving rain from splashing on to the instruments.

Two Callendar Electric Recorders[92] were provided to record temperatures using platinum sensing elements housed in the louvered hut shown in fig 17. These recorders, devised by Professor HL Callendar in 1897, were effectively self-balancing Wheatstone bridges and were an early form of what later became known as the potentiometer recorder. The pen was driven to the left or to the right by two clockwork motors which were wound by the two key shafts seen projecting from the central panel (embossed with the maker's name). The platinum thermometer sensing element was connected via long cables with compensating leads to a Callendar and Griffiths bridge within the recorder. The state of balance of the bridge was detected by the large d'Arsonval (moving coil) galvanometer seen at the top left hand side of the casing. The moving coil had a horizontal arm projecting to the right of fig 17 which carried two noble metal fingers which could make contact with the rotating disc seen on the left hand side of the cylindrical clockwork motor. Contact was made with a platinum tyre attached to the periphery of the disc, the surface of which was kept clean by two leaf springs rubbing on the tyre as it rotated. Each of the fingers was insulated from the arm and connected to the external circuitry by light flexible copper wires. Connection was thus made to energise one of the two brake release coils when the fingers touched the front or rear side of the platinum tyre. The release coils had armature extensions resting on the two brake drums seen in the centre of the mechanism. When one of the release coils was energised the brake would be released to allow the clockwork mechanism to drive the pen and balancing potentiometer to the left or right as required to restore balance. A separate clockwork motor rotated the contact disc. This elaborate arrangement ensured that the very light contact pressure exerted by the galvanometer was sufficient to establish electrical connection. The chart drum was rotated by a separate clock motor making a total of four motors which had to be hand wound (presumably every day).

Continuous records of wind speed and direction were taken by means of the Dines-Baxendall anemograph whilst the wind pressure was registered by means of a Baxendall pressure plate. These can be seen at the top of the mast erected above the roof of the library (figs 12 & 136). They also had a Dr Aitken's dust-counter and a lightning recorder (fig 16)[1, 89].

Appendix 4 The role of Innes in the study of the rotation of the earth

Extract from paper by J Hers delivered in 1968[19]

Although Innes had no academic background, and was largely self-taught, he had an unusually clear and fertile brain, which he applied in many different directions - some of them far removed from astronomy. He never lost his interest in the question of the rotation of the earth and its apparent irregularity, and this led to a series of papers which are still of significance today. Having become increasingly convinced of the great value of occultations for determining the Moon's motion, he started in 1923 a comprehensive programme for not only observing occultations in Johannesburg and reducing the results, but also for reducing a large number of occultations observed elsewhere. This was work of a kind that few today would undertake unless they had access to an electronic computer.

In Innes' own words:

> This heavy work of reducing uniformly all the occultations of stars observed (and so far published) in 1923 was undertaken for several reasons. It was the first year in which Brown's great lunar tables were used in the national ephemerides, so that an immediate comparison was interesting..... What has really been sought for here is the time error of the Moon's ephemeris. This is contrary to the usual practice of astronomers. The astronomer is naturally forced to deal with the two coordinates x, y, z and t (sic) and he assumes that t is correct. The writer ventures to think that the assumption is unwarranted by the facts. He has a belief that the moon pursues its gravitational path with great exactness and that Brown's theory includes every gravitational effect. If this is so, then the deviations of the Moon are not due to errors in x, y and z, but to errors in t, which errors must arise from irregularities in the period of rotation of the earth.

Even at that time this idea was not, of course, new. An irregular rate of rotation of the Earth had been suspected at various times during the last century, and Newcomb had hinted at its possibility on several occasions, but seems to have finally dismissed the idea. To quote Newcomb (1903).

> The evidence seems almost conclusive that the very improbable deviations in the Earth's rotation inferred from the observations of the Moon are unreal, and that the motion of our satellite is really affected by causes which have, up to the present time, eluded investigation.

Brown (1914) in the course of an address to the meeting of the British Association in Australia, exhibited some curves comparing the variation in longitude of the Sun, Moon and Mercury, but does not seem to have come to a conclusion.

The first definite demonstration of variability seems have been due to Glauert who compared the errors in longitude of the Sun, Moon, Venus and

Mercury over the period 1865 to 1915, and made the rather hesitant conclusion that:

From the results obtained, it appears that the errors in longitude of the Moon and the three bodies considered in this paper may be accounted for by a rather irregular variation in the rate of rotation of the Earth, the change of momentum being partially or entirely compensated for by a corresponding change in the mean motion of the Moon.

The next move was made by Innes. On May 7, 1924, the transit of Mercury had been observed in Johannesburg, and Innes used this occasion for bringing up to date Newcomb's paper of 1882, in which the latter had discussed transits of Mercury for the period 1677 to 1881. Innes states: "The objective of this work was the same as Newcomb's: to find an independent check on the rotation of the Earth." He does not seem to have been aware of Glauert's papers until his attention was drawn to it by Prof. Brown at a late stage, when he comments:

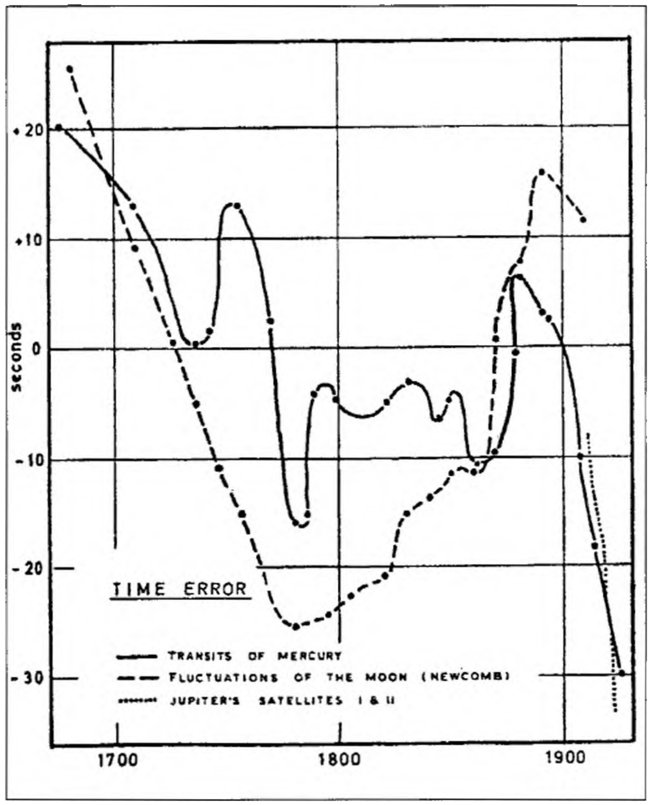
Glauert's investigation shows with a high degree of probability that the errors of the lunar tables are mainly due to the irregularities in the Earth's rotation, and it is somewhat remarkable that they did not attract more attention. This may have been because the data were considered to be somewhat thin, and that by their nature they could not say anything as to the great fluctuations of 1690 1750, and that judgement had to be deferred until they were brought in.

He continues:

In the present paper the correlation is shown to exist almost as completely as could be wished when the probable errors of the old observations are in mind; but the real confirmation is in the almost precise correlations of the last twelve years.

In the diagram which forms part of this paper Innes compares the time error of the transits of Mercury with those of the Moon, as deduced by Newcomb from occultations, and adds the corresponding values for satellites I and II of Jupiter for the period 1910-1923. I do not think any apology is needed for reproducing this diagram here again today, for even if it does not supply absolute proof, it surely is the first real indication of the variable rotation of the Earth.

Where Innes was unique, however, was in the fact that he immediately realised the implications of these results. He states:



Appendix 4 *Earth rotational time errors estimated by Innes in 1924.*

Astronomers have now to face the fact that the Earth's rotation changes abruptly by an amount which is about ± 1 second a year - thus, at the peaks the per saltum change appears to be about 2 seconds in all, and this change may continue until the total reaches ± 30 seconds ....

If the Moon should turn out to be a good time-keeper, then it will be easy enough to find out the time error from month to month by observations of the Moon; one way would be to observe occultations of stars at the dark edge as near to the day of first quarter as possible. Such can be made with ease at conveniently early hours. Because of the irregularities of the Moon's edge, it is necessary that at least a dozen such occultations should be forthcoming; therefore the participation of many observatories should be sought. The occultations when made should be transmitted immediately to some central institution which would undertake their reduction and determine the current time error. To make full (and scientific) use of such observations it is likely enough that the empirical term now incorporated in the Moon's ephemeris should be discarded ......

> If the conclusions reached should be generally approved, it will become necessary to distinguish formally the difference between time as observed, and time in the Newtonian sense. What we observe and must popularly use might be called rotation-time, or the observed time might be called Greenwich Time (G. T.) and the Newtonian time World or Universal Time (U. T.) and the difference should be determined periodically and published as the correction to rotation time.

These are truly prophetic words. Innes probably saw matters somewhat simpler than they later turned out to be, but his definitions for the two systems of time are precisely the same as those in use today, although the names are rather different. His Universal Time is, in fact, what we now know as Ephemeris Time, while our Universal Time is what he calls Rotation Time.

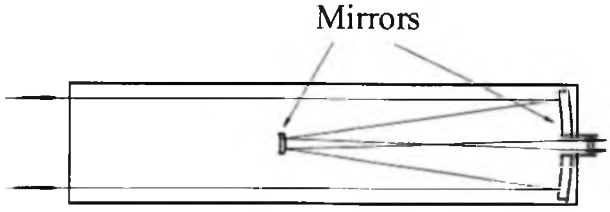
What is perhaps rather astonishing is that it should have taken thirty years for this idea to gain general acceptance. Innes' diagram was published with a note in the Astronomische Nachrichten[32] and as part of an article in the Journal of the RAS of Canada and a fairly general discussion followed, but the reaction was rather timid.

Appendix 5 Telescopes in general

Optical telescopes are broadly divided into two types known as refractors and reflectors. Refractors make use of lenses to enlarge and focus the image of a distant object on the human eye or so that it can be recorded on a photographic emulsion.

The objective lens usually consists of a pair of lenses one being made from flint glass and the other from crown glass. By nature a single lens is not able to focus images of different colour on the same plane whereas compound lenses having components with differing refractive indices can be made to minimise this chromatic aberration.

Reflector telescopes make use of curved mirrors instead of lenses to avoid many of the problems associated with refractor telescopes (including chromatic aberration).



Cassegrain Reflector Telescope

Appendix 6 The main telescopes at the Union/Republic Observatory[49]

Fig 137 shows the location of the main telescopes used at the observatory. In several cases the original sites have been demolished and the positions shown are approximate. Telescope sites are shown as circles with designations T1…T9.

1 In 1907 the 9-inch Grubb telescope was installed on an equatorial mount donated by Sir David Gill (His Majesty's Observatory in the Cape) in a rectangular housing with sliding roof at site T5 (figs 31-33). In 1965 it was transferred to the dome on top of the new building (T7). This telescope is now at UNISA.

   Objective lens diameter = 9 inch (227 mm), focal length = 133 inches (3 389 mm)

2 In 1909 John Franklin-Adams donated his 10-inch (250 mm) astronomical camera to the Transvaal Observatory and it was installed at site T8 (figs 35 & 36). This was moved to the Hartebeespoort Annexe in August 1954.

Refractor Telescope

The focal length of the Cooke triple element lens was 44,2 inches (1 123 mm)

The photographic plate holders were made for 8 x 8 inch (203 x 203 mm) plates.

A second camera was included having a 3,5 inch (90 mm) lens with a 20 inch (508 mm) focal length.

The telescope was fitted with 2 finders each having a diameter of 6 inch (150 mm) and a focal length of 69 inches (1750 mm). These could be directed up to 10 degrees away from the target area.

3 In 1912 Franklin-Adams donated his 6/7-inch Cooke photovisual telescope which was installed on site T3. After the new administrative offices were built this telescope was transferred to site T9 in 1965 (fig 39). In about 1980 a 12,5-inch Tinsley Cassegrain reflector (on loan from C Papadopoulos) was mounted on the same frame as the 6/7-inch telescope at its T9 site. The combination was subsequently donated to the SA Astronomical Society and moved to the Papadopoulos dome (T1).

7-inch (180 mm) telescope focal length = 105 inch (267 cm) 6-inch (150 mm) telescope focal length = 108 inch (2711 mm)

4 In 1925 the 26 1/2-inch (674 mm) Grubb refractor was put into service at its present site T6 (fig 137). Focal length = 429,8 inch (10 916 mm), resolution = 0,212 arcsec.

Micrometer screw-value = 9,089 arcsec for every revolution of the adjusting screw.

Dome size = 22,11 ft (6 660 mm).

5 In 1938 Leiden University installed a 16/16-inch Howard Grubb-Parsons photographic refractor provided by the Rockefeller Foundation on site T4 (fig 50-52). This was moved to the Hartebeespoort annexe in 1957.

Both cameras had Zeiss quadruple lenses - 16 inch (406 mm) diameter, focal length = 90 inch (2 290 mm).

The guider had an 8-inch (200 mm) lens with focal length = 136 inches (3 450 mm).

Photographic plate holders for 8 x 8 inch (200 x 200 mm) and 12 x 12 inch (300 x 300 mm) plates. Plate scale 90"/mm.

Two different objective prisms were also available.

6 At the end of 1968 a 20-inch electronically controlled Boller and Chivens reflector was installed at site T7 (figs 56 & 58). This was transferred to Sutherland in about 1972.

Appendix 7 Asteroids (Minor Planets) officially credited to the Johannesburg Observatory

This list with its comments originate from the International Astronomical Union's Minor Planet Centre.

(715) Transvaalia 1911 April 22 by H E Wood. This is the first numbered minor planet discovered in Africa.

(790) Pretoria 1912 January 16 by H E Wood. Named after the capital city of the Transvaal.

(758) Mancunia 1912 May 18 by H E Wood. Named after the city of Manchester, the native city of Wood. Mancunia is the Latin name of Manchester.

(982) Franklina 1922 May 21 by H E Wood. Named in honour of John Franklin-Adams (1843-1912), British amateur astronomer who donated some of his telescopes to the Union Observatory.

(1702) Kalahari 1924 July 7 by E Hertzsprung.

(1032) Pafuri 1924 May 30 by H E Wood. Named for a river in the northern Transvaal.

(1663) van den Bos 1926 August 4 by H E Wood. Named in honour of W H van den Bos, director of the Union Observatory from 1941 to 1956.

(2193) Jackson 1926 May 18 by H E Wood. In honour of Cyril V Jackson (1903-1988) whose 70? minor planet discoveries constitute a record for the southern hemisphere.

(3300) McGlassen 1928 July 10 by H E Wood. In honour of Van McGlassen, head of Computation Facility at the Harvard-Smithsonian Centre for Astrophysics.

(1305) Pongola 1928 July 19 by H E Wood.
(1096) Reunerta 1928 July 21 by H E Wood. In honour of Dr Reunert, an engineer and friend.
(1116) Catriona 1929 April 5 by C Jackson. Named probably after the novel (1893) by the Scottish poet and novelist Robert Louis Stevenson.
(1186) Turnera 1929 August 1 by C Jackson. In honour of the British astronomer Herbert Hall Turner (1861-1930), director of the Oxford University Observatory.
(1132) Hollandia 1929 September 13 by H van Gent. The Latin name for Holland.
(1133) Lugduna 1929 September 13 by H van Gent. Lugdunum Batavorum is the Latin name for the city of Leiden, The Netherlands.
(1627) Ivar 1929 September 25 by E Hertzsprung. In honour of his late brother.
(1226) Golia 1930 April 22 by H van Gent. In honour of Golius, the first professor of astronomy and founder of the Leiden observatory in 1633.
(1267) Geertruida 1930 April 23 by H van Gent. In honour of the daughter of Mrs Hamerslag, a sister of G Pels.
(1225) Ariane 1930 April 23 by H van Gent. Named for the principal role Ariane Leprieur in the play Le Chemin de Crete by the French dramatist Gabriel Marcel (1889-1973).
(1165) Imprinetta 1930 April 24 by H van Gent. In honour of the wife of the discoverer.
(1268) Libya 1930 April 29 by C Jackson.
(1666) van Gent 1930 July 22 by H van Gent. In honour of Dr H van Gent who was a Leiden observer in South Africa from 1928 to 1946.
(1667) Pels 1930 September 16 by H van Gent. In honour of G Pels (1893-1966) a life long member of the scientific staff of the Leiden Observatory.
(1945) Wesselink 1930 July 22 by H van Gent. In honour of A J Wesselink (1909-1995) Astronomer at the Leiden, Radcliffe and Yale Observatories.
(1752) van Herk 1930 July 22 by H van Gent. In honour of G van Herk (1907-   ) former staff member of the Leiden Observatory and a well-known authority on astrometry.
(1595) Tanga 1930 June 19 by C Jackson and H E Wood. A Port on the eastern seabord of Tanzania.
(1689) Floris-Jan 1930 September 16 by H van Gent. Named after Floris-Jan van der Meulen, the 5000th visitor to a 14-day astronomical exhibition at the Leiden Observatory.
(1738) Oosterhoff 1930 September 16 by H van Gent. In memory of P Th. Oosterhoff (1904-1963) who spent most of his life as a classical astronomer and academic teacher at Gottingen Observatory.
(2831) Stevin 1930 September 17 by H van Gent. In memory of Simon Stevin (1548-1620) Dutch Mathematician, inventor of the decimal point.
(1914) Hartbeespoortdam 1930 September 28 by H van Gent. Named for the dam near which the Leiden Southern Observatory was located from 1957 to 1982.
(1193) Africa 1931 April 24 by C Jackson. The continent of Africa.
(1946) Walraven 1931 August 8 by H van Gent. In honour of Th Walraven (1916-   ) retired professor of astronomy at the University of Leiden and resident astronomer at the Leiden Southern Station near Hartbeespoortdam.
(1197) Rhodesia 1931 June 9 by C Jackson. Named after the country now named Zimbabwe.
(1194) Aletta 1931 May 13 by C Jackson. Named in honour of the wife of the discoverer.
(1196) Sheba 1931 May 21 by C Jackson. Named for the biblical queen of Sheba, who visited Solomon.

(1195) Orangia 1931 May 21 by C Jackson.
Named for the province of Orange Free State.

(1242) Zambesia 1932 April 28 by C Jackson.
The name applies to the former British Territories in the Zambesi Basin.

(1246) Chaka 1932 July 23 by C Jackson.
Named for Chaka (or Tchaka) king of the Zulu tribe and founder of the Zulu empire in 1812.

(1241) Dysonia 1932 March 4 by H E Wood.
In honour of Sir Frank Watson Dyson (1868-1939) Astronomer Royal of England.

(1243) Pamela 1932 May 7 by C Jackson.
Named in honour of the daughter of the discoverer.

(1244) Deira 1932 May 25 by C Jackson.
Named after the ancient name of the birth-place of the discoverer. Jackson was born in the town of Ossett, Yorkshire.

(1245) Calvinia 1932 May 26 by C Jackson.
Named for the town in the Cape Province.

(1248) Jugurtha 1932 September 1 by C Jackson
Named after the Numidian king (160-104 BC) and enemy of Rome. Jugurtha was throttled to death in Rome.

(1264) Letaba 1933 April 21 by C Jackson.
Named for the river in the Transvaal.

(1282) Utopia 1933 August 17 by C Jackson.
Named for the imaginary country, a place of ideal perfection.

(1279) Uganda 1933 June 15 by C Jackson.
Named for the country.

(1278) Kenya 1933 June 15 by C Jackson.
Named for the country.

(1367) Nongoma 1934 July 3 by C Jackson.
Named for the capital city of the Kwa-Zulu homeland.

(1325) Inanda 1934 July 14 by C Jackson.
This is a name of a village community inhabited by the Zulus.

(1326) Losaka 1934 July 14 by C Jackson.
Named for the capital of Zambia, Lusaka.

(2066) Palala 1934 June 4 by C Jackson.
Named for a river, a tributary of the Limpopo in the north-western Transvaal.

(1349) Bechuana 1934 June 13 by C Jackson.
Named for the region that became the state of Botswana.

(1324) Knysna 1934 June 15 by C Jackson.
Name for the town.

(1319) Disa 1934 March 19 by C Jackson.
Named for the large genus of African terrestrial Orchids.

(1318) Nerina 1934 March 24 by C Jackson.
Named after a genus of South African bulbous herbs.

(1321) Majuba 1934 May 7 by C Jackson.
Named for the mountain in northwest Natal.

(1753) Mieke 1934 May 10 by H van Gent.
In honour of the wife (Mieke Oort-Graadt van Roggen, 1906-1993) of former director of the Leiden Observatory, Jan Hendrik Oort.

(1320) Impala 1934 May 13 by C Jackson.
Named after the antelope.

(1323) Tugela 1934 May 19 by C Jackson.
Named after the river in Natal.

(1327) Namaqua 1934 September 7.
Named after the coastal region.

(1925) Franklin-Adams 1934 September 9 by H van Gent.
In memory of John Franklin-Adams (1843-1912), the British amateur astronomer who donated the photographic refractor that was used for the observations of minor planets.

(1337) Gerarda 1934 September 9 by H van Gent.
Named in honour of Mrs G Prins, wife of Mr Prins who was a computor at the Leiden Observatory.

(1383) Limburgia 1934 September 9 by H van Gent.
Named for the province of Limburg in southern Netherlands.

(1384) Kniertje 1934 September 9 by H van Gent.
Named after the principal character in the Dutch play Op Hoop van Zegen by Hermanus Heyermans.

(1336) Zeelandia 1934 September 9 by H van Gent. Named for a province in Netherlands.
(1670) Minnaert 1934 September 9 by H van Gent. In honour of Prof Marcel G J Minnaert (1893-1970) who was director of the Utrecht Observatory from 1937 to 1963.
(1694) Kaiser 1934 September 29 by H van Gent. In honour of Prof Frederick Kaiser (1808-1872) who was director of Leiden Observatory from 1837 to 1872.
(1948) Kampala 1935 April 3 by C Jackson. Named for the capital of Uganda.
(1354) Botha 1935 April 3 by C Jackson. Named for Louis Botha (1862-1919) first prime minister of the Union of South Africa.
(1368) Numidia 1935 April 30 by C Jackson. Named for the ancient country in north Africa, east of Mauretania, in modern Algeria.
(1355) Magoeba 1935 April 30 by C Jackson. The name of a chief of the Northern Transvaal.
(1634) Ndola 1935 August 19 by C Jackson. Named for the mining town in Zambia
(1474) Beira 1935 August 20 by C Jackson. Name of the port in Mozambique.
(1342) Brabantia 1935 February 13 by H van Gent. Named for a part of Brabant, which is a province of the Netherlands.
(2378) Pannekoek 1935 February 13 by H van Gent. In memory of A Pannekoek (1873-1960), Dutch astronomer.
(1353) Maartje 1935 February 13 by H van Gent. Named in honour of the daughter of B G Mekking who was a computor at the Leiden Observatory.
(1357) Khama 1935 July 2 by C Jackson. Name of the late chief of the Bechuana tribe and a distinguished leader.
(1358) Gaika 1935 July 21 by C Jackson. Name of a chief of the Transkei.
(1359) Prieska 1935 July 22 by C Jackson. Name of a town in the Cape Province.
(1360) Tarka 1935 July 22 by C Jackson. Name of a chief whose name is given to Tarkastad.
(1641) Tana 1935 July 25 by C Jackson. Named for a river in Kenya
(2865) Laurel 1935 July 31 by C Jackson. Named for Stan Laurel (1890-1965), American comedian (born Arthur Stanley Jefferson in Ulverson, England).
(1362) Griqua 1935 July 31 by C Jackson. Named for the tribe of people from Griqualand.
(1784) Benguella 1935 June 30 by C. Jackson. Named for the chief port of Angola.
(1356) Nyanza 1935 May 3 by C. Jackson. Named for a region in south western Kenya with the capital Kisumu.
(1639) Ruanda 1935 May 3 by C. Jackson. Named for the state of Ruanda-Urundi.
(1693) Hertzsprung 1936 August 16 by G.N. Neujmin. Named in honour of the late Prof. E. Hertzsprung (1873-1967), Director of the Leiden Observatory from 1934 till 1945.
(1385) Gelria 1935 May 24 by H. Van Gent. Named for the province Gelderland in the eastern Netherlands bordering on the Ijsselmeer.
Gelre is an old name of Gelderland.
(1712) Angola 1935 May 28 by C. Jackson. Named for the state on the south western coast of Africa.
(1879) Broederstroom 1935 October 16 by H. Van Gent. Named for the village near which the Leiden Southern Observatory was located 1957 to 1982.
(1686) De Sitter 1935 Sept 28 by H. Van Gent. Named in honour of the late Prof. Willem de Sitter (1872-1934), director of the Leiden Observatory from 1918 till 1934.
(2801) Huygens 1935 Sept 28 by H. Van Gent. Named in memory of Christian Huygens (1629-1695), Dutch physicist and astronomer, well known for his wave theory

of light and as the discoverer of Saturn's satellite Titan.

(4511) Rembrandt 1935 Sept 28 by H. Van Gent. Named after Rembrandt Harmensz van Rijn, Dutch painter.

(1986) Plaut 1935 Sept 28 by H. Van Gent. Named in honour of Lukas Plaut (1910-1984), Dutch astronomer, worked at the Leiden Observatory 1933 to 1940, and Kapteyn Laboratory in Groningen 1940 to 1975. Well known for his investigations of RR. Lyrae variables near the Galactic Centre.

(1389) Onnie 1935 Sept 28 by H. Van Gent. Named in honour of Mrs A. Kruyt, sister-in-law of G. Pels.

(2945) Zanstra 1935 Sept 28 by H. Van Gent. Named in memory of H. Zanstra (1894-1972), Dutch astronomer, director of the Astronomical Institute of the Municipal University in Amsterdam 1946 to 1959. Well know for his method of obtaining the surface temperatures of the central stars of planetary nebulae.

(4296) van Woerkom 1935 Sept 28 by H. Van Gent. Named in honour of Adrianus Jan J. Van Woerkom (1915-1991), Dutch-born astronomer, who worked in Leiden on the distribution of comet orbits and at Yale Observatory on problems of celestial mechanics.

(2203) van Rhijn 1935 Sept 28 by H. Van Gent. Named in memory of Pieter J. Van Rhijn (1886-1960), Dutch astronomer, former director of the Kapteyn Astronomical Laboratory at Groningen. His main activity was the investigation of the Galactic structure.

(2019) van Albada 1935 Sept 28 by H. Van Gent. Named in memory of G.B. van Albada (1911-1972), Dutch astronomer, director of the Basscha Observatory in Lembang 1948-1958, and the Astronomical Institute of the Municipal University of Amsterdam from 1959 until his death.

(4359) Berlage 1935 Sept 28 by H. Van Gent. Named in honour of H.P. Berlage (1896-1968), Dutch meteorologist and astronomer. His main astronomical activities were investigations about the origin of the solar system.

(1396) Outeniqua 1936 August 9 by C. Jackson. Name of a range of mountains in south western Cape Province and also home of a now extinct race of Hottentots.

(1397) Umtata 1936 August 9 by C. Jackson. Name of the capital town of the native province of the Transkei and seat of the native administration.

(1816) Liberia 1936 January 29 by C. Jackson. Named for the state on the western coast of Africa.

(1949) Messina 1936 July 8 by C. Jackson. Named for a copper-mining town on the border between South Africa and Zimbabwe-Rhodesia.

7102 (Unnamed) 1936 July 12 by C Jackson.

(1394) Algoa 1936 June 12 by C. Jackson. Name of a South African Bay which has historical associations.

(1490) Limpopo 1936 June 14 by C. Jackson. Name of the large river which flows round the northern edge of the Transvaal and through Mozambique.

(1393) Sofala 1936 May 25 by C. Jackson. Name of the largest province of the former Portuguese African Territory of Mozambique.

(1432) Ethiopia 1937 August 1 by C. Jackson. Ancient name of Abyssinia; still called the empire of Ethiopia.

(1456) Saldanha 1937 July 2 by C. Jackson. Named for the newly developed harbour on the southwest tip of South Africa.

(1429) Pemba 1937 July 2 by C. Jackson. A large island off the East Coast of Africa which was under the rule of the Sultan of Zanzibar.

(1428) Mombasa 1937 July 5 by C. Jackson.

Name of the chief port in Kenya, East Africa, which has also ancient historical associations.

(1430) Somalia 1937 July 5 by C. Jackson. Named for the state in the northeast of Africa.

(5452) (Unnamed) 1937 NN 1937 July 5 by C. Jackson.

(1431) Luanda 1937 July 29 by C. Jackson. Named for the capital city of Angola.

(1427) Ruvuma 1937 May 16 by C. Jackson. Name of the most important river in Tanzania.

(3768) 1937 RB 1937 Sept 5 by C. Jackson.

(1468) Zomba 1938 July 23 by C. Jackson. Name of an important town in Nyassaland.

(1467) Mashona 1938 July 30 by C. Jackson. Name of a large race of native people who inhabit Zimbabwe.

(2825) Crosby 1938 Sept 19 by C. Jackson. Named for Harry Lillis ('Bing') Crosby (1903-1977), American singer and film actor.

(1505) Koranna 1939 April 21 by C. Jackson. Name of a tribe of wandering bushmen who inhabit the southern part of the Kalahari Desert in southern Africa.

(1676) Kariba 1939 June 15 by C. Jackson. Named for a large manmade lake between Zambia and Zimbabwe.

(1817) Katanga 1939 June 20 by C. Jackson. Named for the chief mining area of the Congo, today named Zaire.

(1506) Xosa 1939 May 15 by C. Jackson. Name of a tribe of native peoples of the Cape Province who early came into contact with the white people. Today spelt Xhosa.

(1568) Aisleen 1946 August 21 by E.L. Johnson. Named by the discoverer in honour of his wife.

(1585) Union 1947 Sept 7 by E.L. Johnson. Named in honour of the Union Observatory at Johannesburg.

(2829) Bobhope 1948 August 9 by E.L. Johnson. Named in honour of Bob Hope (real name Leslie Townes Hope), American comedian.

(1623) Vivian 1948 August 9 by E.L. Johnson. Named in honour of the daughter of W.P. Hirst, who calculated the preliminary orbit for this and several other planets discovered by Johnson.

(1885) Herero 1948 August 9 by E.L. Johnson. Named for a tribe in the northern highlands of Namibia who fought a disastrous war with the Nama Hottentots in 1930.

(1819) Laputa 1948 August 9 by E.L. Johnson. Named for the floating island in Gulliver's Travels by Jonathan Swift.

(1731) Smuts 1948 August 9 by E.L. Johnson. In honour of Field-marshal Jan Christiaan Smuts (1870-1950), under whom the discoverer fought in both World Wars.

(1618) Dawn 1948 July 5 by E.L. Johnson. Named by the discoverer in honour of his granddaughter.

(5038) Overbeek 1948 KF 1948 May 31 by E.L. Johnson. Named for Danie Overbeek, (1920-2001) amateur astronomer and variable star observer.

(1922) Zulu 1949 April 25 by E.L. Johnson. Named for the well-known South African tribe, to recognize some of the tribesmen who were faithful workmen at the Johannesburg Observatory.

(3184) Raab 1949 August 22 by E.L. Johnson. Named in honour of Herbert Raab (1969-), author of the widely-used and acclaimed Astrometrica software package, which has enabled many amateur astronomers to participate in their own astrometric programs on comets and minor planets. Raab is a software developer and is also president of the Linzer Astronomische Gemeinschaft, the oldest amateur association in Austria.

(2651) Karen 1949 August 28 by E.L. Johnson. Named by F.N. Bowman, who found the key identification involving this planet, in honour of Karen S. Mayer, his sister-in-law, and also Karen S. Franz, a fellow physics major at the University of Cincinnati.

(1760) Sandra 1950 April 10 by E.L. Johnson.

Named by the discoverer in honour of his granddaughter.

(2546) Libitina 1950 March 23 by E.L. Johnson.
Named for an ancient Roman divinity who presided over the burial of the dead.

(1580) Betulia 1950 May 22 by E.L. Johnson.
This planet has been named at the request of Dr S.J. Herrick in honour of his wife.

(1607) Mavis 1950 Sept 3 by E.L. Johnson.
Named in honour of the wife of J.A. Bruwer, astronomer at the observatory in Johannesburg.

(1609) Brenda 1951 July 10 by E.L. Johnson.
Named by the discoverer in honour of his granddaughter.

(2718) Handley 1951 July 30 by E.L. Johnson.
Named for Tommy Handley (1894-1949), one of Britain's greatest entertainers of the Second World War.

(1660) Wood 1953 April 7 by J.A. Bruwer.
Named in honour of H.E. Wood (1881-1946), second Director of the Republic (then Union) Observatory (1928-1941). He had the prime responsibility for the Franklin-Adams camera since its acquisition in 1909 and inaugurated the Observatory's program for observing minor planets.

(1701) Okavango 1953 July 6 by J. Churms.
Named for a large river in southern Africa. It flows into a swamp of the same name in Botswana.

(3284) Niebuhr 1953 July 13 by J.A Bruwer.
Named in memory of Carsten Niebuhr (1733-1815), astronomer-surveyor, the sole survivor of the ill-fated Danish expedition to Arabia Felix (Yemen) in 1760-67. During an adventurous return voyage via India, and at great personal sacrifice, he carefully copied the inscriptions at the ruins of Persepolis. This served as the basis for the subsequent decoding of the cuneiform script and thus our access to source documents of early astronomical observations in that geographical area.

(1658) Innes 1953 July 13 by J.A Bruwer.
Named in honour of R.T.A. Innes (1861-1933), first Director of the Republic Observatory (originally Transvaal Observa-tory, later Union Observatory), from 1903 to 1927. Well-known for his observations of double stars, his deliberate search for Proxima Centauri, and he also made important theoretical and computational contributions to celestial mechanics, including the first convincing demonstration of the irregular rotation of the Earth.

(2025) Nortia 1953 June 6 by J. Churms.
Nortia was the Etruscan goddess of fortune who was worshipped at Volsinii. Each year a nail was driven into the wall of her temple, for the purpose of counting the years.

(1794) Finsen 1970 April 7 by J.A Bruwer.
Named in honour of W.S. Finsen (1905-1979), Director of the Republic Observatory from 1957 to 1965. He has contributed immensely to the discovery and observation of double stars both micrometrically and by means of the eyepiece interferometer he invented.

Appendix 8 Other staff employed at the Observatory

The following list of staff employed at the Observatory but not detailed in the main text was compiled from the annual reports[75] and other sources[49, 23] It is presented for what it is worth without claiming to be complete:

Armstrong BMF appointed as Assistant Technical Officer in 1968 and resigned in 1969.

Churms Joseph (fig 92) left the Cape Observatory to join the staff of the Union Observatory in January 1952. He resigned in December 1957 to move to the Cape Town Observatory. As well as being a qualified astronomer he was also a professional violinist.

De Klerk ca 1969/70 double star observer (Greg Roberts)

De Villiers Chris D, BSc (Eng) was appointed as Assistant Research Officer in July 1965 to work in the time department. He resigned in May 1970.

Jan Ho technician ca late 1960s.

Knipe George Frederick Graham had a degree in chemistry but as an enthusiastic amateur astronomer he joined the Union Observatory in May 1958 and remained on the staff until his death in December 1973. He used the 20-inch Boller and Chivens reflector extensively for photoelectric photometry until it was moved to Sutherland. He was married but had no children.

Lake Ron ca 1970.

Lategan OP appointed as assistant Professional Officer on 2 May 1960 – single.

Newburg John appointed as Senior Research Officer to work on double stars in June 1965 resigned in September 1970 - married.

Powell FE joined as an Assistant Professional Officer in January 1963 to work in the time department and resigned in May 1965 - single.

Roberts Gregory (always known as Greg) (see section 9.2) appointed as Technical Officer in 1969. He was an ardent amateur radio enthusiast and built equipment for the observatory staff to receive their own satellite weather pictures. He photographed Mars using the 26½ inch telescope as part of the 'Mars Patrol' organised by the Lowell Observatory in Arizona in 1973. He was transferred to the SAAO in Sutherland - married.

Roux Nikki administration assistant.

Seligman Peter C was employed during the 1950s working with Jan Hers in the time standardisation section. He lived in the van den Bos asbestos prefab after Sylvia Bosman retired in 1949.He resigned in April 1959 – married with one son.

Shultze worked in the administration section.

Smuts Danie J appointed as Assistant Professional Officer on 1 May 1959. He worked in the time department and was married

Smith GH appointed as Assistant Research Officer in January 1969 and resigned in January 1970.

Straka Dr J appointed as Senior Research Officer in June 1970. He was a theoretician (celestial mechanics) and was born in Czechoslovakia. According to G Roberts he was a political refugee from East Germany where he had been working for Zeiss.

Van der Spuy KR joined the staff in about 1910. In 1912 he applied for admission to the Kimberley pilot training school and was accepted in 1914. He distinguished himself flying in Europe and Russia during WWI and on his return established the South African Airforce under the command of General Sir Pierre van Reyneveld. During WWII he rose the rank of Major General and became Director General of Technical Services.

Webster George W was appointed as Assistant Physicist in December 1949 to work in the time department and built the ZUO transmitter – single.

Wisse Mrs Marijke appointed as Assistant Research Officer in1970 - Nov 1971.

Wisse Peter NJ appointed as Research Officer in January 1970 – Nov 1971. The Wisses worked mainly on photometric measurements of long-period stars.

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