On Her Majesty's Service

PERME Recruitment Brochures. 1 Folder of PERME with colour photo of Sea Wolf Rocket and Sea Skua rocket and details of staff grade salaries 2 Introductio to PERME and the RME. Typescript. 3 PERME opportunities for Scientists and Engineers. 2 copies 1 referenced for photos. 4 Potential Vacancies for Scientists and engineers at PERME 1979 — WAI 485

B/W Photographs taken by C Ellis used in recruitment campaign (* used in brochure 3) — WAI 413

Code No. 27-33

Procurement Executive
Ministry of Defence

PERME

Propellants Explosives & Rocket Motor Establishment

Westcott & Waltham Abbey

Introduction

Following the unification, in 1973, of the Explosives Research and Development Establishment (ERDE) Waltham Abbey and the Rocket Propulsion Establishment (RPE) Westcott, the combined Establishment was renamed in February 1977, the Propellants, Explosives and Rocket Motor Establishment (PERME).

PERME undertakes research, exploratory development, project development and support, and in some cases production in the fields of rocket motors, rocket and gun propellants, gas generators, power cartridges and explosives for UK Defence purposes and Civil applications.

The Director of PERME is also Head of the Rocket Motor Executive (RME)* which co-ordinates all the United Kingdom resources in the field of rocket propulsion, and has overall responsibility for the development, production and commercial exploitation of rocket motors and rocket propellants.

*Rocket Motor Executive is located at Westcott.

Westcott

The work is concerned mainly with:
Solid Propellant Rocket Motors
Liquid Propellant Rocket Motors
Gas Generators & Power Cartridges

For this purpose the following expertise and technical facilities are maintained:

1. RESEARCH TEAMS studying

- ☐ the application of solid propellants to rocket motors
- ☐ the application of liquid propellants to rocket motors,
- ☐ materials of high specific strength and high temperature resistance,
- ☐ combustion phenomena,
- ☐ the rocket exhaust plume,
- ☐ instrumentation and non-destructive testing techniques,
- ☐ ignition phenomena,
- ☐ stress analysis and failure criteria, and
- ☐ environmental effects on rocket motors.

2. TECHNICAL FACILITIES to conduct

- ☐ static firing of rocket motors, including firing in vacuum or underwater conditions,
- ☐ vibration, centrifuge and drop tests on rocket motors,
- ☐ filling of solid propellant motors,
- ☐ filling of liquid propellant motors, and
- ☐ non-destructive testing.

3. ENGINEERING FACILITIES to provide

- ☐ conventional machining and grinding operations,
- ☐ welding and brazing,
- ☐ carpentry,
- ☐ ultrasonic and spark machining, and
- ☐ computer operated machining.

4. COMPUTING FACILITIES to provide

- ☐ support to scientific research,
- ☐ computer aided design and stress analysis, and
- ☐ accounting and resource control.

Waltham Abbey

Waltham Abbey is concerned mainly with:
Propellant Compositions for Rocket Motors,
Gas Generators, Power Cartridges & Guns
Explosive Compositions for Ordnance
Ingredients for Explosives & Propellants
Materials Development & Processing

For this purpose the following expertise and technical facilities are maintained:

1. RESEARCH TEAMS studying

- ☐ propellant development,
- ☐ primary explosives and some high explosive compositions,
- ☐ synthesis of propellant ingredients, and production,
- ☐ combustion and hazard assessment,
- ☐ rheological and ballistic properties of propellants,
- ☐ adhesives, plastics and rubbers, composites, synthesis of unusual polymers,
- ☐ environmental behaviour and compatibility of propellants and explosives with materials, and
- ☐ advanced analytical techniques.

2. TECHNICAL FACILITIES to conduct

- ☐ limited production of solid propellants,
- ☐ filling and firing of solid propellant motors,
- ☐ pilot scale production of ingredients of propellants and explosives, and specialised materials,
- ☐ performance and safety tests on explosives and propellants,
- ☐ sophisticated analyses by chromatographic, spectroscopic and crystallographic techniques.

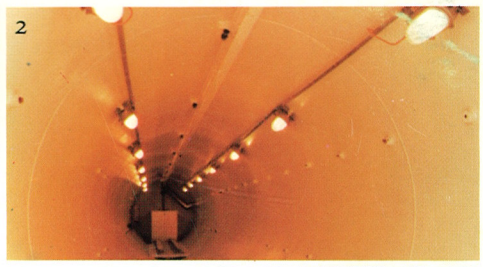
3. ENGINEERING FACILITIES to provide

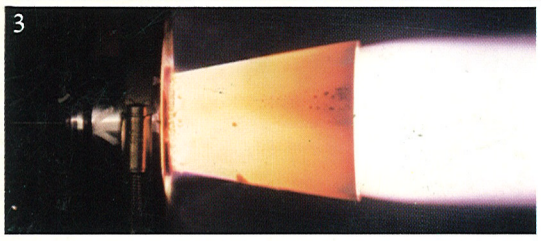
- ☐ conventional machining and grinding operations,
- ☐ welding and brazing,
- ☐ carpentry,
- ☐ model making, and
- ☐ pilot scale production equipment.

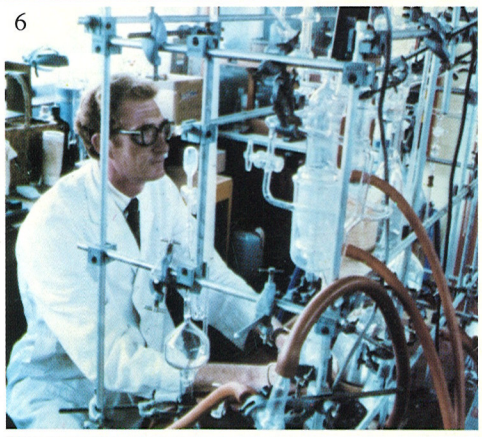
ience Group

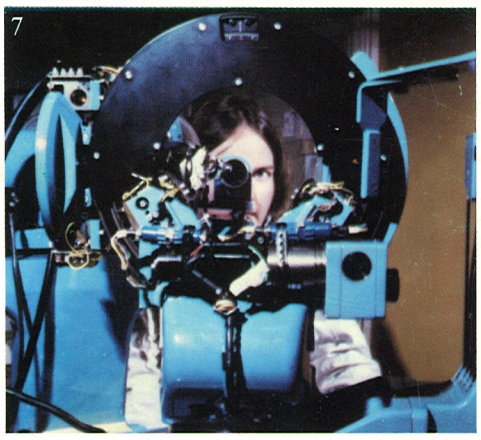
Civil Service is responsible for initiating, directing
part of the scientific research and testing in
h establishments and laboratories. It is
from Assistant Scientific Officer with
hief Scientific Officer. Grades above this,
held by Directors of the large R & D
ithin the 'Open Structure' of the
der Secretary level and above.
uited into the Scientific
r and Senior Scientific

Seawolf









1. rocket firing to measure characteristics of exhaust plume 2. vacuum chamber used for rocket motor firings 3. firing of carbon-carbon composite expansion cone 4. Blowpipe, rocket motors developed at PERME 5. Sea Skua, boost motor developed at PERME 6. solid propellant gas analysis techniques 7. studies of the crystal structure of explosives.

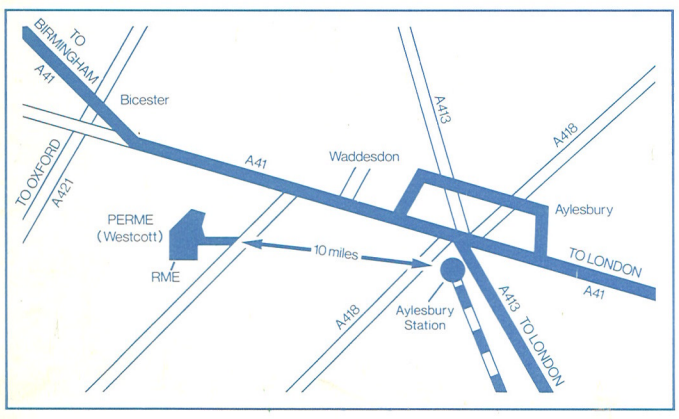
How to contact PERME Westcott

Postal Address

Procurement Executive, Ministry of Defence,
Propellants, Explosives and Rocket Motor Establishment,
Westcott, Aylesbury, Buckinghamshire HP18 0NZ
United Kingdom
Telephone: Aylesbury (STD 0296) 5989 Telex: 83144

Travel

Road: Map showing the location of Westcott.
For road travellers Westcott is on the A41, mid-way between Aylesbury and Bicester.
Rail: There is a regular train service from London to Aylesbury. The journey from Marylebone Station to Aylesbury Station takes 60 minutes.
If requested in advance, cars can be arranged to meet visitors and transport them to Westcott.



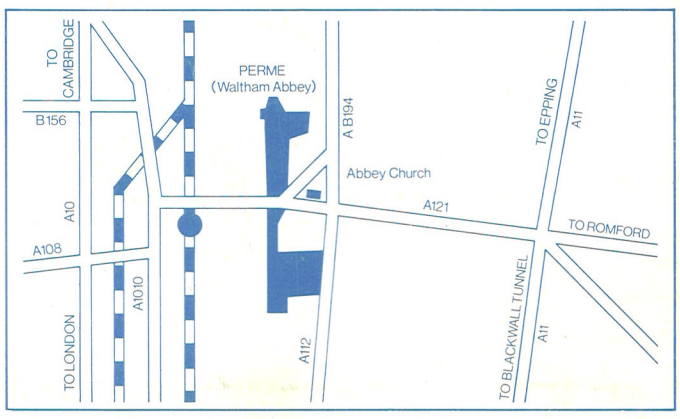
How to contact PERME Waltham Abbey

Postal Address

Procurement Executive, Ministry of Defence,
Propellants, Explosives and Rocket Motor Establishment,
Waltham Abbey, Essex EN9 1BP United Kingdom
Telephone: Lea Valley (STD 0992) 713030 Telex: 267455

Travel

Road: Map showing the location of Waltham Abbey.
For road travellers Waltham Abbey is 16 miles NE of London.
Rail: There is a frequent train service from London (Victoria Line) on the Underground to Blackhorse Road Station.
The journey from Charing Cross to Blackhorse Road, changing at Warren Street, takes about 40 minutes.
If requested in advance, cars can be arranged to meet visitors and transport them to Waltham Abbey.



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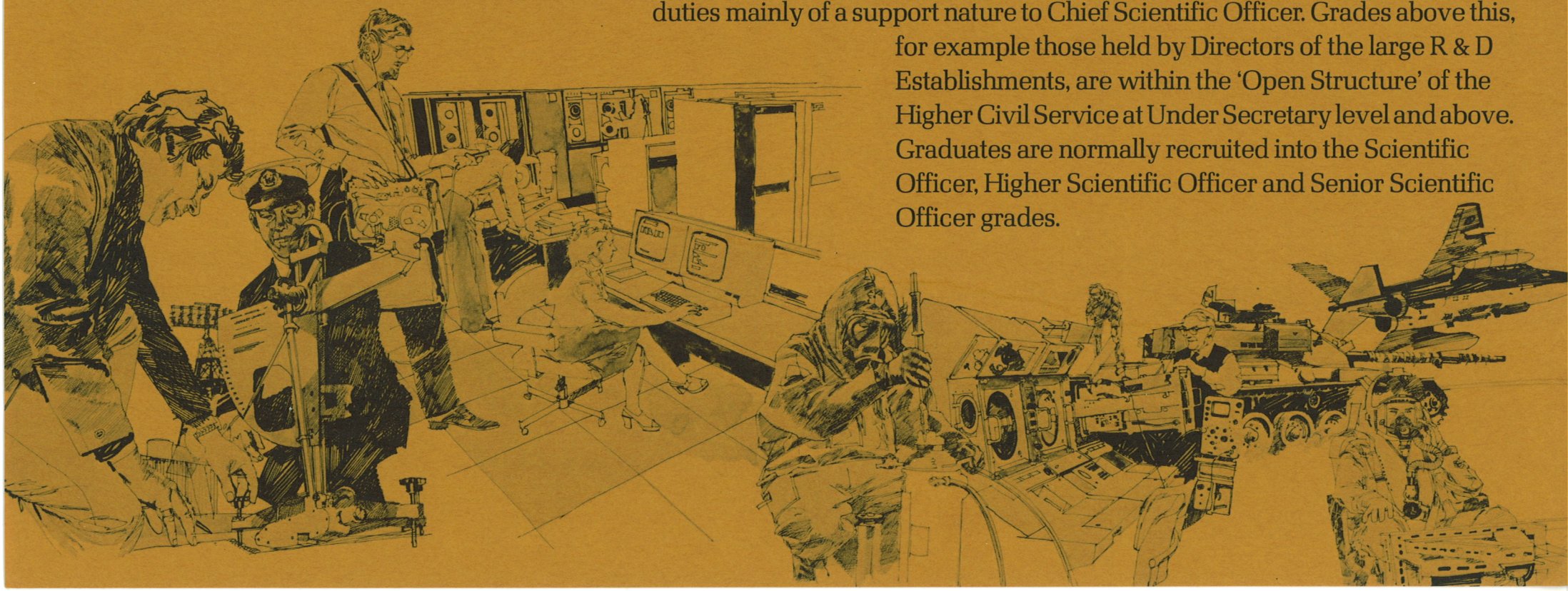
The Science Group

The Science Group of the Civil Service is responsible for initiating, directing and carrying out the greater part of the scientific research and testing in numerous Government research establishments and laboratories. It is composed of eight grades ranging from Assistant Scientific Officer with duties mainly of a support nature to Chief Scientific Officer. Grades above this, for example those held by Directors of the large R & D Establishments, are within the 'Open Structure' of the Higher Civil Service at Under Secretary level and above. Graduates are normally recruited into the Scientific Officer, Higher Scientific Officer and Senior Scientific Officer grades.



Other Opportunities

SCIENTIFIC RESEARCH FELLOWS

There are a small number of vacancies for Principal, Senior and Junior Fellowships.

Candidates for Junior Fellowships should have a 1st or 2nd class honours degree with at least 2 years' postgraduate research experience; for a Senior Fellowship, a minimum of 3 years' experience is required.

Candidates for Principal Fellowships must have had a considerable period of research experience and be generally accepted as leading workers in their field.

These Fellowships are normally of 3 years' duration and Fellows are given considerable freedom to develop the work on their own lines.

Stipends Principal Fellows £5510-£7210
Senior Fellows £4129-£5155
Junior Fellows £2901-£3671

VACATION STUDENTS

Some of the Department's research establishments accept students during the summer vacation. These students work on research projects as part of a team and this experience provides an excellent opportunity to see some of the work undertaken at a particular establishment and the facilities available to scientists employed there.

Payment of a weekly salary is made.

Applications for consideration should be made direct to research establishments not later than the end of January.

MEDICAL OFFICER (RESEARCH) AND PSYCHOLOGISTS

There may also be vacancies for staff in the grades of Medical Officer (Research) and Psychologist at those establishments concerned with human factors research. Basically, these establishments are concerned with research into the effects of the abnormal conditions encountered, for example, in high altitude flight or deep sea diving, on human physiology and psychology and also with research into defence against bacteriological or chemical attack.

Candidates for the basic Psychologist grade should have a 1st or 2nd class honours degree in psychology while candidates for the Medical Officer (Research) grade should be fully registered medical practitioners in the United Kingdom.

Salaries
Basic Psychologist £3113-£4842
(with a special increment of £412 after 2 years' satisfactory service).

Senior Psychologist £5393-£6520
Principal Psychologist £6791-£8729
Senior Principal Psychologist as for SPSO
Medical Officer (Research) £8222-£11041

Within the Civil Service there are also posts at Senior and Principal Medical Officer levels carrying salaries of £11208 and £11652 respectively.

Applications for such posts should be made to the Civil Service Commission, Alencon Link, Basingstoke, Hampshire.

Enquiries relating to all aspects of employment in any of the above grades should be addressed to:

Procurement Executive,
Ministry of Defence,
CMS 1b3 Room 310,
Savoy Hill House, Savoy Hill,
London WC2R 0BX.

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Salaries and Allowances

SCIENTIFIC OFFICER

Entry into this grade is normally limited to those under 27 years of age and the qualification required is a degree, HND, HNC or equivalent, in a scientific, engineering or mathematical subject, but older, recently qualified candidates may also be considered.

Salary
£2839-£4415 by annual increments. Successful candidates may receive a commencing salary above the minimum of the scale if their qualifications and experience warrant it.

Annual Leave
4 weeks rising to 4 weeks and 2 days after 7 years' total service, 5 weeks after 17 years' total service and 6 weeks after 27 years' total service.

SENIOR SCIENTIFIC OFFICER

Candidates for entry into this grade must be at least 25 and normally under 32 years of age with a 1st or 2nd class honours degree, or equivalent, in a scientific subject (including engineering and mathematics) and must have at least 4 years' appropriate postgraduate or other approved experience.

Salary
£5154-£6898 by nine annual increments. Successful candidates would normally enter this grade at the minimum point on the scale but exceptionally, if their experience is considered to be of special value and relevance to the post offered, a higher commencing salary may be authorised.

Annual Leave
As for Higher Scientific Officer.

HIGHER SCIENTIFIC OFFICER

Candidates for entry into this grade must normally be under 30 years of age with qualifications as for Scientific Officer (above) but they must also have undertaken postgraduate research work or had other relevant experience since qualifying. Those candidates with a 1st or 2nd class honours degree or equivalent must have at least 2 years' relevant postgraduate experience and other candidates at least 5 years' appropriate experience after qualifying.

Salary
£4101-£5448 by nine annual increments. Successful candidates may be given a commencing salary above the minimum of the scale if it is considered that their experience is of special value to the Department.

Annual Leave
4 weeks and 2 days rising to 5 weeks after 10 years' total service. 6 weeks after 20 years' total service.

HIGHER GRADES

Although there is occasional recruitment to the higher grades, entry to these is normally by promotion. Current salaries are as follows:

Principal Scientific Officer	£6609-£8461
Senior Principal Scientific Officer	£10043-£11300
Deputy Chief Scientific Officer	£11718-£12492
Chief Scientific Officer	£13047

Beyond this there are a limited number of posts carrying still higher salaries.

London Allowances
Staff working in inner or outer London receive additional allowances of £465 pa and £275 pa respectively.

Career Prospects

Within the Science Group, promotion is by merit. Up to the level of Principal Scientific Officer, promotion is usually gained as a result of annual reviews, in which officers recommended by senior staff at their local Establishments are interviewed by a central panel which assesses their general ability and the quality of their contributions to the work of the Ministry. An outstanding officer, who will almost certainly hold an honours degree qualification, can reach PSO level by age 30 or even earlier, and such officers will undoubtedly rise higher in the science Group.

It should be remembered that management ability is valued just as highly as scientific skill. Many of the scientists in the Ministry of Defence are employed in directing research; monitoring the progress of contracts placed externally; managing projects at the development stage; or acting as an interface between the military 'user' and the R&D Establishment. For officers whose careers develop in this way promotion above the level of Principal Scientific Officer is by competition for specific posts.

It is recognised, however, that not all scientists are interested in management activities, or have management talents. There are opportunities for these staff to pursue scientific work 'at the bench' for the whole of a career, whilst outstanding scientists in this category may reach the higher grades above Principal Scientific Officer solely on the grounds of their scientific ability through an Individual Merit promotion scheme. An officer promoted under this scheme is free of major managerial responsibilities and so is able to pursue his particular topic without other commitments.

It is considered important that the careers of staff in the Science Group are studied and managed by people who are themselves fully aware of the problems encountered by a scientist during his career. Accordingly the appropriate Personnel Division in London HQ numbers several scientists among its staff, including the Director.

1308/2.

INTRODUCTION TO PERME AND THE RME

The Propellants, Explosives and Rocket Motor Establishment, PERME, comprises two main units approximately 52 miles apart, and a smaller unit at Woolwich. One unit is located at Waltham Abbey, Essex, 16 miles north-east of London and the other at Westcott, Aylesbury, Buckinghamshire, 50 miles north-west of London. The Waltham Abbey unit is divided into two sites, the North Site occupying an area of 253 acres and the South Site, occupying an area of 212 acres. As a result of a rationalisation programme within the Ministry of Defence, the North Site is being closed and its staff and facilities transferred to the South Site. The Westcott site occupies an area of 623 acres. Approximately 700 staff are employed at each main unit. The Rocket Motor Executive, RME, with some 25 staff is also located at Westcott.

THE ROLE OF PERME AND THE RME

PERME is one of 13 research and development establishments in the Procurement Executive, Ministry of Defence and, as shown in the Top Management Structure Chart, is responsible through the Deputy Controller, R&D Establishments and Research, Sector B to the Controller, R&D Establishments and Research, Mr W J Charnley.

The Director of PERME is also Head of the Rocket Motor Executive.

PERME is responsible for a programme of research, exploratory development, project development, and in some areas production, in the fields of

a) rocket propulsion, covering rocket motors, rocket propellants, power cartridges and gas generation systems for auxiliary power units;

b) gun and small arms propellants, and

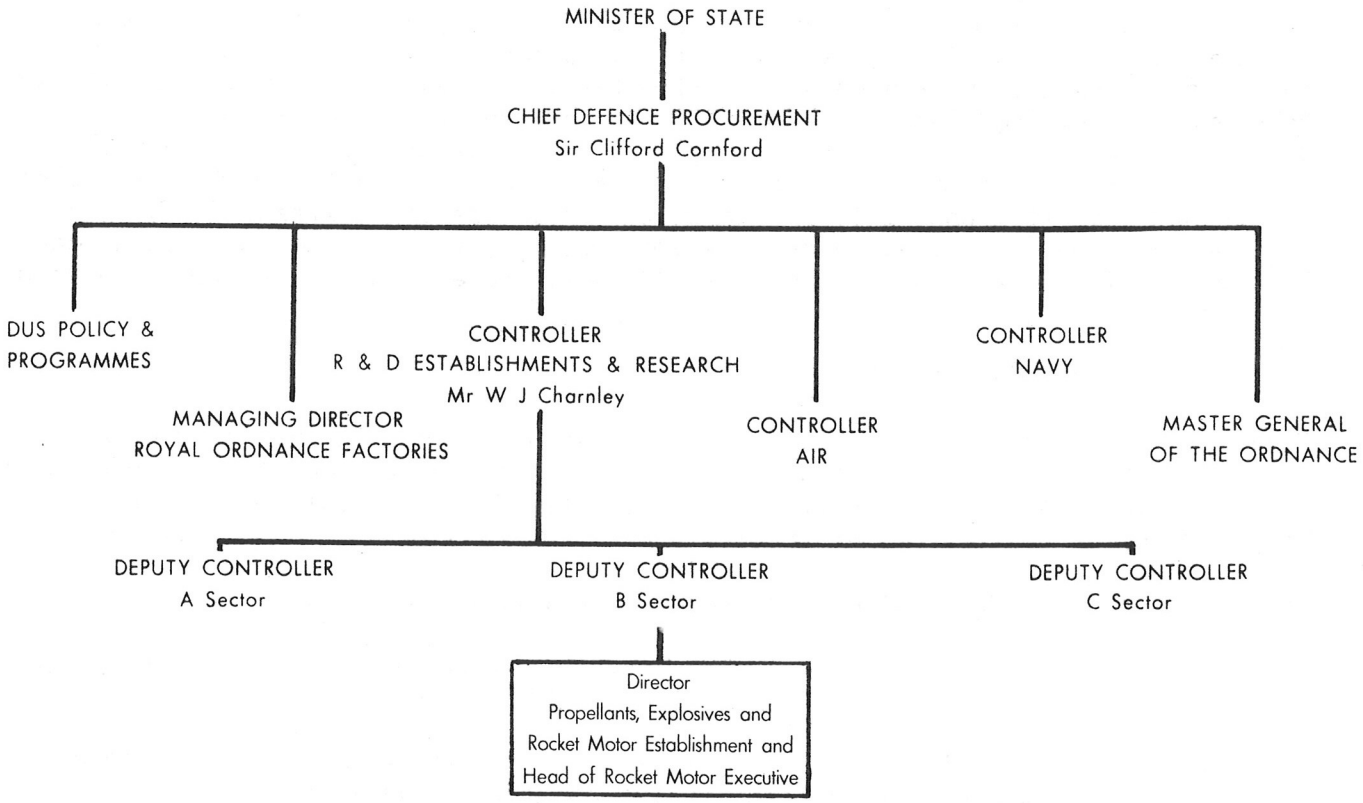
c) initiatory explosives.

The programme provides the technical support to the weapon design authorities of the Land, Sea and Air Controllerates of the Procurement Executive for weapons in service, under development and required in the future. PERME's work on rocket propulsion is supported mainly by Bristol Aerojet Limited which undertakes research, design, development and production of rocket motor bodies, nozzles and other components, and by Royal Ordnance Factories which carry out propellant manufacture and filling, igniter filling and the production of rocket motor hardware. In the rocket propulsion field, only one other organisation, IMI Summerfield, IMIS, (a Government Agency factory which is managed by Imperial Metal Industries Limited on behalf of the Procurement Executive) undertakes overall design, development and testing of rocket motors. IMI Summerfield undertakes research, and develops and manufactures solid propellant rocket motors using the cast double base propellant system.

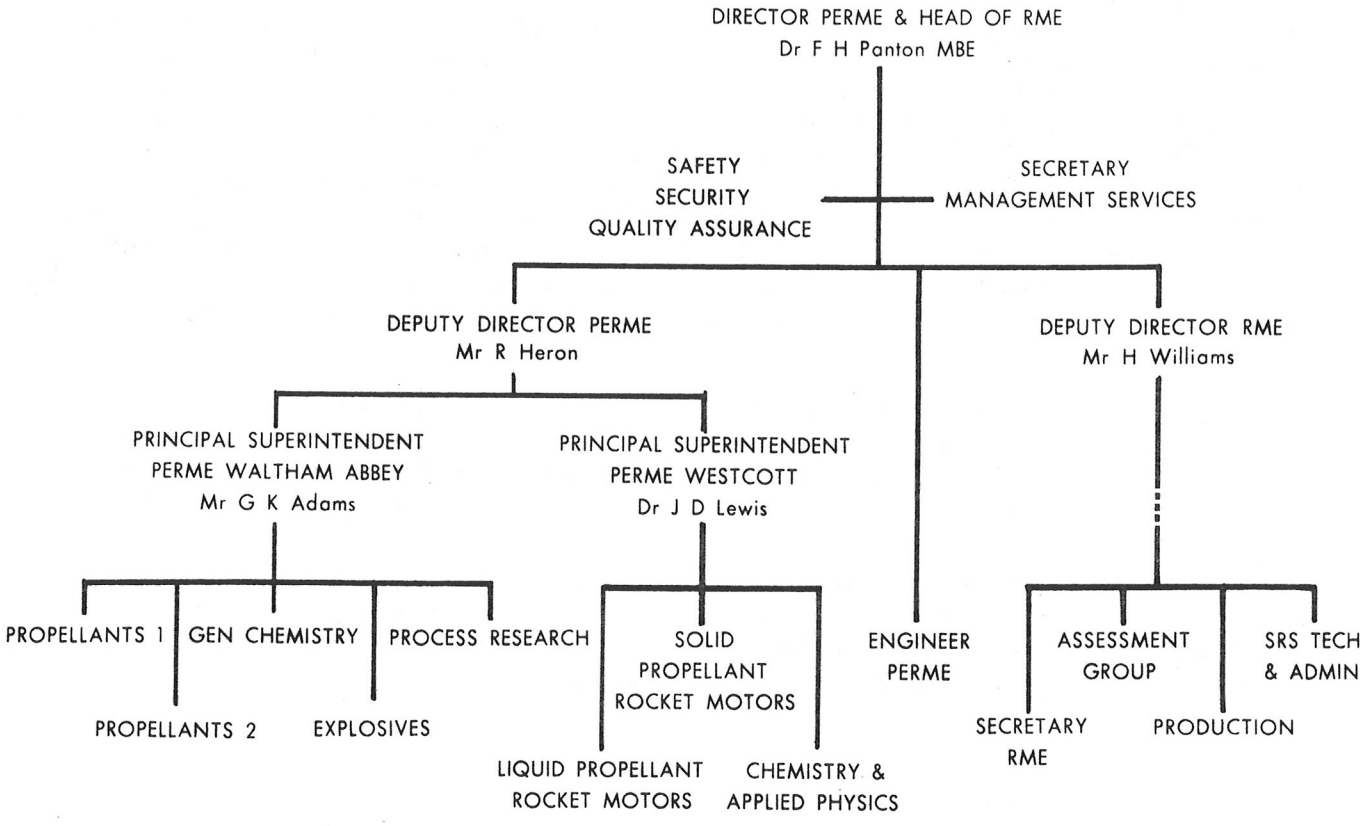
PERME and IMIS with their supporting resources embrace the entire rocket motor design, development and production capabilities in the United Kingdom. No independent industrial capabilities exist outside the Procurement Executive, Ministry of Defence.

The Rocket Motor Executive was specially set up to co-ordinate and exploit commercially the UK rocket motor capabilities. Accordingly it is able to negotiate and accept contracts for the design, development and production of rocket motors for defence and civil applications.

TOP MANAGEMENT - MINISTRY OF DEFENCE



PERME/RME MANAGEMENT STRUCTURE



HISTORY OF THE WESTCOTT ESTABLISHMENT

At the end of World War II British interest in rocket technology was stimulated by the awareness of German advances in this field, and the Ministry of Supply set up, in 1946, the Guided Projectile Establishment, to be responsible for research and development in ground-launched guided missiles. The site, at Westcott, was a disused RAF base. Many of the original buildings were utilized after extensive conversion to provide, for instance, workshops, specialised facilities, and test sites for firing motors. Large test sites permitting static testing of complete missiles were also constructed. Following German practice, early research was concentrated on liquid bi-propellant engines, with sections on fuel supply, combustion chamber design, instrumentation, etc.

In 1947 the Establishment became the Rocket Propulsion Department of the Royal Aircraft Establishment. Its terms of reference were narrowed to include only the propulsion aspects of rockets, work on all other aspects being transferred to the Guided Weapons Department of the RAE.

In 1949 work was started on solid propellant motors. To satisfy the need, created by the use of new plastic propellants, for new motor filling techniques an experimental filling factory was instigated in 1950 and completed in 1952. A significant contribution to Britain's Upper Atmosphere Research Programme was the development of the Raven motor containing one ton of plastic propellant and was used in the Skylark Upper Atmosphere Research Vehicle, which reached altitudes of over 100 miles.

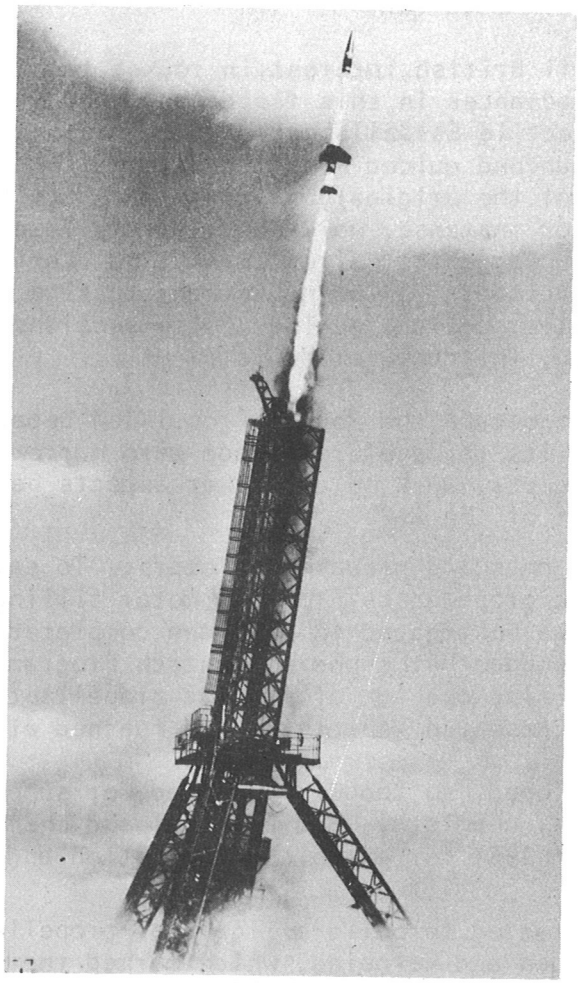
As motor technology developed, so too did the need for supporting research, particularly in materials, chemistry, and physical and chemical studies of combustion processes. In 1951 for example a Combustion and Materials Division was formed.

In 1955 Rolls Royce contracted to build a liquid bi-propellant engine, designated RZ1 and using liquid oxygen and kerosine, which formed the propulsion unit of Blue Streak. Testing of the engine required facilities capable of handling thrusts greater than any yet encountered at Westcott, as well as new measuring and recording equipment. With this objective the P2 Site was prepared and tests were started in 1958. By 1960 some 500 firings had been made.

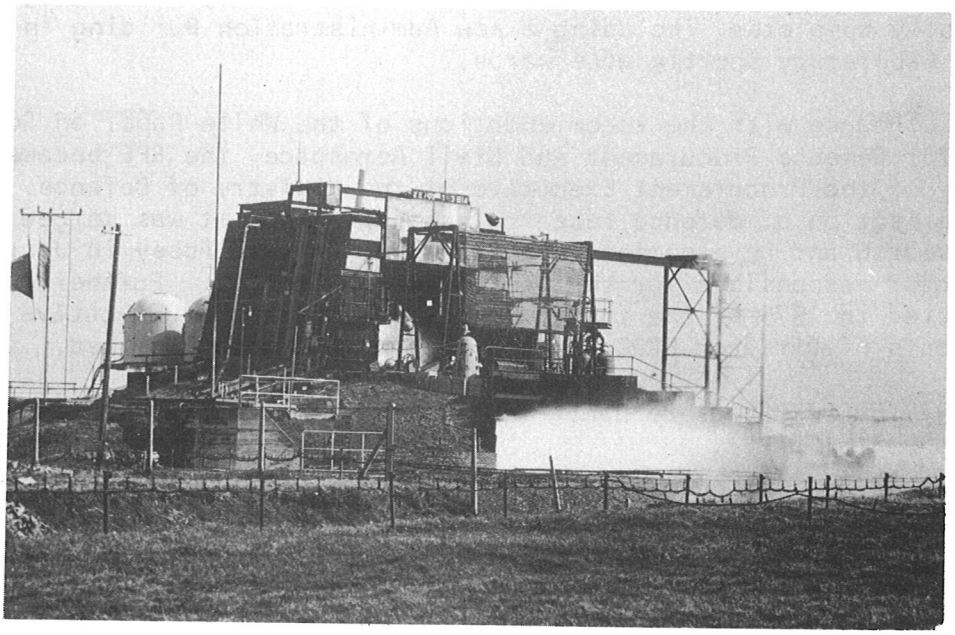
The link with RAE was severed in August 1958 and the name of the Establishment changed to the Rocket Propulsion Establishment. Several major building projects were subsequently completed, including a new Administration Building in 1968 and a new Materials Laboratory shortly afterwards.

In 1971, in accordance with the recommendations of the White Paper on Government Organisation for Defence Procurement and Civil Aerospace, the RPE became the responsibility of the Procurement Executive of the Ministry of Defence. As part of the rationalisation of defence research establishments it was merged with the Explosives Research and Development Establishment, Waltham Abbey in January 1973, with one Director responsible for the unified Establishment. Further rationalisation was effected in 1975 by the transfer of the Rocket Motor Executive to Westcott. In 1976 the posts of Director ERDE/RPE and Head of RME were combined.

In February 1977 ERDE/RPE was re-named the Propellants, Explosives and Rocket Motor Establishment (PERME).



SKYLARK BEING TESTED AT WOOMERA
IN EARLY 1960's



DEVELOPMENT TEST FIRINGS FOR THE BLUE STREAK
BEING CARRIED OUT AT P2 SITE CIRCA 1963

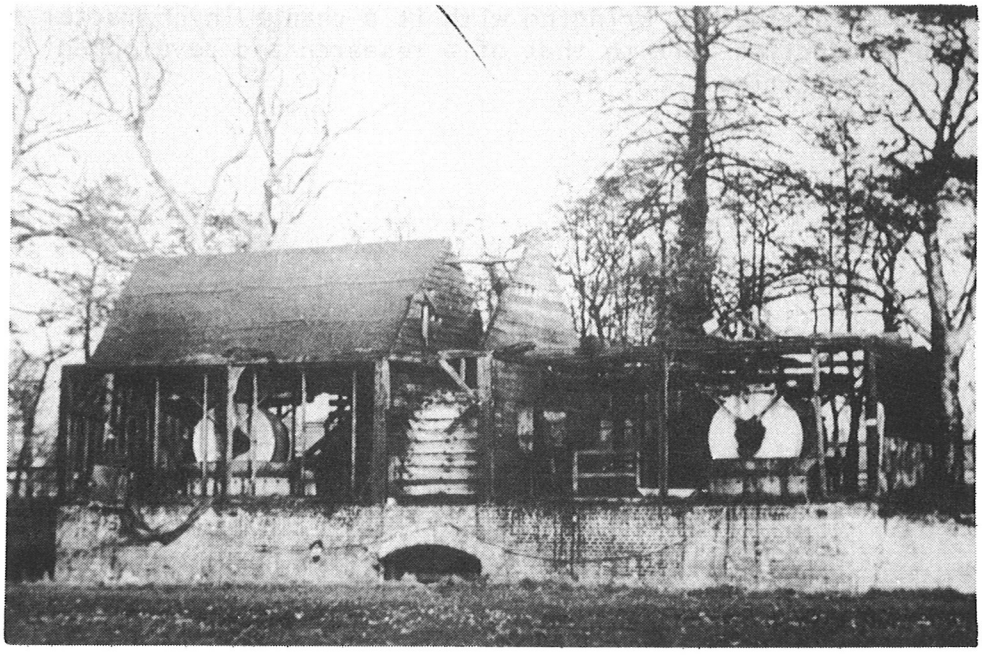
HISTORY OF THE WALTHAM ABBEY ESTABLISHMENT

The Establishment occupies a site originally used for the manufacture of gunpowder but the early days of the factory are largely a matter of conjecture and legend. The first positive link between Waltham Abbey and gunpowder is contained in the State Papers of 1561 in the form of a letter to John Tamworth of Waltham Abbey concerning a contract for the supply of saltpetre and sulphur. The importance of the local manufacture was emphasized a century later by the local minister of religion, Dr Thomas Fuller, who wrote that there was more gunpowder made by the mills in his parish 'than in all England besides'. Unfortunately powder-making was a hazardous occupation and the Parish Registers for 1665 record the burials of two workmen killed by a mill explosion. The mills at this time were horse-driven but they were converted to water power by the Walton family in whose hands they remained for more than a hundred years until they were bought by the Government in 1787 from John Walton. The man who played the greatest part in this acquisition was Lieutenant General Sir William Congreve, who disputed the widely-held belief that the private manufacturers made better and cheaper gunpowder than the Government. Later Congreve demonstrated convincingly the superiority of the powder from the Royal Gunpowder Factory and was still able to show savings of some £50000 a year. Walton's Powder Mills were capable of producing 6000 barrels of gunpowder a year but by the time of the Napoleonic Wars the output was of the order of 25000 barrels. The quality of Waltham Abbey powder was recognized overseas and both sides in the American Civil War drew on the experience and expertise of the Factory. The United States Ordnance Manual for 1862 records that no one makes better powder than the British.

For several hundred years the sole product of the Factory was gunpowder but in the second half of the 19th century the manufacture of other explosives commenced. In 1872 a plant was erected for the production of guncotton but this plant was soon found to be inadequate and the first land on the South Site was acquired in 1885 for a new guncotton factory. A decision of the newly-appointed Explosives Committee, with Sir Frederick Abel as President, resulted in the setting up of further plant in 1891 for the manufacture of nitroglycerine and the first production of cordite. Other explosives produced since the turn of the century include tetryl, TNT and RDX. RDX, or Research Department Explosive, has been described as the high explosive of World War II: it is significant that for the first years of the war the Royal Gunpowder Factory was this country's only source of production, just as it had been earlier for cordite during the first two years of the First World War.

The days of the Royal Gunpowder Factory came to an end in 1945 when the present Establishment came into being, bringing with it a change in character from the role of a major production unit to that of a research and development organization with pilot plant facilities.

LT. GENERAL SIR WILLIAM CONGREVE



THE RUINS OF THE LAST PAIR OF MILLS - 1956

THE WORK OF PERME WESTCOTT

The work at Westcott is concentrated on rocket motors, gas generators and power cartridges and is carried out in three research and development Divisions supported by Administration and Engineering Divisions and by specialist assistants to the Director as at Waltham Abbey.

Solid Propellant Rocket Motors Division

This Division is responsible for all aspects of design and development of solid propellant rocket motors, gas generators and power cartridges, for military and civil applications. These are produced to meet user requirements, including those of Prime Contractors such as British Aerospace and work extends from the period from initial conception through development and production to 'in service' surveillance throughout the life of the rocket motor.

The Division is also responsible for developing motor filling procedures and specifying these to the Royal Ordnance Factory responsible for production filling. Extramural support is provided mainly by Bristol Aerojet Limited and by various Royal Ordnance Factories.

Although the Division is mainly engaged in development work some effort is deployed on research

Liquid Propellant Rocket Motors Division

Undertakes design, development and research on rocket motors utilising packageable liquid propellants, such as inhibited red fuming nitric acid as oxidant, and mixed amine fuels, which can be sealed into tanks, ready for instant use but storable for the whole life of the missile. Packaged liquid propellant motors are used in military applications where control of thrust on command is necessary. This feature demands a high degree of mechanical complexity, requiring components such as control valves, pistons, etc.

The Division is also responsible for the development of special handling procedures necessary for the propellants, for tank filling procedures, and in-service training and surveillance.

Chemistry and Applied Physics Division

This Division, working towards the progressive improvement of overall rocket motor performance, contributes to most aspects of rocket technology; materials and techniques of construction; methods of proving quality and performance; integrity of propellant charges; liquid propellants and their containment; motor functioning and the rocket exhaust plume. In all of these the Division's prime responsibility is to look to the future so the emphasis is on research. Innovation is however frequently carried through to development. Some routine testing and analysis are performed.

THE WORK OF PERME WALTHAM ABBEY

At Waltham Abbey the work is concentrated on the formulation and qualification (in terms of meeting operational, safety and economic requirements) of solid rocket propellants, gun and small arms propellants, initiatory explosives, and certain plastics and rubber components used mostly in association with explosives and propellants. The work is carried out in five scientific branches, supported by Administration and Engineering Branches and by specialist assistants to the Director who are responsible for example for Quality Assurance, Safety (embracing Ambulance, Fire Brigade and Surgery Staffs), Management Services (embracing a Library and Information Service) and Security.

Propellants 1 Branch

Carries out research, development and pilot scale production of propellants based mainly on nitrocellulose and nitroglycerine for use in guns, rockets and related devices. These propellants are widely used in small arms, artillery, naval and tank guns and in guided weapons.

Propellants 2 Branch

Undertakes research, development and pilot scale production of composite propellants based on an inorganic oxidising salt, normally ammonium perchlorate, and a plastic or rubbery binder: such propellants, extensively used in the past both for defence purposes and in motors for civil space and meteorological sounding rockets, are likely to find increasing use in weapons systems. The Branch also studies adhesion problems and the application of stiff fibre-reinforced materials in high technology structures.

General Chemistry Branch

Provides analytical and physical-chemical services for the remainder of the Waltham Abbey Establishment and undertakes liaison in the UK on behalf of the joint (Australian-UK) Tropical Trials and Research Establishment in Queensland, Australia.

Explosives Branch

Develops initiatory explosives (for which it has a production facility at the Royal Arsenal at Woolwich), and defines the hazards associated with the use of explosives and solid propellants.

Process Research Branch

Undertakes research into chemical manufacturing processes for the UK Defence Industry and carries out production of ingredients and non-metallic components not otherwise available in the United Kingdom.

Advice and Support Work

All Branches give specialist advice to many parts of the Ministry of Defence, in particular to the Royal Ordnance Factories, and to other public and private bodies.

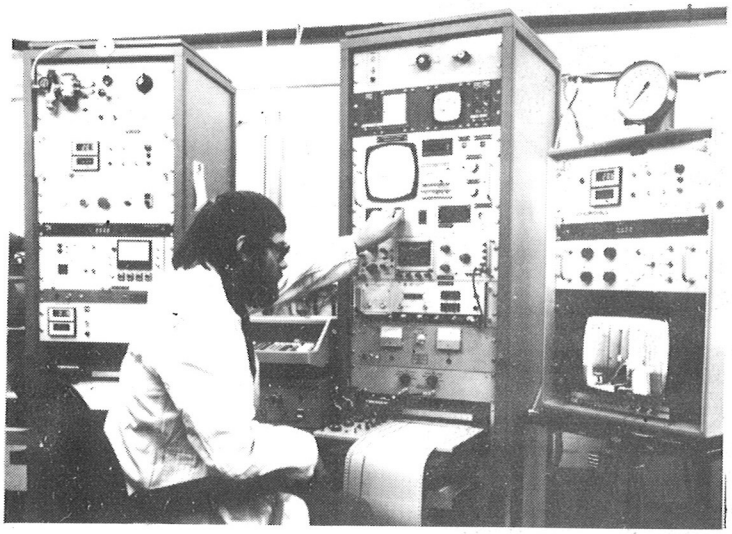
PERME

Opportunities for Scientists and Engineers

PERME (Waltham Abbey) PROPELLANTS 1 BRANCH

The Propellants 1 Branch at PERME Waltham Abbey carries out research, development and industrial production for special nitrocellulose propellant compositions required by the Ministry of Defence.

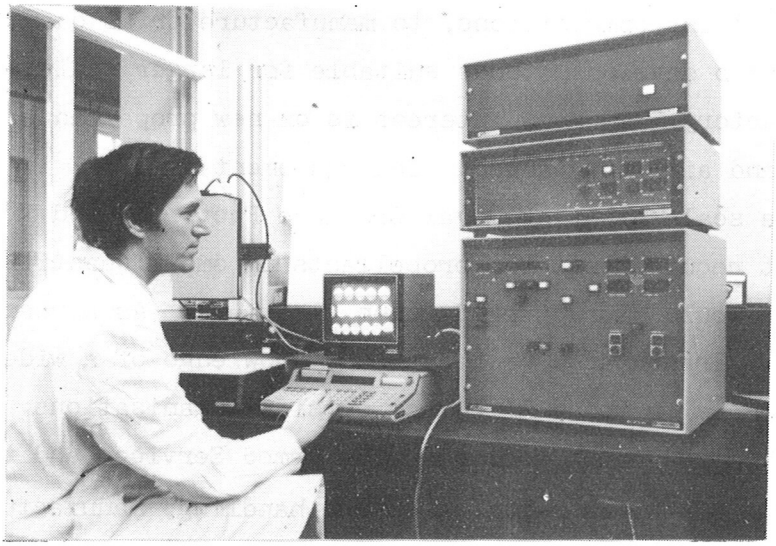
The research activities include the study of the influence of molecular weight distribution of nitrocellulose on its ability to make satisfactory propellants using techniques such as gel permeation chromatography, osmometry, viscometry and light scattering. Also studied are rheological properties of nitrocellulose/plasticiser doughs and the structure of propellants. Some of the methods used are optical and electron microscopy, dielectric relaxation spectroscopy and pulsed NMR. Diffusion mechanisms of plasticisers in nitrocellulose and other cellulose derivatives are under examination.



Torque Rheometer and Capillary Extrusion Rheometer Facilities for Studying Double-Base Propellant Processing Characteristics

Roy Carter

A considerable volume of effort is devoted to development which is largely chemical engineering. Processes are devised and exploratory trials are carried out in small scale equipment from which data for scaling are derived. Some

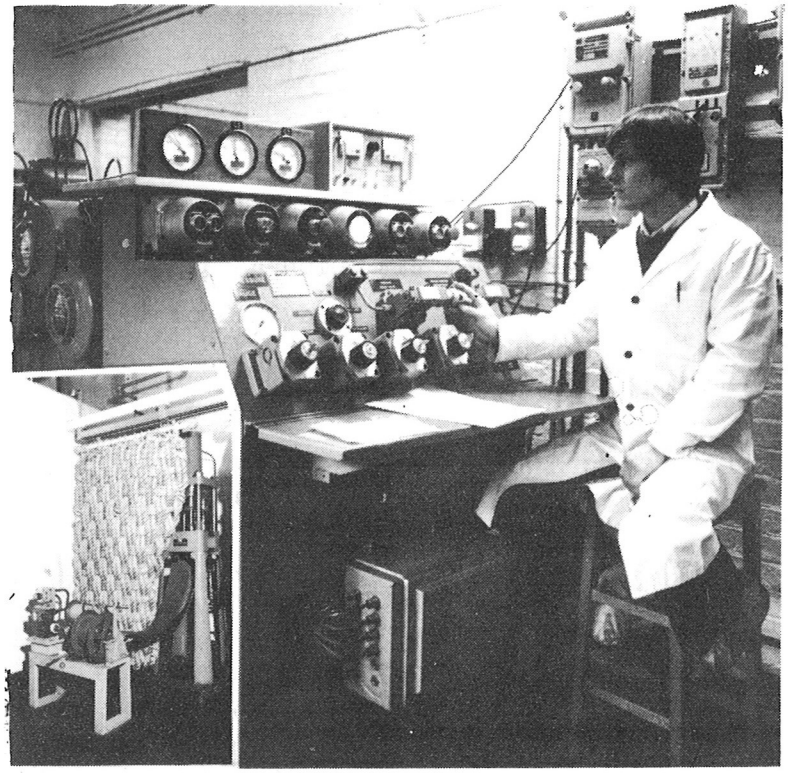


Optomax Television Image Analyser for Automatic Measurement of Gun Propellant

Roy France

equipment is designed at the Establishment in collaboration with Engineering designers, some is purchased suitably modified for use with propellant materials from industry. The chemical engineer is responsible for the conception of the process through small scale to the design of plant for full scale production. Remote control systems and automation constitute essential aspects of process improvement and there is a wide field of work concerned with the application of microprocessors to enable operations to be carried out in greater safety.

Other development work involves mathematical modelling of typical processing equipment and the evaluation of basic chemical engineering parameters in such areas as mixing, diffusion and heat transfer.

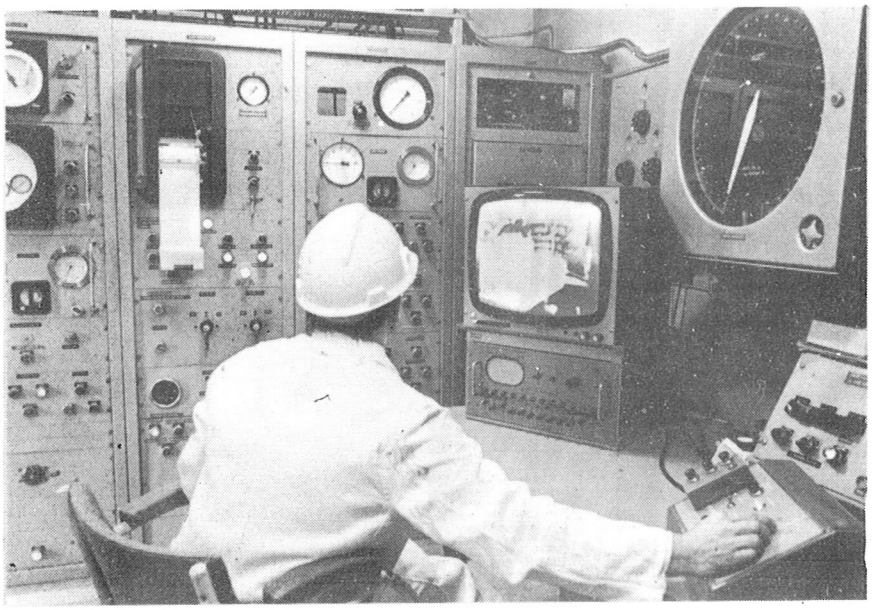


Operating the Remotely Controlled Propellant Extrusion Press

An important function of the Branch is to interpret requirements for the armed forces in terms of propellant compositions, to manufacture trial quantities for assessment, and then to develop methods suitable for larger scale manufacture at an Ordnance factory. Current interest is on new propellants for tank guns, rockets, mortars and aircraft cannon. The equipment at PERME is more adaptable than the large scale plant at Royal Ordnance Factories and it is therefore used to meet urgent requirements for propellants in small quantities or unusual compositions which would disrupt production elsewhere. As a result the personnel in Propellants 1 Branch acquire background knowledge of a wide range of propellants and they are in touch with many outside organisations. They are called upon to advise the weapon designer, the Armed Services and the Ordnance Board on a wide range of topics relating to the handling, manufacture and use of colloidal nitrocellulose propellants.

PERME (Waltham Abbey) PROPELLANTS 2 BRANCH

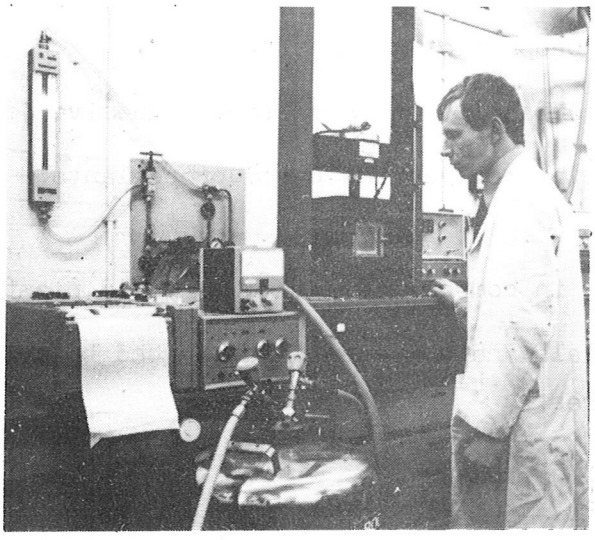
This group of more than thirty qualified scientists (chemists, physicists and materials scientists) together with supporting personnel is responsible for all the United Kingdom research and development on composite solid rocket propellants based on plastic or rubbery binder systems. While the main work of the Branch is on solid propellants, there are also active groups working on powerful composite high explosives, on the applications of composite materials containing high strength fibres to rocket and aerospace systems, and on structural adhesives.



Large Scale Rubbery Propellant Processing by Remote Control

Gordon Bromberger

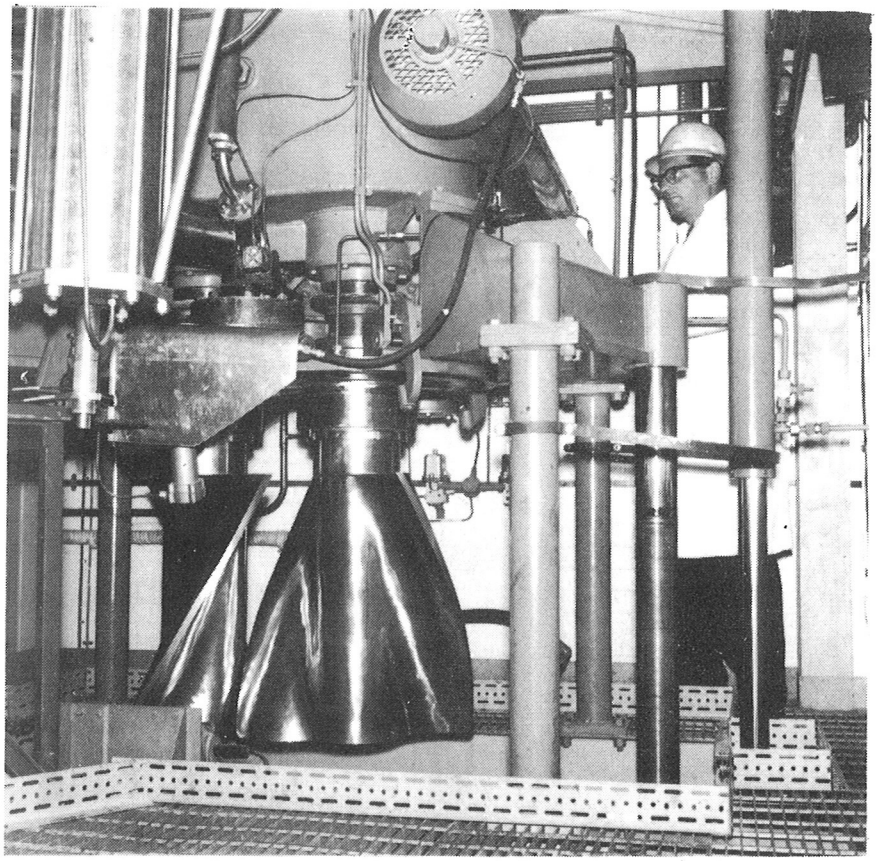
A very wide spectrum of work is carried out in the scientific and technological fields including studies of the basic ingredients, formulation of materials to meet specific requirements, development of production processes and the measurement of chemical and physical properties of the finished products. Many different types of scientific and technological equipment are used in the Branch, ranging from pure research equipment including modern analytical



Measurement of Solid Rocket Propellants on a Tensile Testing Machine

Turner-Hutch

methods for the study of reaction rates in complex systems to pilot-scale and full scale mixing plant capable of manufacturing tonnage quantities of material. This is backed by sophisticated quality control equipment and instruments for measuring the mechanical and rheological properties of products.



Vertical Mixer for Rubbery-Type Solid Propellants

The wide variety of work carried out in the Branch is shown by the following selection of recent internal reports and open literature publications:

"Uniaxial stress relaxation of composite propellants:

Part 1 Uniaxial stress relaxation of 3 composite propellants.

2 Stress relaxation of rubbery propellant.

3 Stress relaxation of propellant binders."

"Carboxy-terminated polybutadiene cure studies - Effect of experimental variables on epoxide cures and properties of gumstocks."

"Predicting and increasing the durability of structural adhesive joints."

"The fracture of nitrocellulose/nitroglycerine based propellants. Fracture Mechanics"

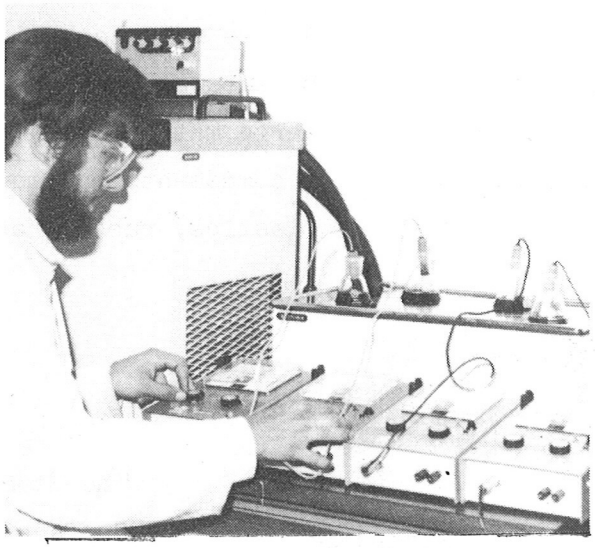
"Use of localised reinforcement in components design to yield plastically"

"Manufacture of metallic materials and components reinforced by silicon carbide whiskers and other fibres."

PERME (Waltham Abbey) PROCESS RESEARCH BRANCH

The Process Research Branch at PERME, Waltham Abbey, is a recognised "centre of expertise" on the techno-economic evaluation of new processes for the production of explosives and propellant ingredients, from laboratory synthesis to pilot scale production and in the case of polymeric materials prototype component production. This support area is vitally necessary to the Ministry of Defence if new ingredients used in improved small scale formulations are to be smoothly transferred to successful large scale production on a competitive basis and within acceptable time limits. The Branch also examines new routes to existing key ordnance chemicals where market fluctuation of raw material prices or the desire for a guaranteed indigenous supply can dictate a change in manufacturing process in order to remain competitive.

In recent years there has been a considerable upsurge in demands for know-how on large scale production of strategic chemicals used in weapon systems. This has arisen because the high cost of weapon trials makes it essential to be as certain as possible that large scale production and availability of materials does not introduce variation which invalidates the initial trials. The situation has been aggravated by the rationalisation of product lines by many commercial firms which has often caused them to abandon production of the high quality but low tonnage MOD requirements. In these circumstances in-house production is often the only means of preventing serious losses of time and money.



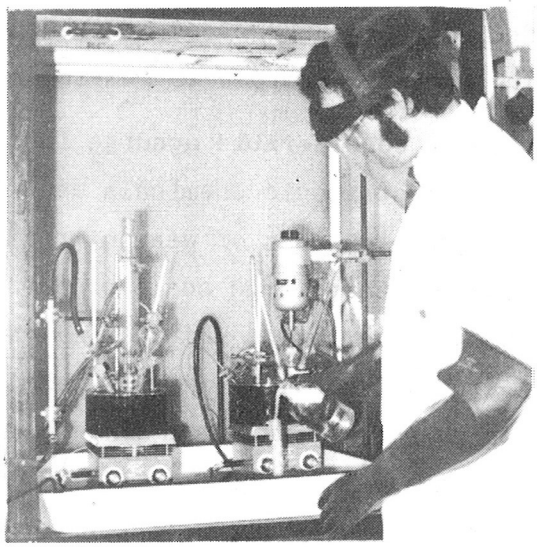
Kinetic Studies

Peter Honey

PERME maintains a multi-purpose capability for small scale production at a reasonable cost. Successive pilot plant studies over the years have resulted in plant being available for the production of most types of chemical used in the ordnance field. Thus, not only does the Branch undertake process development studies but it also supplies the interim pre-production quantities required for R & D trials. It follows that, when production quantities are

required, the expertise and knowledge is available to ensure smooth transfer of the processes to large scale production at the Royal Ordnance Factories or by commercial firms.

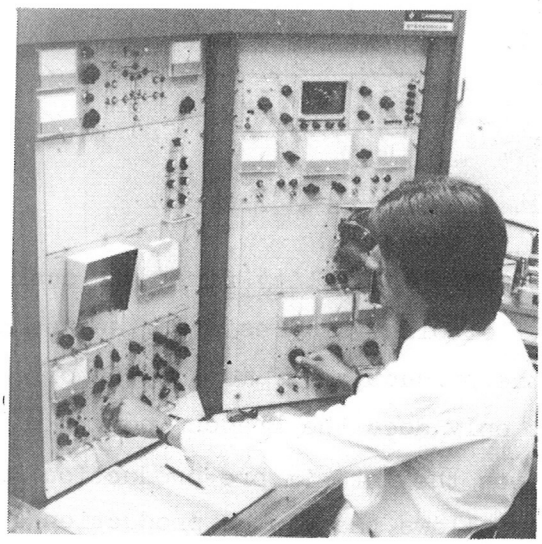
The Branch employs organic and polymer chemists, chemical engineers and material scientists. In addition to assisting the chemical engineers on process development studies, the Chemistry Sections carry out basic research particularly in organic explosives chemistry and in polymer chemistry. A wide range of novel materials which may have Defence significance are synthesised and characterised.



High Temperature Nitrations

Peter Gedding

The material scientists are employed in the Materials Processing Sections whose major role is to maintain and extend knowledge of polymers and to apply this knowledge to Defence requirements. One of the main tasks is to help Service designers produce new designs for components so that maximum benefit may be taken of the unique properties of polymeric materials. To this end the group carries out formulation studies, designs components and moulds and produces prototype mouldings in a variety of plastics, rubbers and composite materials.



The Study of Fracture Surfaces Using a Scanning Electron Microscope

Peter Kosecki

PERME (Waltham Abbey) EXPLOSIVES BRANCH

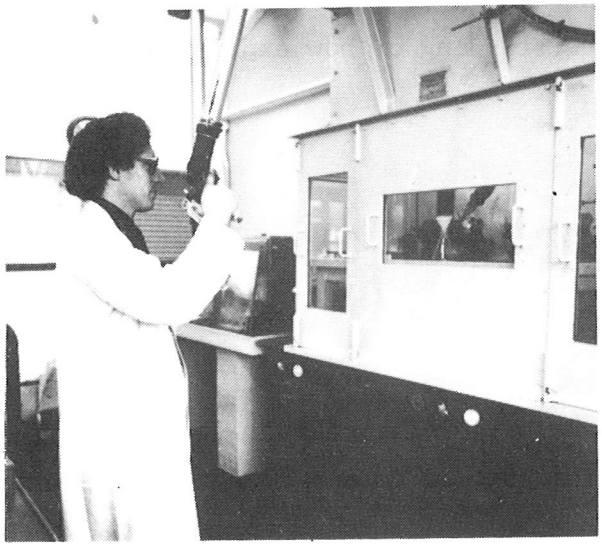
The Explosives Branch at PERME is responsible for research and development of initiating explosives and for studies of potential hazards likely to be encountered in preparing, handling and storing all classes of explosive substance.

Initiating or primary explosives (eg lead azide, lead styphnate, potassium picrate) are the first stage in the explosive train of all detonating ordnance. They provide the necessary power to initiate the more insensitive secondary explosives which form the main explosive charge. Initiating explosives are required to perform the contradictory functions of responding rapidly to a small but controlled initiation stimulus either thermal, mechanical or electrical, providing a powerful response capable of initiating high order reaction in the secondary explosive and at the same time satisfying stringent safety requirements in respect of manufacture and handling.

An Analysis of High Speed Photographic Records with Relation to Detonation

Alan Griffiths

Explosives Branch is responsible for research and development of all initiating explosives used in UK munitions and has unique facilities for

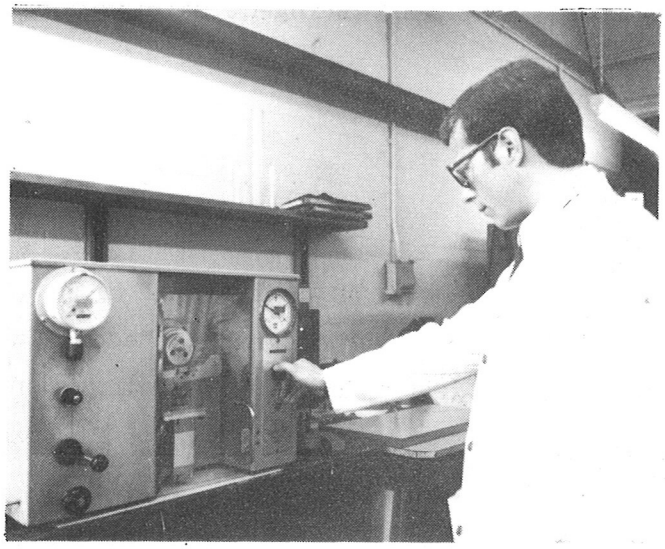


Remote Preparation of Sensitive Primary Explosives using Master Slave Unit

Les Baker

exploratory work on sensitive explosives from milligram up to full factory production scale. Explosive compositions developed at PERME are used in many foreign as well as British munitions and processes developed and patented at Waltham Abbey are exploited under license by many overseas countries. Work on initiating explosives presents challenging problems in the fields of synthetic organic chemistry, crystal morphology and chemical process engineering.

Study of hazard and sensitiveness of all classes of explosives, from initiators to propellants, is an essential part of the work of any Establishment where such materials are developed and provides the vital information required for safe handling and processing of potentially dangerous substances. The response of a wide range of energetic materials to controlled stimuli such as impact, friction, heat and electric spark, is studied and tests developed to



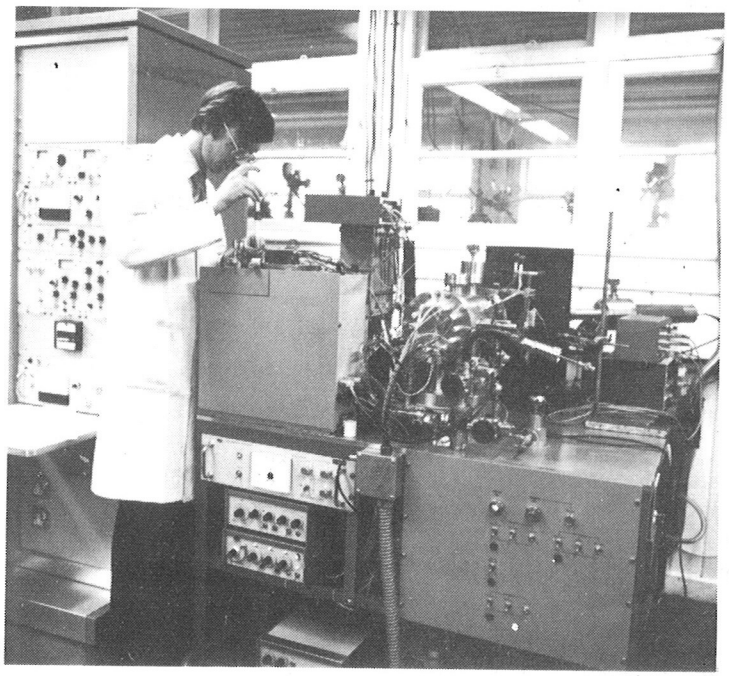
The Testing of Explosives Using a Rotary Friction Machine

Dave Mullenger

simulate potential hazardous situations which may arise in working with such materials. The rapidity of reaction of many of these materials requires sophisticated instrumentation to follow the sequence of events, and high speed recording techniques, both photographic and electronic, are used to resolve changes occurring in fractions of a microsecond. Work in this field provides the opportunity for the physicist and physical chemist to study transient events and to contribute to the understanding of how explosives are initiated and burn to detonation.

PERME (Waltham Abbey) GENERAL CHEMISTRY BRANCH

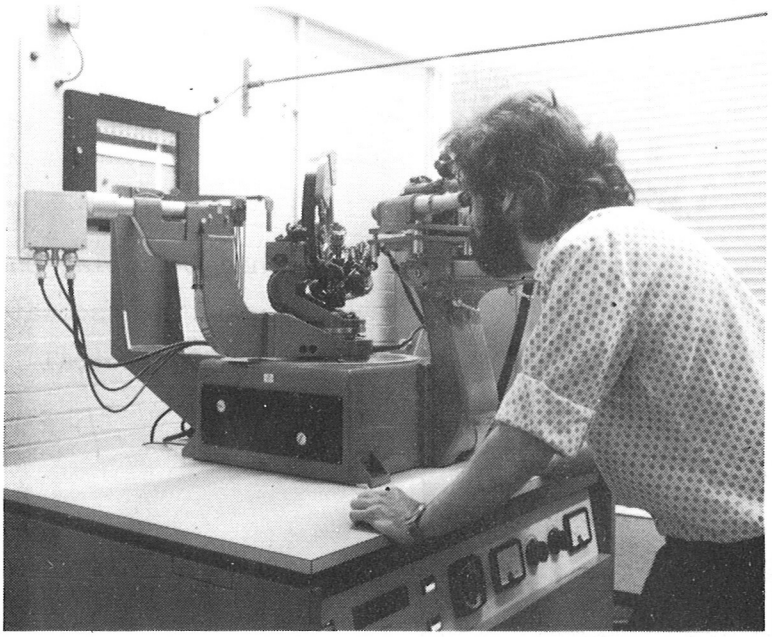
General Chemistry Branch, by the application of analytical techniques such as chromatography (HPLC, TLC, GLC, GPC), mass spectrometry, nuclear magnetic resonance, X-ray crystallography, optical spectroscopy and thermal analysis provides essential support for the work of the rest of PERME and certain other MOD establishments at the same time carrying out research on new and improved analytical methods relevant to MOD requirements.



A Gas-Chromatography Mass Spectrometry System built jointly by the Physical Chemistry and Electronics Development Sections

John Rowley

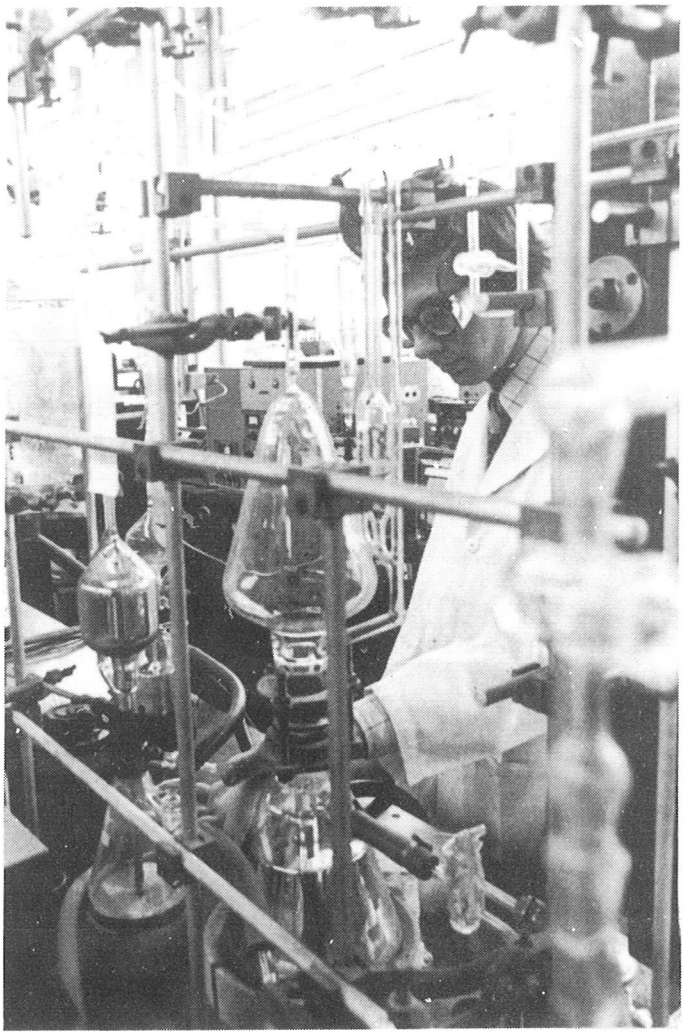
Basic research on the kinetics of the formation and degradation of polymeric and other materials is aimed at understanding and predicting the long term physical and chemical behaviour of explosive and propellant formulations.



Studies of the Crystal Structures of Explosives

Brian Clements

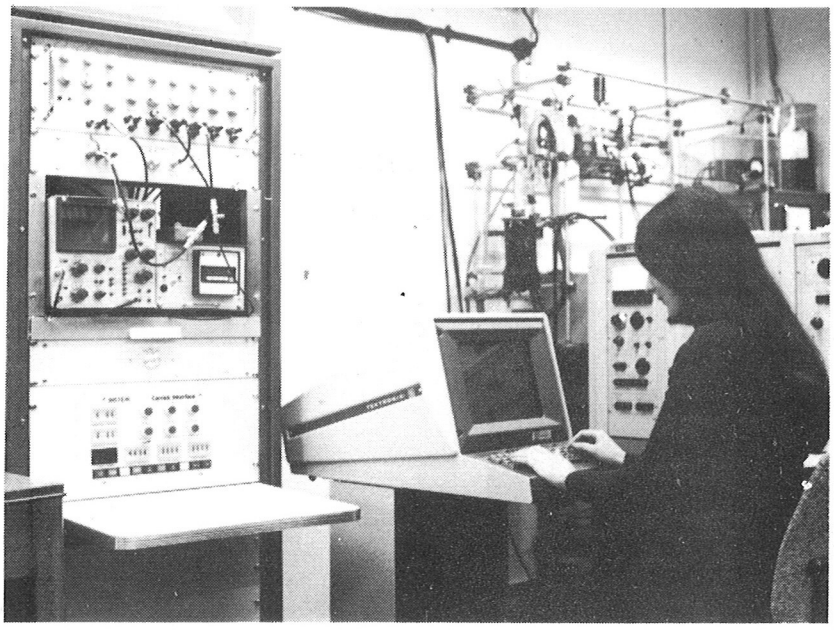
The Electronic Instrumentation Section designs and fabricates specialised electronic equipment to meet the needs of the Establishment (WA).



Solid Propellant Gas
Analysis Techniques

John Rowley

The Mathematics and Computing Section operates a central computer system on the site and carries out mathematic and statistical work of other scientists on request.



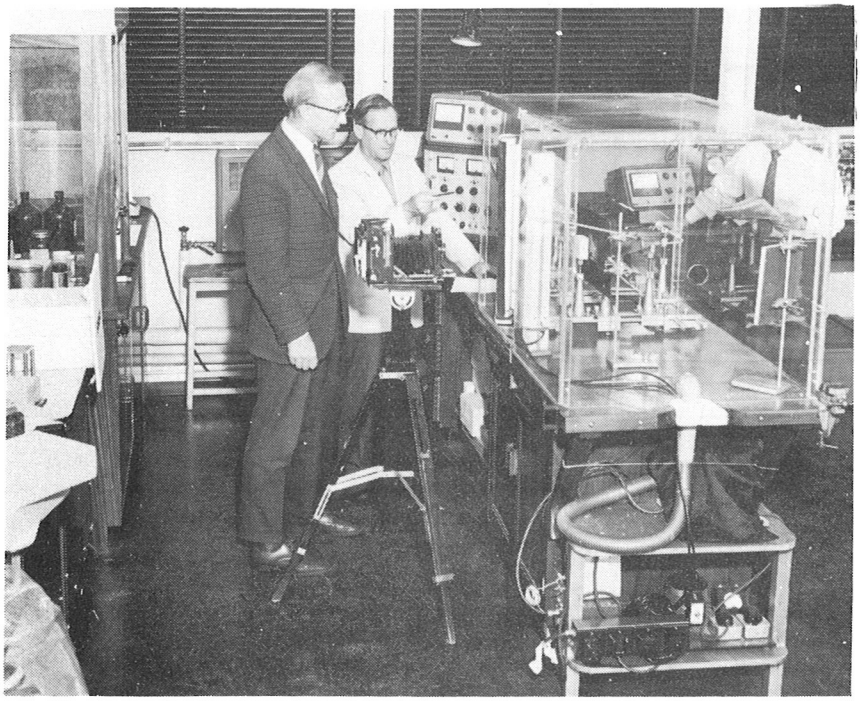
A Graphical Display Unit being used in association with a Mass Spectral Data System

?

PERME (Westcott) CHEMISTRY AND APPLIED PHYSICS DIVISION

The Chemistry and Applied Physics Division at PERME Westcott performs a number of different roles aimed at the progressive improvement of overall rocket motor performance. Contributions to most aspects of rocket technology are made: materials and techniques of construction; methods of proving quality and performanc; integrity of propellant charges; liquid propellants and their containment; motor functioning and the rocket exhaust flame. In all of these the Division's prime responsibility is to look to the future, so the emphasis is on research but innovation is frequently carried through into development and some routine assessment and analysis is performed.

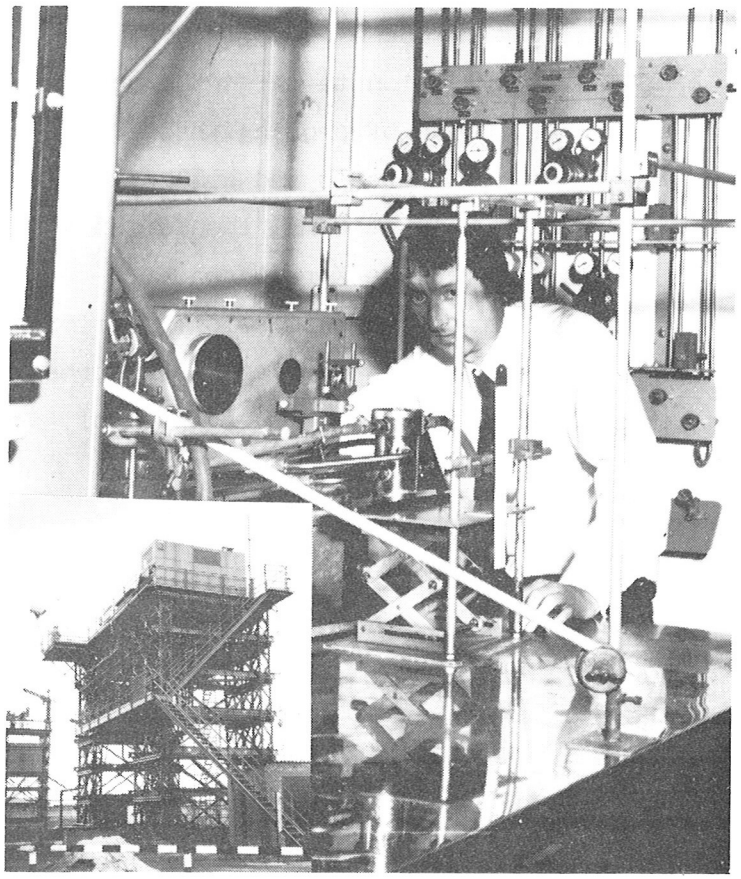
Demands for improved efficiency in motor structures are likely to remain unabated and require full exploitation of newly available commercial products as well as highly specialised materials developed in house exclusively for rockets. Economical techniques for component fabrication to match the new materials need to be devised together with novel means of proving their quality. The materials science involved embraces high strength steels and alloys, fibre reinforced plastics and graphites, composite materials, thermal insulation and refractories. Non-destructive testing techniques include X-radiography, ultrasonics, optical and ultrasonic holography, stress wave emission. Optimisation of complex, multicomponent motor structures requires sophisticated stress analysis procedures. All of these techniques themselves are the subject of research to improve their capabilities.



Research on Non-destructive Testing Techniques, for example, "Stress Wave Emission"

The long-term storage of prepackaged liquid propellants may present severe problems of instability, corrosivity and toxicity which need to be addressed by chemical kineticists, analysts and materials scientists.

On the motor functioning side attention must be given to efficient ignition of the propellant charge within the motor chamber and to the in-service problems which derive from the intense exhaust flame that commonly accompanies high performance rockets. Full ignition must be achieved within a few milliseconds with absolute reliability, in all service conditions and preferably without leaving the "signature" of a smoke pall. Similarly, the signature of the exhaust flame in the visible region or the infrared may need to be minimised, as do any other features of the exhaust which interfere with guidance and tracking systems. In these areas experimental research is difficult and expensive and considerable reliance is placed on complex theoretical analysis and prediction. Powerful computing facilities and programming advisory services are available on site.



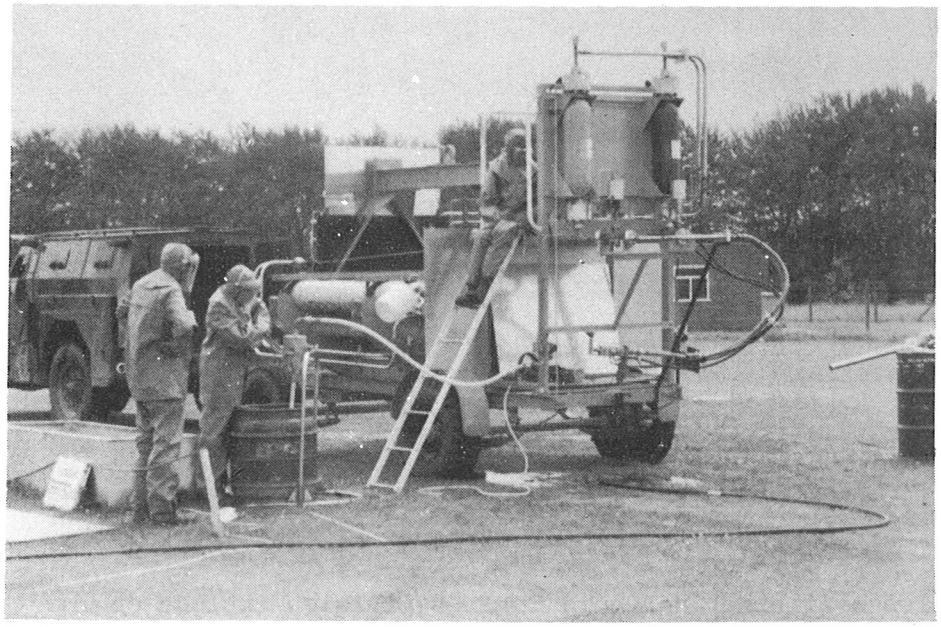
Theoretical Studies of Turbulent, High Temperature Rocket Flames
Inset: Theoretical studies are also carried out on actual rocket motor firings.

The precision required of future rocket systems demands higher orders of accuracy in performance measuring devices and in this area also progress must keep pace. Methods of high speed data collection and preferably automatic analysis are developed in parallel.

Obviously to achieve integrated improvements in overall rocket motor performance, a well-balanced team of high calibre scientists covering a wide range of disciplines is required. The first class research team maintained within the Division receives strong industrial R & D support, notably from Bristol Aerojet Ltd, so there is minimum constraint on practical implementation of research ideas.

PERME (Westcott) LIQUID ENGINES DIVISION

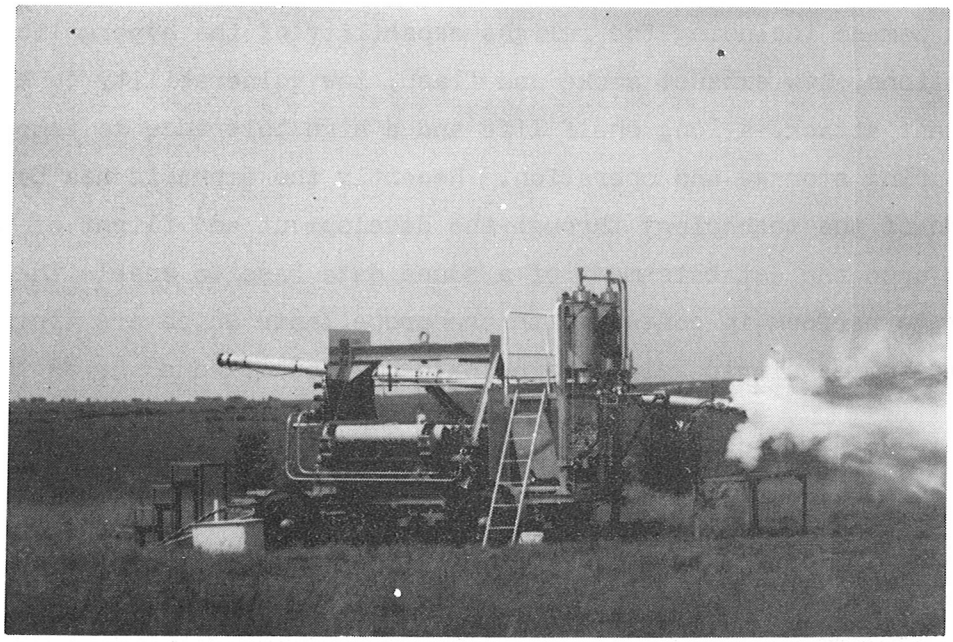
Liquid Engines Division of PERME (Westcott) is the only centre in the UK providing research and development into liquid propellant rocket engines. The work is concentrated upon making available to missile systems designers the potential advantages offered by modern liquid bi-propellant propulsion and is focussed upon the technology of packageable propellant combinations which can be sealed hermetically in tanks of common construction materials for the service life of the missile. The potential advantages to be gained include thrust control upon demand including the relight capability of the hypergolic propellant combinations, low exhaust smoke and flash, low vulnerability to high energy fragment attack, a long shelf life and a high tolerance to temperature excursions during storage and operation. Recently the emphasis has been on the demonstration of the technology through the development and flight of test vehicles and upon the establishment of a sound data base to enable the selection of materials to perform in contact with the propellants which are typically inhibited red fuming nitric acid, as the oxidant, and mixed amine fuels.



Preparation of Recoilless Gun System for Firing

The Division will soon undertake a further development programme whereby the currently available UK technology will be extended to include several advanced features including bladder expulsion techniques and continuously variable thrust on command. The programme will probably be conducted with the ultimate objective of producing a second series of flight test vehicles.

The liquid propellant rocket engine can be conveniently divided into several major and discrete areas of development each of which requires a different combination of disciplines to ensure that attention is given to all the aspects of design. These areas include the propellant storage and expulsion assemblies, the propellant flow control system, the injector/thrust chamber assembly and the gas generator which produces the motive energy necessary to drive the propellants into the engine.



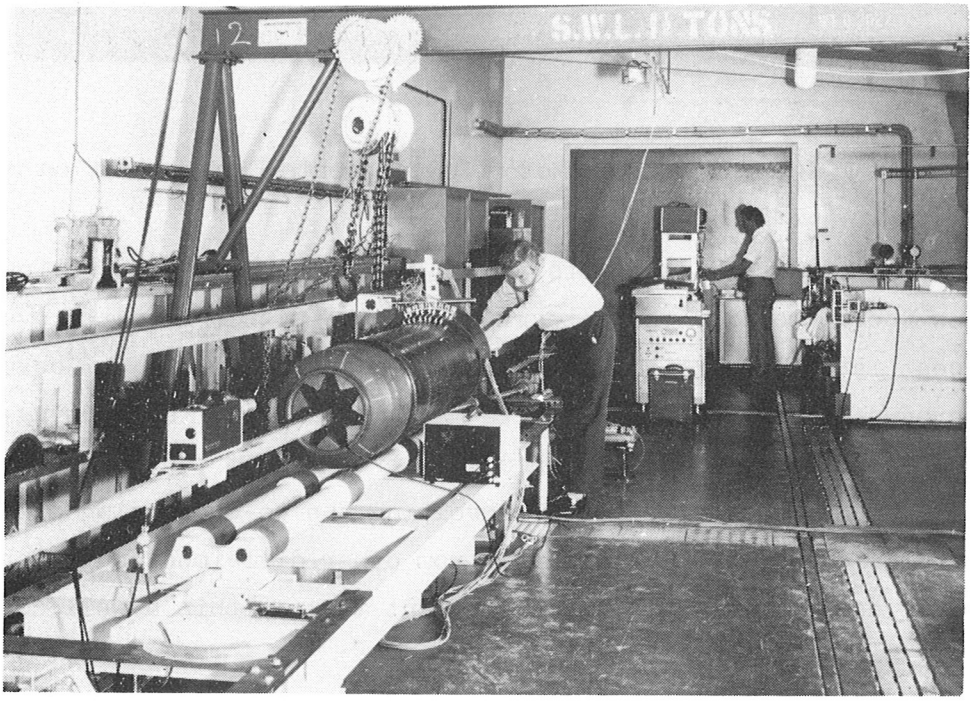
Firing of Recoilless Gun at LARKHILL

Disciplines required to perform R & D in these areas, usually in an interdisciplinary team, are physical chemistry, mechanical, chemical and combustion engineering, applied thermodynamics and heat transfer. An associated area of development is in mathematical modelling of the system and here the various disciplines must combine with that of applied mathematics.

Facilities available in Liquid Engines Division include engine test sites and flow control laboratories with the necessary instrumentation and back-up resources. A hybrid computer capability also is available as well as the PERME Computer Section facility which offers a wide range of computing facilities.

PERME (Westcott) SOLID PROPELLANT MOTORS DIVISION

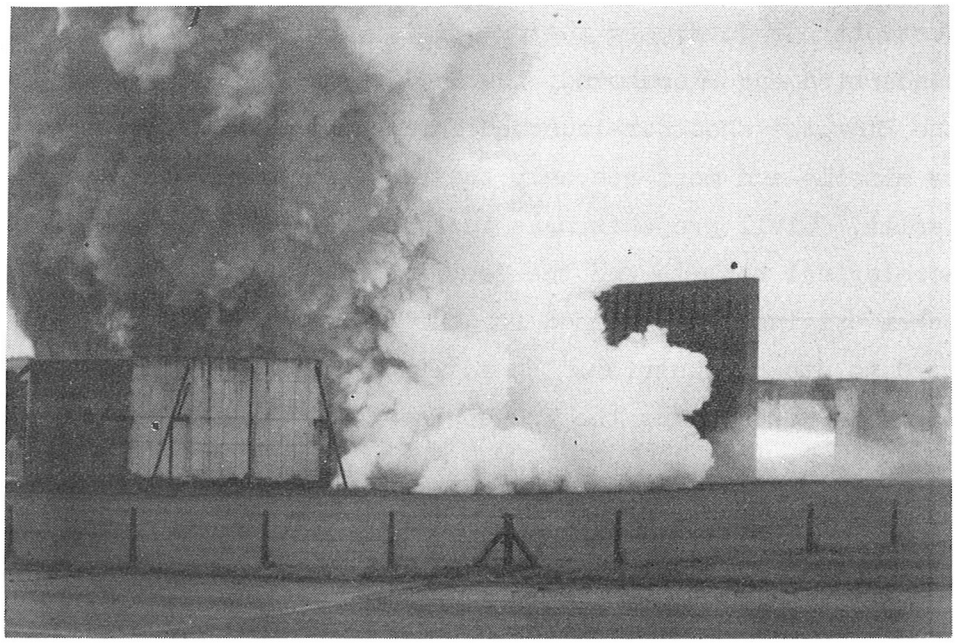
Solid Propellant Motors Division, Westcott, is responsible for the design and development of solid rocket motors, gas generators and power cartridges for a wide range of military and civil applications. Past missile projects for which Westcott has developed the propulsion include the surface to air missiles Thunderbird and Bloodhound, the Red Top and Firestreak air to air missiles, the Blowpipe shoulder-launched anti-aircraft missile, the Sea Wolf ship defence missile and most recently the boost motor for the Sea Skua anti-shipping missile. Civil projects have included propulsion for the Skua and Petrel meteorological rockets and the very successful Skylark high-altitude sounding rocket originally developed for the Science Research Council but now being exported to other countries. In addition Solid Propellant Motors Division was responsible for developing the Apogee Motor for the Black Arrow orbital test vehicle.



Research on all aspects of Solid Propellant Rocket Motor Technology is carried out

Current and future work in the Division includes work on the next generation of air-to-air, ground-to-air and anti-tank missiles, demanding use of novel design concepts and advanced technology. In addition the Division maintains a research programme aimed at bringing new materials and component technology up to the point at which they can be used on service projects. This

research currently includes work integrating new propellants, composite materials and advanced thrust vector control systems into complete motor designs.



Proof Firings of Rocket Motor Developments Carried out on Site

The Division requires scientists and engineers capable of handling the design of new rocket motors, the integrating of the system into the overall missile concept in collaboration with the Prime Contractor and the development through to production of new motors while managing external supporting companies and facilities. Recruits should be prepared to take on early technical management responsibilities, involving the co-ordination of a wide range of scientific and technical inputs from other divisions and establishments and to be active in practical development tasks within a well defined time scale.

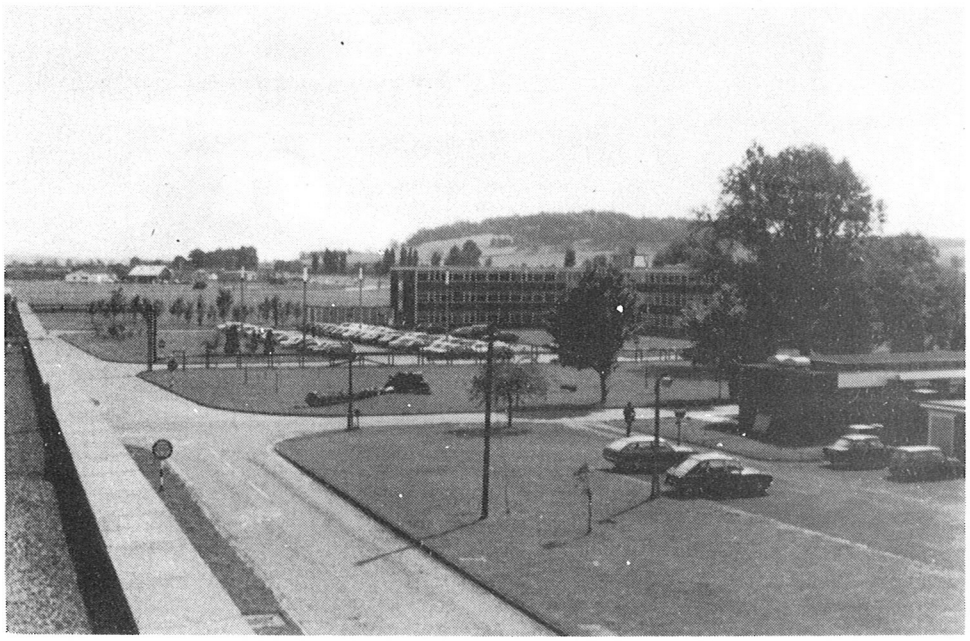
SOME OF THE ADVANTAGES OF A CIVIL SERVICE SCIENTIFIC CAREER IN PERME

1 Security of employment.

2 Salaries include a non-contributory, cost of living index-linked pension scheme. They are structured in separate pay scales for each grade which allow for a predicted minimum financial future. (Our impression is that, particularly at the middle and higher levels, pay rates compare favourably with those in industry.)

3 Depending on availability, there are houses to rent at both PERME locations.

4 Promotion is on merit. There is provision for staff as they progress in their careers to take on more managerial responsibilities but the Civil Service also provides for those who wish to do so, to concentrate entirely on scientific work for the whole of their careers. Outstanding scientists may reach the higher grades above Principal Scientific Officer, solely on their scientific ability, through an 'Individual Merit' promotion scheme.



Main Office Block at Westcott housing Administration, Library, Drawing/Design and Liquid Engines Division

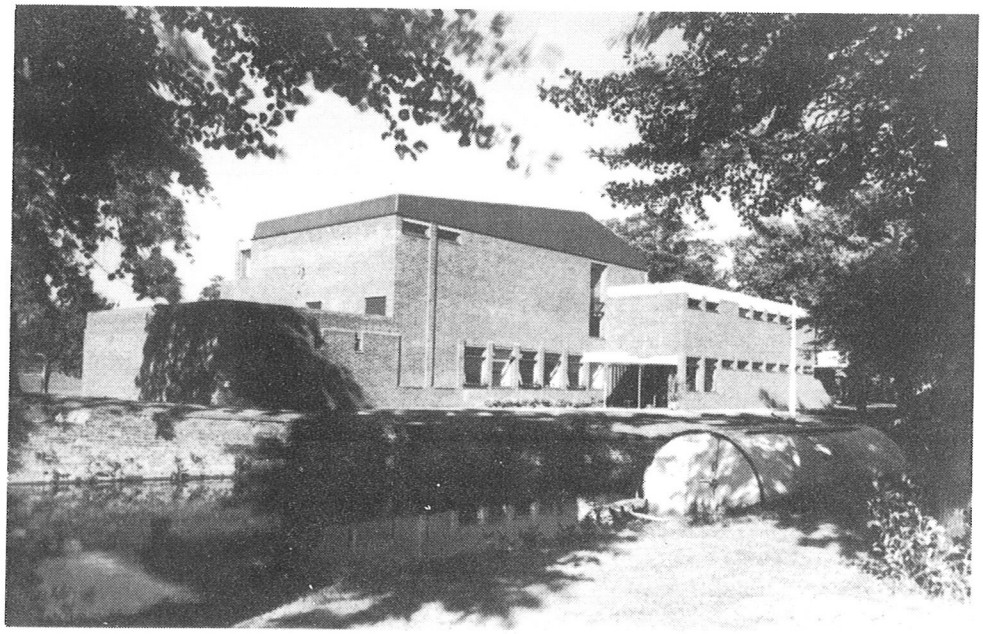
5 After initial training, graduate members of scientific staff are given responsible positions in a project environment early in their careers, and are encouraged to define and prosecute their own research and development programmes which may extend over a long time scale.

6 Members of staff are assisted wherever possible to gain further professional qualifications either by submission of theses based on

their in-house activities to chosen Universities or occasionally by secondment to such Universities.

7 At both PERME locations staff have access to the latest scientific equipment, instrumentation, pilot plant and test facilities, to carry out their research and development activities.

8 Subject to security clearance, individual scientists and engineers are given every encouragement to publish accounts of their work in the open literature. In support of this a wide coverage of appropriate journals and reference works is available through the library and information services and ample opportunities exist to travel in the UK and abroad to meet scientific colleagues and to attend conferences and symposia.



Library and Lecture Theatre at Waltham Abbey

9 The Civil Service is the employer of the largest scientific work force in the UK and can offer the widest range of scientific posts. Scientists wishing to broaden their scientific experience may obtain internal transfers to other Establishments within the Ministry of Defence or indeed, within the wider Civil Service. It is also possible for scientists wishing to become administrators to transfer, after appropriate training, into the administrative grades.

PERME (Waltham Abbey) SOCIAL AND SPORTS CLUB

At Waltham Abbey a thriving Social and Sports Club promotes leisure and sporting activities for the benefit of all employees of the Establishment. Total membership, which includes full members, family members and associate members, currently amounts to 900. The Club engenders a happy and friendly atmosphere which spreads into the working environment and fosters a spirit of comradeship which is unusual in an organisation of this size. Although authorised by the Director and aided by the Establishment in respect of facilities and services, the administration and management of the Club is independent of the official side - it is run by the members for the members. The Club publishes its own magazine to inform members of Club news and forthcoming activities.

The central focus of the Club is a conveniently sited building outside the security perimeter of the Establishment, which can therefore be used by members' families, friends and guests. The building houses an excellent bar and lounge, TV lounge, snooker and billiard rooms and a room which is variously used for activities such as music appreciation, bridge and chess. The Club and bar is open every evening throughout the year and provides an excellent forum to make friends, to get to know colleagues or to simply relax over a few drinks. Periodically, special events such as wine-tastings and "discos" are staged in the Club lounge. These are supplemented by regular dances on a larger scale using the Establishment canteen. There are also regular outings to suit all tastes, for example, visits to a night club or theatre - and even a day trip to France was organised this year.

Sporting activities are an important and popular feature of the Club scene. Some sports are catered for internally - there are three all weather tennis courts, and indoor rifle range and inside the Establishment there are many streams which provide excellent angling. Other sports are subsidised to use local facilities to encourage participation in golf, soccer, cricket, badminton, squash and croquet. The Club will sponsor any activity for which there is a reasonable interest. All in all it makes PERME a better place in which to work.

PERME (Westcott) SOCIAL AND SPORTS CLUB

The Social and Sports Club premises are situated to one side of the Playing Field and Tennis Courts at the Southern end of the Establishment, and comprise a Dance Hall, two Licensed Lounge Bars and a two table Billiards Room, all under one roof.

The Club is open to members daily from 12 noon - 2 pm and on Wednesday and Sunday evenings from 7 30 - 10 30 pm. Friday and Saturday from 7 30 - 11 00 pm.

In addition to the usual attractions of darts, drinks at 'Club prices', colour TV, etc the Club promotes entertainments and leisure pursuits ranging from Christmas parties and pantomime visits for the children, to Dances, Theatre outings and Continental Coach Tours throughout the year for members and their friends.

Through its various Section Committees it sponsors a wide variety of Sports and Hobbies, including Angling, Athletics, Badminton, Cricket, Dancing, Football, Gliding, Golf, Motoring, Squash, Table Tennis and Tennis.

Most of these Sections are very active and all are pleased to welcome new members.

WASC 1308/4

POTENTIAL VACANCIES FOR SCIENTISTS AND ENGINEERS AT PERME: 1979

1 Analysis of Propellants

Development of new and improved methods for the analysis of propellants, their ingredients and related materials, using instrumental techniques such as high pressure liquid chromatography and flame emission/atomic absorption spectroscopy. This post would suit a graduate chemist with a strong interest in analytical chemistry.

2 Stability and Compatibility of Explosives and Propellants

Application of thermo-analytical methods, such as differential thermal analysis, thermo gravimetric analysis and microcalorimetry, to the study of the stability of explosives and propellants and their compatibility with other materials. This post would suit a graduate chemist with a strong interest in analytical chemistry or thermodynamics and kinetics.

3 Degradation of Explosives and Propellants

Study of a wide variety of problems connected with the chemical degradation of explosives and propellants in service or during storage, using instrumental analytical techniques such as gas-liquid chromatography and high pressure liquid chromatography. This post would suit a graduate chemist with a strong interest in analytical chemistry.

4 Kinetics of Degradation of Propellants

Research within a group concerned with the kinetics of chemical degradation of propellants and other defence materials. This post would suit a physical or physical organic chemist: appointment at post-graduate (Ph D) level requires experience in organic reaction kinetics and a knowledge of a variety of modern instrumental analytical techniques is desirable; a graduate (B Sc) appointed would have a strong interest in organic reaction kinetics.

5 X-ray Crystallography

X-ray crystallographic examination of constituents of explosives and related materials using powder and single crystal methods. This work is suitable for a post-graduate (M Sc or Ph D) chemist with experience in X-ray crystallography and a wide knowledge of chemistry.

6 Analysis of Composite Rubbery Propellants

Investigation of the cure and ageing of composite rubbery propellants, based on functionally-terminated polybutadiene with suitable cross-linking agents, using a wide range of spectroscopic, chromatographic and mechanical testing techniques. Close collaboration with teams manufacturing experimental propellants will be necessary. This post is suitable for a chemist/materials scientist: appointment at post-graduate (Ph D) level requires experience in the kinetics of polymer formation and degradation.

7 Application of NMR Spectroscopy

Member of a small group which uses NMR spectroscopy in solving a wide range of problems related to the synthesis of propellant ingredients and the production of propellants, polymers and explosives. This post would suit a chemist with an interest in instrumental analysis: appointment at post-graduate (Ph D) level requires experience in the use of NMR spectroscopy.

8 Mathematical Support

Member of a small team which provides mathematical, statistical and computational support for other scientists in the Establishment. This post would suit a physicist/applied mathematician with good knowledge and ability in both disciplines.

9 New Primary Explosive Systems

Research into new primary explosive systems. This will involve the laboratory-scale synthesis of nitrated aromatic or heterocyclic compounds and their metallic derivatives, evaluation of explosive properties, and the development of suitable large-scale production processes. This post is suitable for a graduate organic or inorganic chemist.

10 Process for Production of an Explosive

Process development studies, design, installation and operation of pilot-plant, and design of full-scale plant, for a new explosive required by MOD. This post would suit a chemical engineer/applied chemist.

11 Process for Production of Polymers

Collaboration in pilot-plant studies related to the production of high quality butadiene/styrene polymers, leading to installation of a full-scale facility in a Royal Ordnance Factory. This post would suit a chemical engineer/applied chemist.

12 Supplies of Strategic Chemicals

Review of the future availability of key strategic ordnance chemicals. This work includes the assessment of the effect of new pollution and safety legislation, and will embrace process development studies to minimise these effects. This post would suit a chemical engineer/applied chemist.

13 Fibre-reinforced Composite Materials

Development of processes for the utilisation of modern, high-strength fibres such as carbon fibre, and to tailor-make complementary resin systems, for high performance composite materials. This post would suit a chemical engineer with an interest in materials science.

14 Synthesis of Explosives

Synthesis of explosives and intermediate compounds, with special emphasis on newer methods of synthesis. Liaison with chemical engineering groups on scale-up, production efficiency, and particularly to reduce or eliminate toxic by-products. This post would suit an organic chemist with some knowledge of instrumental analytical techniques.

15 Synthesis of Novel Polymers

Development of methods for synthesising novel block copolymers. Participation in a wide variety of synthetic problems associated with polymers of interest to MOD. This post would suit an organic chemist, preferably with experience in polymer chemistry.

16 Behaviour of Composite Materials

Study of the behaviour of composite materials under high stress, high temperature, or prolonged exposure. Development of better materials for the purpose, in conjunction with experts in materials processing and structural

design. This is an interdisciplinary post for scientists having initial qualifications in physics, engineering, materials science or physical chemistry.

17 Fraction Criteria and Mechanisms

Experimental and theoretical studies on failure criteria and mechanisms in viscoelastic propellant materials, leading to identification of structure/property relationships. Use of these data to predict service lifetimes of propellant charges in rocket motors. This post would suit a materials scientist/physicist/mechanical engineer (B Sc or Ph D level).

18 Adhesion

Study of adhesion and adhesives primarily in support of guided weapons, involving technical service work in the field, laboratory studies, and development work on eg new adhesive systems. This post would suit a materials scientist/chemist (B Sc level).

19, 20 Processing of Composite Propellants (Two Posts)

Investigation of problems arising in plant scale manufacture and processing of composite propellants and ingredients. These include mixing and extrusion of propellants, grinding of ingredients, and associated quality control work. Both plant and laboratory investigations will be involved, with close co-ordination between the two. These posts would suit applied chemists/physicists/chemical engineers (B Sc level).

21 Formulation of Composite Propellants

Studies of the cure and ageing of composite rubbery propellants based on functionally-terminated polybutadienes reacted with suitable cross-linking agents. Additionally, to take a general interest in the field of propellant processing and formulation, with the object of becoming more involved in project work after 1 - 2 years experience. This post would suit a materials scientist/chemist/applied chemist/polymer chemist (B Sc or Ph D level).

22 Ballistic Phenomena of Propellants

Study of the interaction of internal ballistic phenomena (eg erosive burning, ignition shock stressing) with double-base propellant formulation.

This post would suit an applied chemist/physicist with high numeracy; a strong interest in data storage and retrieval techniques related to millisecond high pressure operations would be an advantage.

23 Processing of Double-Base Propellants

Study of new processes for the production of double-base propellants. Pilot-plant will be designed/selected following initial laboratory studies; operation of the pilot-plant will provide the design data base for future production plant. This post would suit a chemical engineer.

24 Control of Double-Base Propellant Manufacturing Processes

Studies of modernisation of double-base propellant processes, involving the design/selection of control instrumentation and automation techniques and/or the ability to carry out mathematical modelling of plant operations. This post would suit a chemical engineer.

25 Formulation and Manufacture of Double-Base Rocket Propellants

Member of a team working on the formulation and manufacture of propellants for rockets, gas generators etc. This post would suit an applied chemist/chemist who has an interest in becoming increasingly involved in plant or general management in the longer term.

26 Formulation and Manufacture of Gun Propellants

Member of a team working on the formulation and manufacture of gun propellants. This post would suit an applied chemist/chemist who has an interest in becoming increasingly involved in plant or general management in the longer term.

27 Propellant Ignition and Combustion

Study of propellant ignition with pyrotechnic and pyrogen devices. Analysis of radiative, convective and conductive heat transport and mass transfer. Computation and measurement of pressure waves in combustion chambers: noise generated and acoustic instabilities set up. This work would suit a physicist or engineer (B Sc level) with interests in thermodynamics and fluid mechanics.

28 Compatibility of Fuels, Oxidisers and Hardware

Study of reactions between fuels (eg hydrazine), oxidisers (eg red fuming nitric acid) and container materials (eg metals, plastics). Requires investigation of the interaction of diffusion and chemical kinetic processes, with particular emphasis on surface effects. The work would suit a physical chemist (Ph D level) with interests extending into both organic and inorganic fields.

29 Materials Technology

This work involves development of the application of new materials to rocket motor casings, nozzles and other components. The materials include refractories, graphites, glasses and composites. The work would suit a metallurgist or materials scientist (B Sc or Ph D) with interests in high strength, light, stress-resistant and corrosion resistant materials.

30 Non-Destructive Testing

Use of holographic, acoustic, optical and other methods for testing integrity of motor components such as casings, propellant charges, inhibitors and liners. Particular emphasis placed on the development of novel instrumentation for these methods, including real-time data processing. The work would interest a graduate in physics or engineering with enthusiasm for computing, electronics and gaining experience of a wide range of instrumentation techniques.

31 Rocket Exhaust Flames

Theoretical study of turbulent, high-temperature rocket exhaust diffusion flames. Computer predictions of flame structures with the object of calculating radiative, electrical and other properties. Ability to come to terms with complex problems in fluid dynamics, chemistry and numerical analysis is required. The work might best suit an applied mathematician or physicist with strong computing interests (B Sc level).

32 Analysis of Liquid Propellant Combustion

Theoretical analysis of fuel and oxidiser flow supply systems, mixing processes and combustion, droplet evaporation and burning and mixed phase

combustion chemistry. Synthesis of fluid dynamics, thermochemistry and kinetics for combustion chamber and nozzle processes. Development of numerical analysis procedures for computing internal flow field properties. This work requires an ability to identify key system parameters and produce practical solutions to real problems. It would suit a physical chemist, physicist or engineer interested in interdisciplinary research (Ph D or graduate level).

33 High Performance Packaged Liquid Engines

Research on new liquid propellant engines for highly controllable propulsion systems. Emphasis on advanced fuel and oxidiser supply units, combustion ignition processes, fuel/oxidiser/metal compatibility and storage problems and total propulsion package integrity. The work would suit an engineer (Ph D or B Sc level) with strong interests in system design who is able to draw upon the expertise of others in thermodynamics and fluid flow.

34 Advanced Tactical Rocket Propulsion Design

Design and development of prototype solid propellant rocket motors with high thrust, long lifetime fuel/oxidiser combinations, lightweight but strong casings and nozzles, high manoeuverability and low production of exhaust flame and smoke. This work would suit an engineer with interests in total system design who is able to draw effectively upon available research expertise in materials science, propellant technology, combustion engineering and flow dynamics (Ph D or B Sc level).

35 Solid Propellant Rocket Motor Project Control

Design-to-development control of rocket motors for tactical missiles. Project interests vary from very short (a few milliseconds) burn time motors to sustainer motors burning for hundreds of seconds, with a wide range of propellants and other components. This work requires an engineer with the ability to communicate effectively with scientists, other engineers and users in the armed services. He will need to produce effective engineering solutions to practical problems on firm time scales, and must therefore be capable of developing good management skills (B Sc engineering).

36 Gas Generator and Power Cartridge Technology

Work on gas generators and power cartridges for pressurisation of combustion chambers and other applications. Propellant combinations are required to produce controllable temperatures and pressures in vessels of variable configurations. Design of generators with negligible smoke production is a prime requirement. This work might suit an engineer or chemist (B Sc level) with interests in propellants, thermodynamics and fluid mechanics.

13 November 1978

WASC No	BRIEF DESCRIPTION
1308/05	PERME Waltham Abbey. B/W photographs taken by C Ellis, 24 July 1978, many of which were used for a recruitment campaign and recruitment brochures in the late 1970's and early 1980's.
/1	South Site. P1 Branch - Mr Roy Carter.
/2	South Site. P1 Branch - Mr Roy France.
/3	South Site. P1 Branch - Operating the Remotely-controlled propellants extrusion press.
/4	South Site. P2 Branch - Mr Geoff Turner-Mutch.
/5	South Site. PR Branch - Mr Peter Harvey (?)
/6	South Site. PR Branch - Mr Peter Golding
/7	South Site. PR Branch - Mr Tony Kosecki
/8	North Site. Explosives Branch - Mr Alan Griffiths
/9	North Site. Explosives Branch - Mr Les Bates
/10	North Site. Explosives Branch - Mr Dave Mullenger
/11	North Site. General Chemistry - Mr John Rowley
/12	North Site. General Chemistry - Mr John Rowley
/13	North Site. General Chemistry - A Graphical Display Unit being used in association with a Mass Spectral Data System.
/14	South Site. P2 Branch - Mr Bob Torry
/15	South Site. P2 Branch - Mr Bob Torry
/16	South Site. P2 Branch - Mr Bob Torry and Mr Doug Barnard
/17	South Site. P2 Branch - Mr Gordon Bromberger
/18	South Site. P2 Branch - Mr Gordon Bromberger
/19	South Site. P1 Branch - High-pressure strand burner facility for measuring rates of burning of experimental composite propellants.
/20	South Site. P1 Branch - High-pressure strand burner facility for measuring rates of burning of experimental composite propellants.
/21	South Site. P2 Branch - Dr R Stenson
/22	South Site. P2 Branch - Mechanical Spectrometer for Dynamic Testing of Solid Propellants.
/23	South Site. P2 Branch - Mr P Kennett
/24	South Site. P1 Branch - Mr J R Anderson
/25	South Site. P1 Branch - Remotely-controlled propellants extrusion press with rope mantlets for protection.
/26	North Site. GC Branch - Melanie Pierce-Butler
/27	A batch of B/W and colour contact prints of photographs taken, including Melanie Pierce-Butler with Full-Circle Single Crystal Diffractometer, Mr Gordon Bromberger with Vertical Mixer and Mr Mike Farey with Glassware for Gas Analysis Plant.

PHOTO DESCRIPTIONS WASC-1308-05

WASC No	BRIEF DESCRIPTION
1553	Combustible cartridge case. Colour print (showing Richard Stevens) to accompany text for "The Scientist and the Soldier" poster.
1555	Propellants, Explosives, and Rocket Motor Establishment, Westcott, Aylesbury, Bucks; Waltham Abbey, Essex. A Ministry of Defence R & D Establishment within the Procurement Executive. An information package for a recruitment campaign in the late 1970's(?) 22 sheets. Xerographic copy.
1556	Colour photographs taken by J Curtis. for illustrations of the PERME Brochure, 1979. Original.
1557	Full set (from 1 - 30) of positive colour transparencies, taken by J Curtis, for illustrations of the PERME Brochure, 1979. Also included are prints from transparency Nos 11, 16, 19, 21.
1558	PERME Waltham Abbey. B/W photographs taken by C Ellis, 24 July 1978, many of which were used for a recruitment campaign and recruitment brochures in the late 1970's and early 1980's.
/1	South Site. P1 Branch - Mr Roy Carter.
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WASC No	BRIEF DESCRIPTION
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/20	South Site. P1 Branch - High-pressure strand burner facility for measuring rates of burning of experimental composite propellants.
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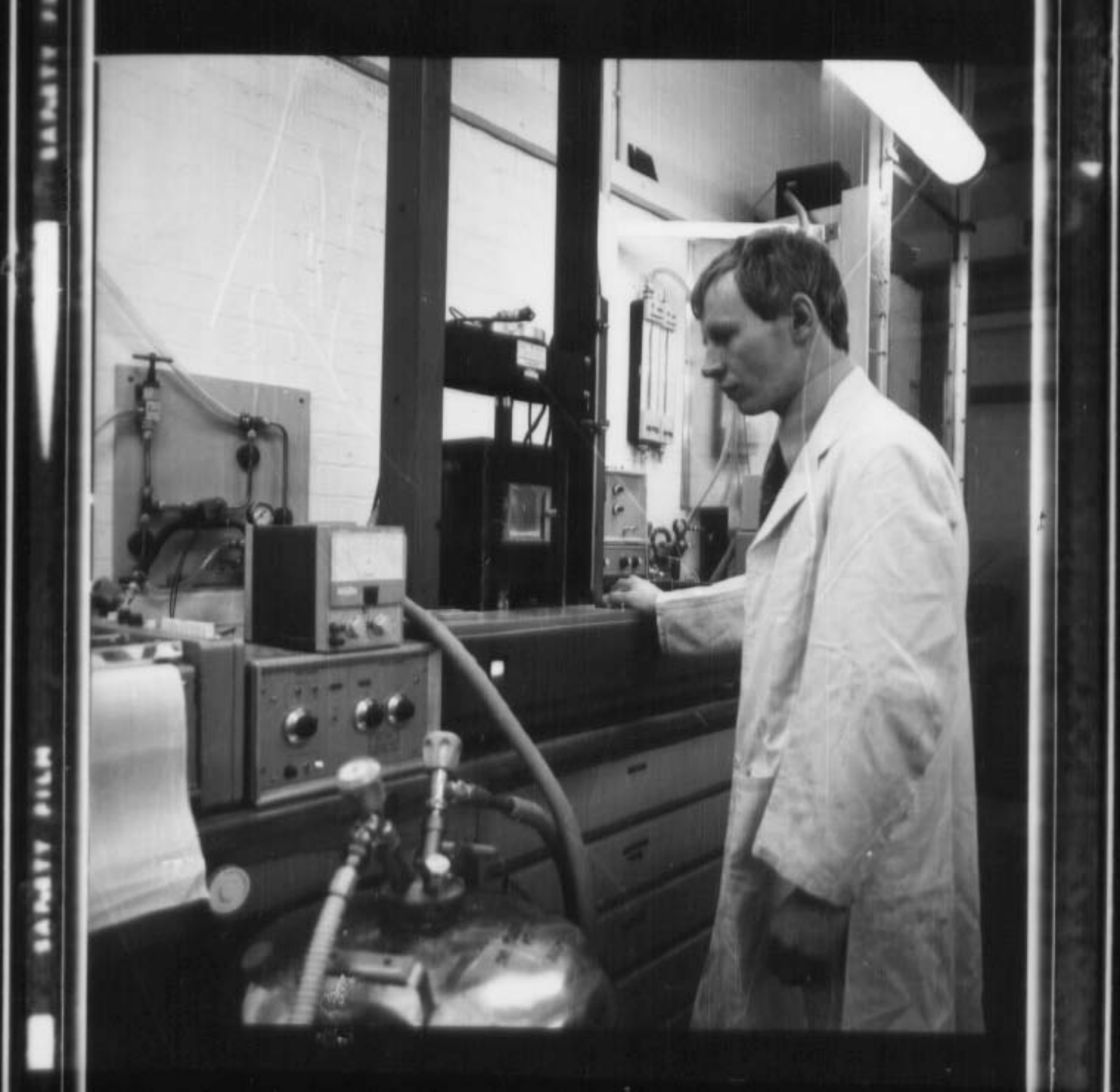
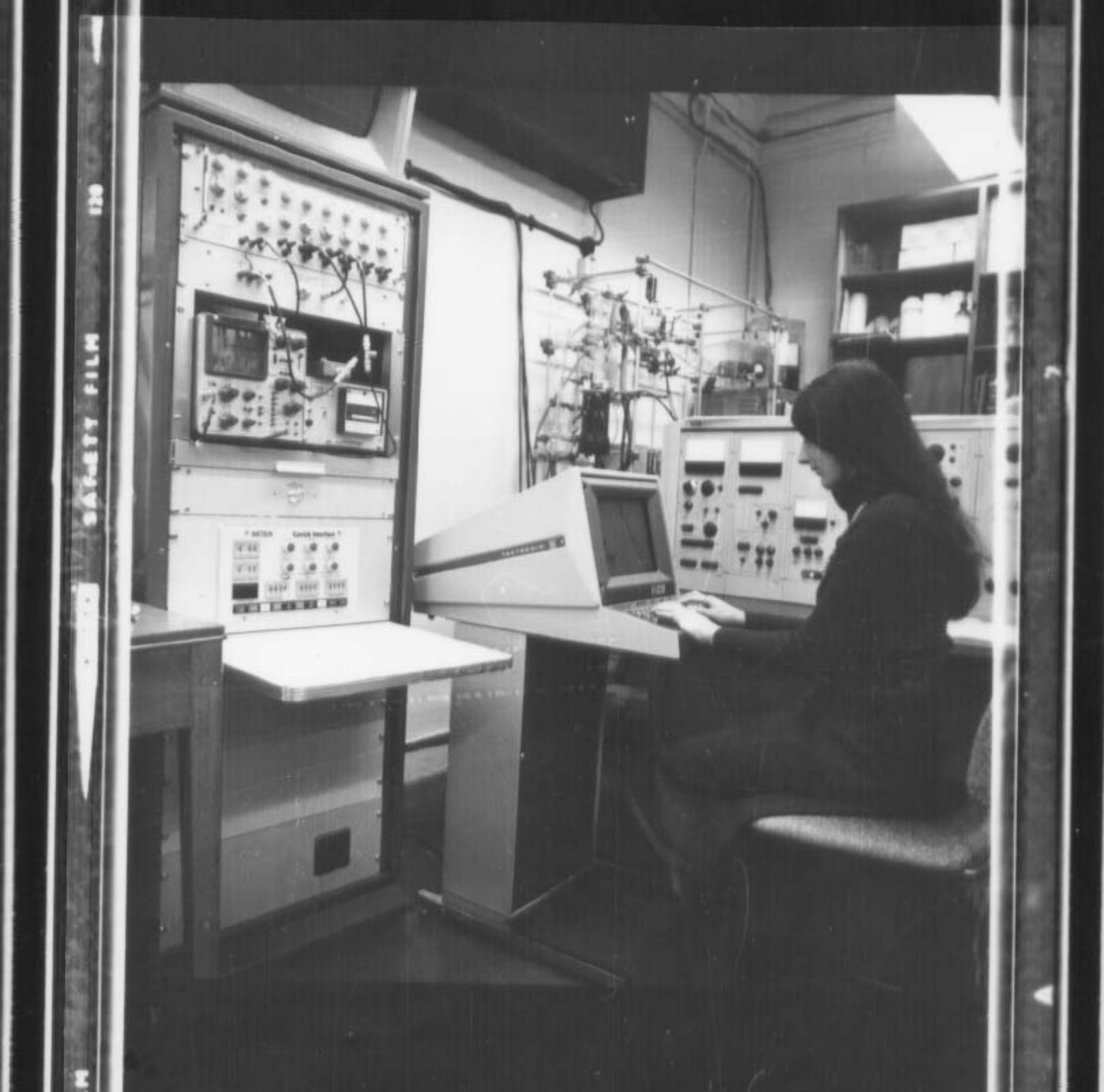
1559	Report of the Explosives Committee, Appointed jointly by The Royal Cornwall Polytechnic Society, The Miners'association of Cornwall and Devon, and The Mining Institute of Cornwall (Appendix). Lake & Lake, 1880. Title page, pp 3-20. Xerographic copy.
1560	Three men from ERDE Labour Pool (Grasscutters). B/W photograph (taken August 1965) showing. from left to right: Mr Henry Guenigalt, Mr Ernie Warwick and Mr Percy Pryke.
1561	ERDE South Site, Building No P752. B/W photograph.
1562	ERDE North Site. View across Mill Head Pool. B/W photograph, taken 12 July 1966.
1563	ERDE. Buildings on Lower Island. B/W photograph.
1565	Glassblowing at ERDE. B/W photographs (3 different views) of Ben George at work.
1566	ERDE South Site. Arched Footbridge. B/W photograph, taken April 1967.
1568	ERDE North Site. Hazard Assessment Section. Mr R G Westlake operating the Rotter Impact Machine in Building No L149. B/W photograph, taken Summer 1966.



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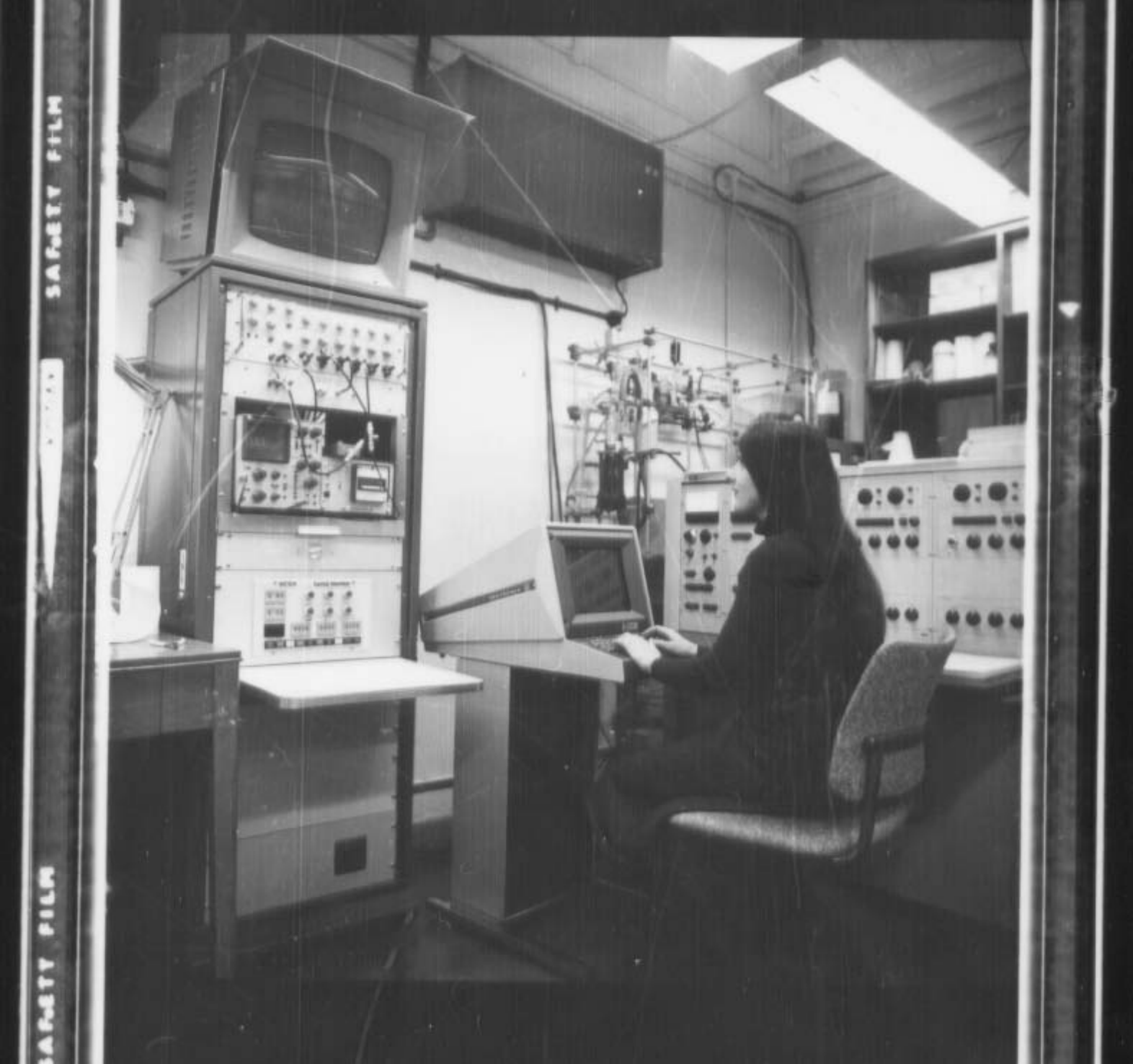
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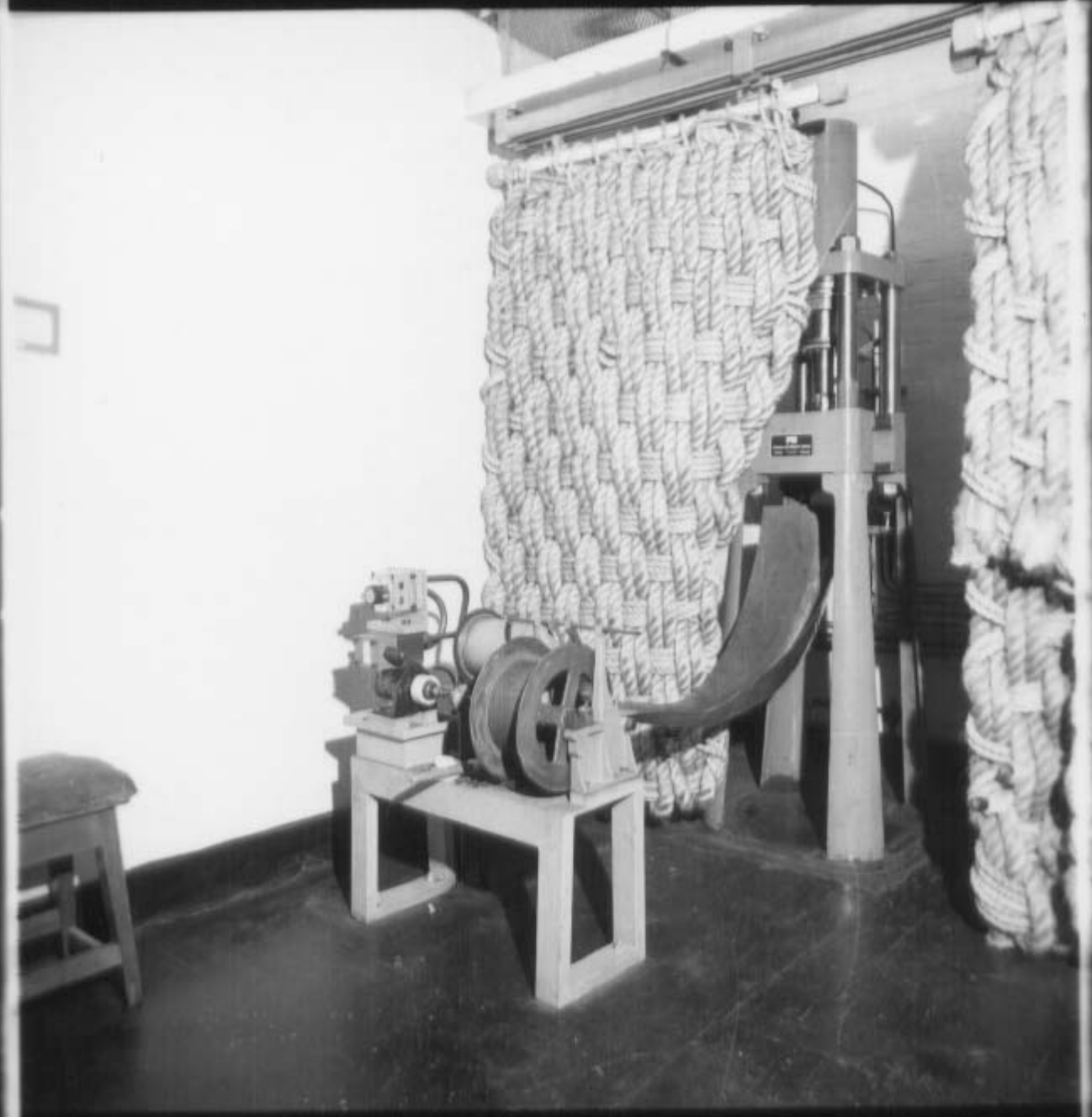


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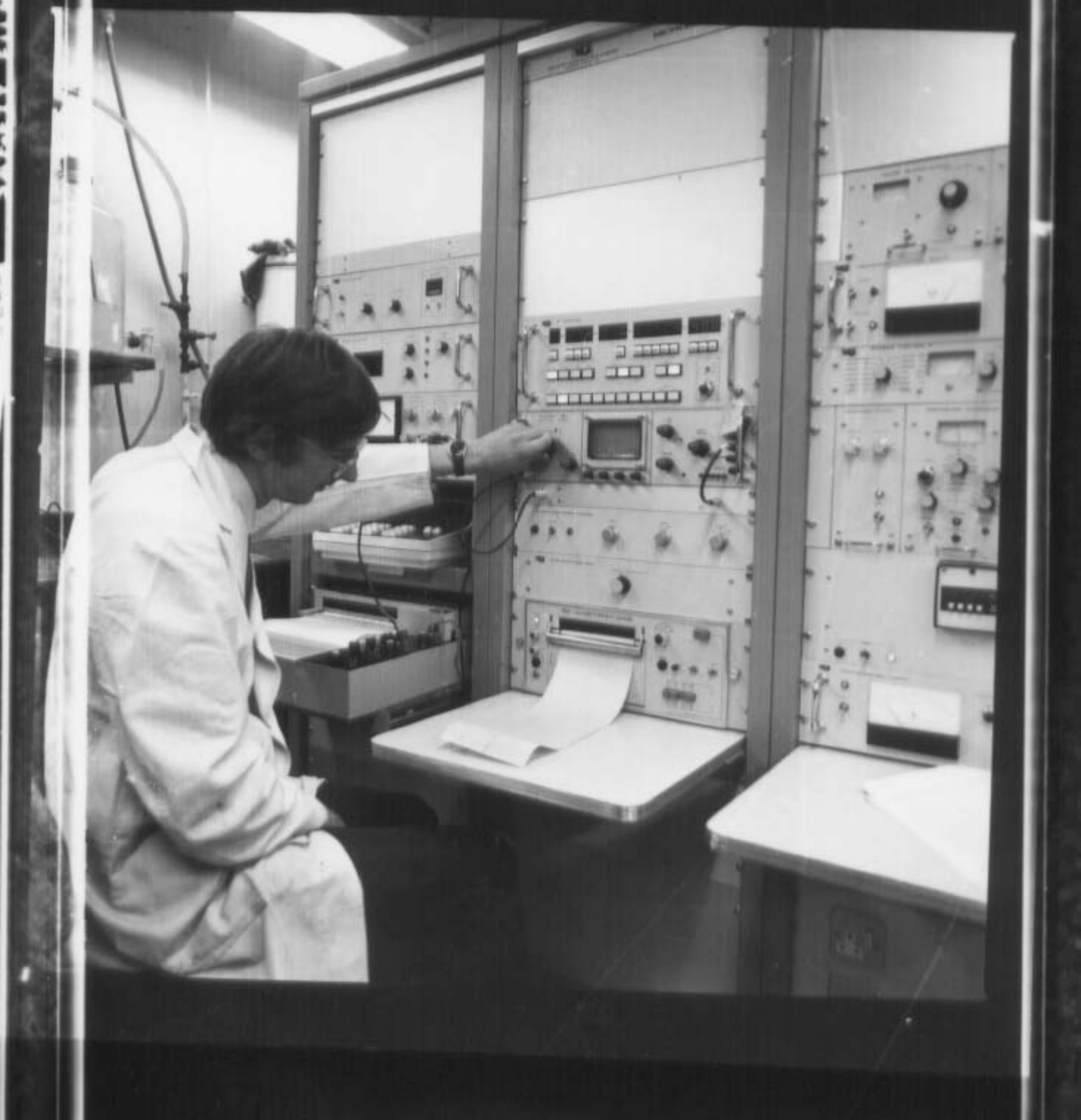


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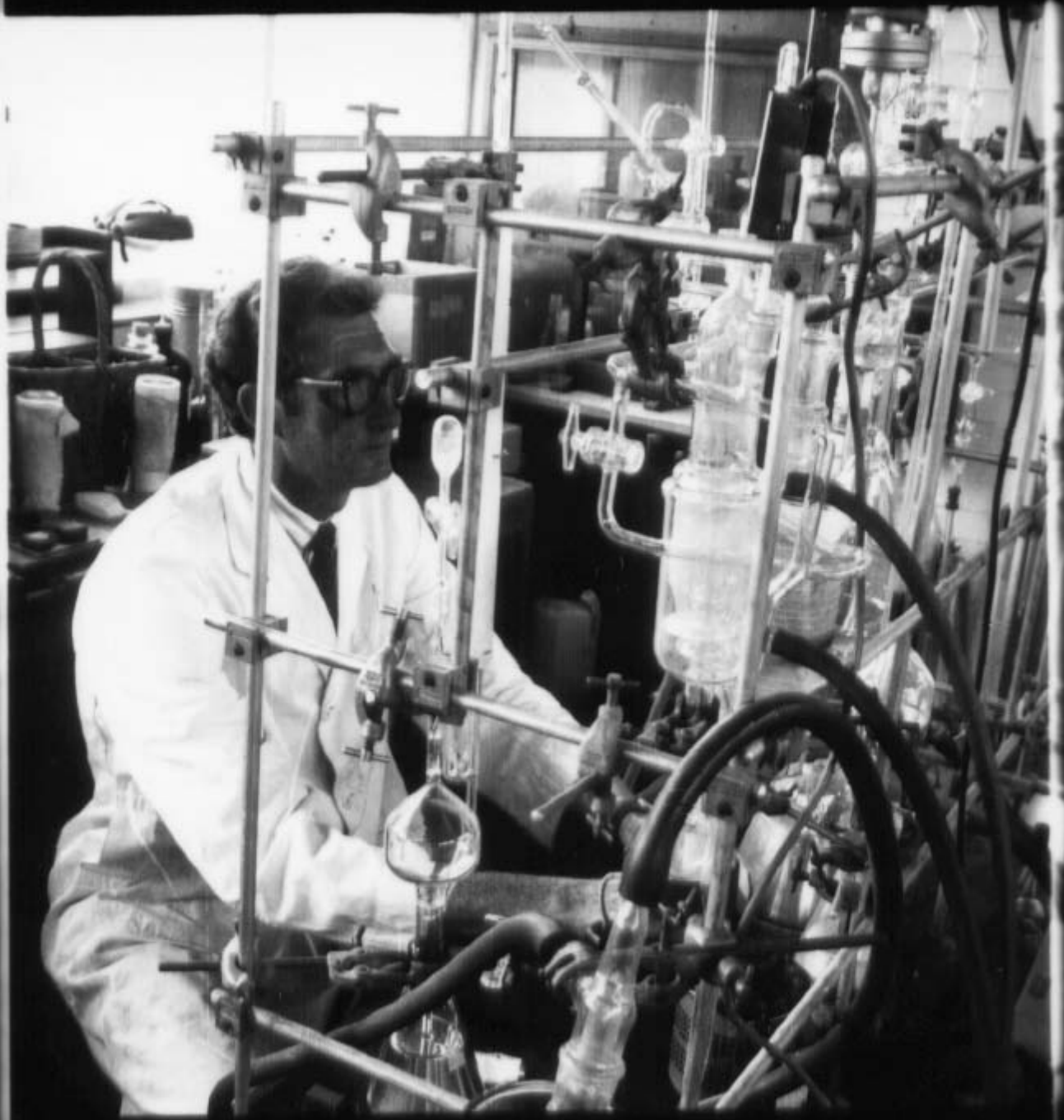

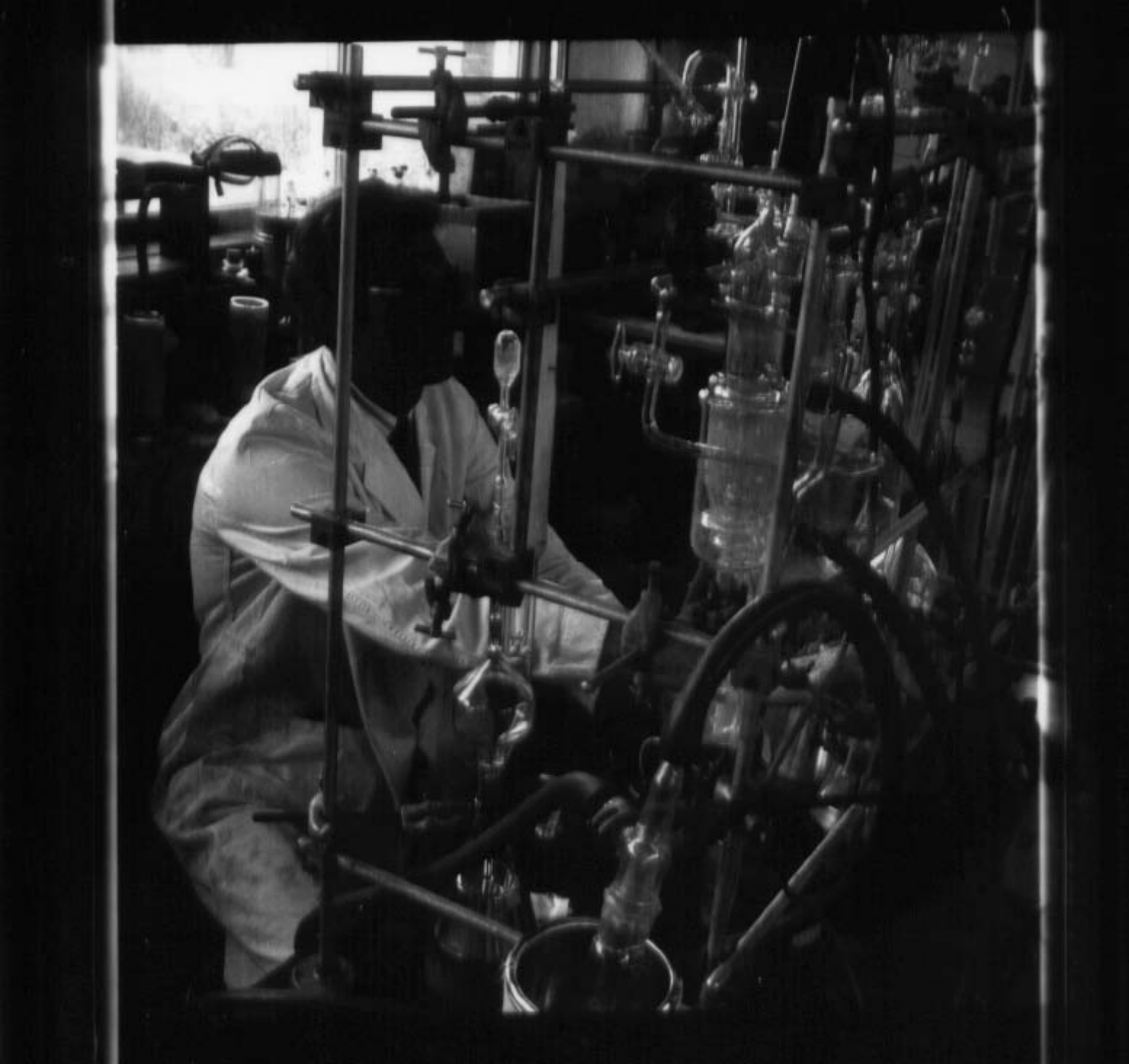

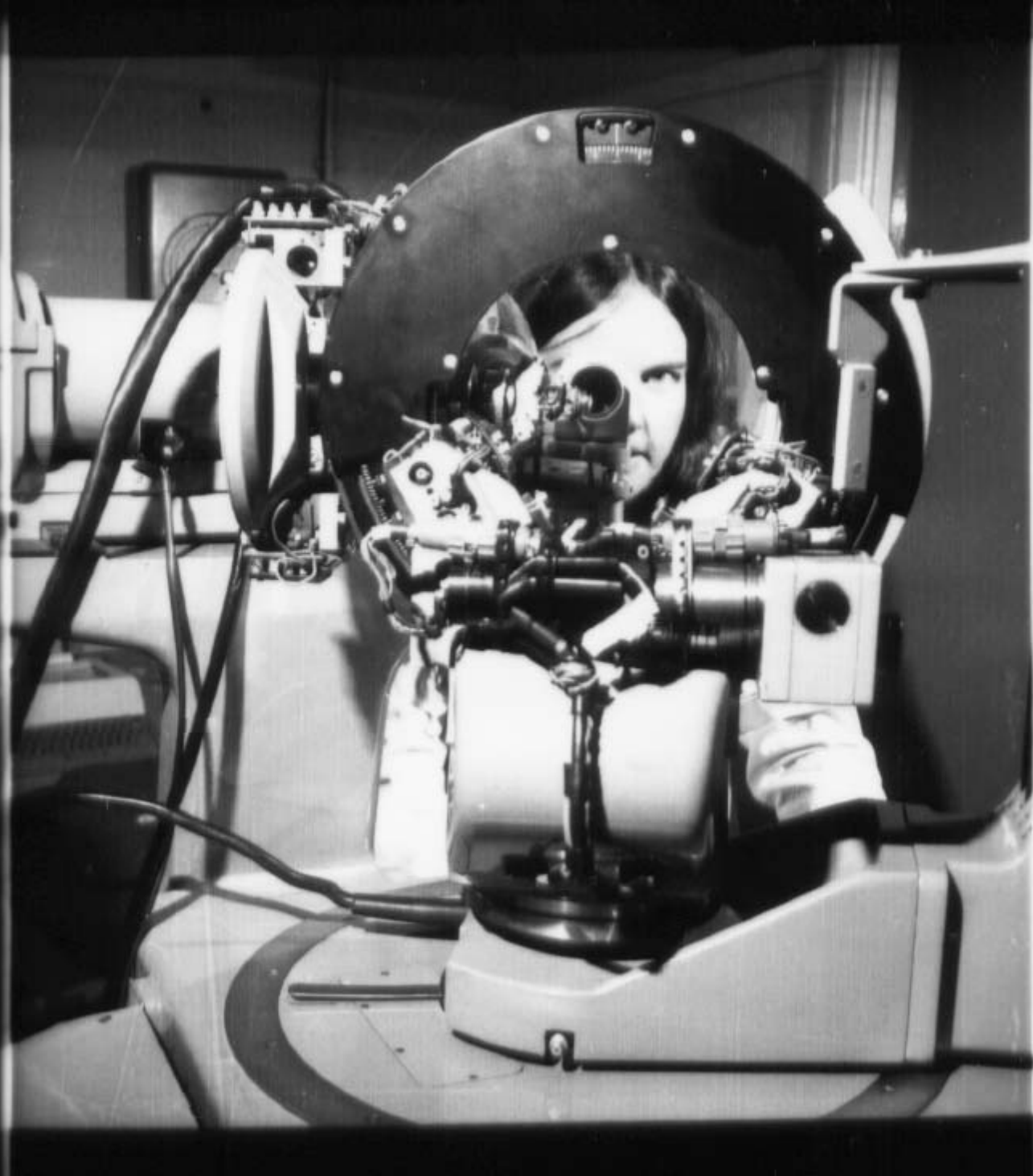

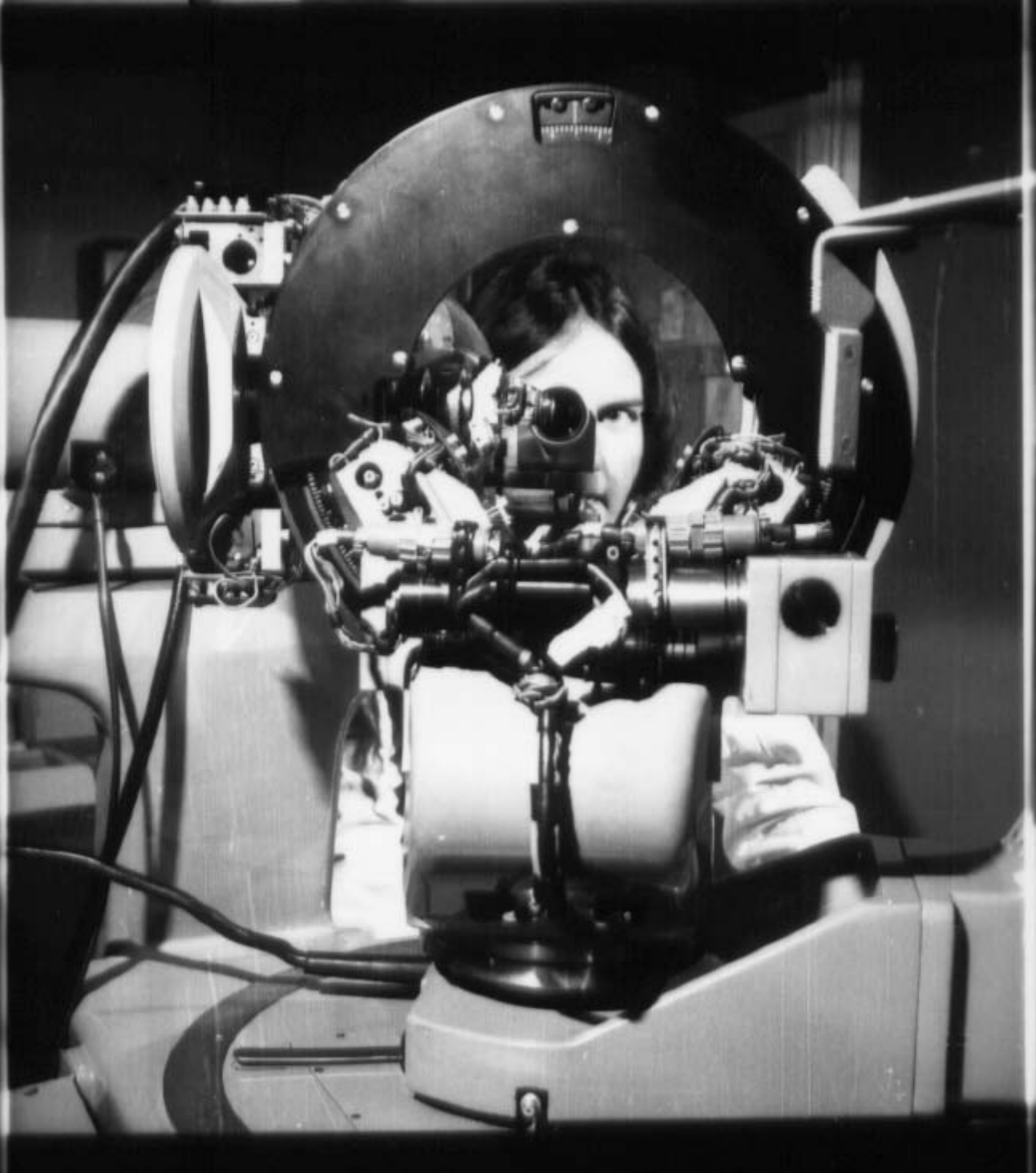

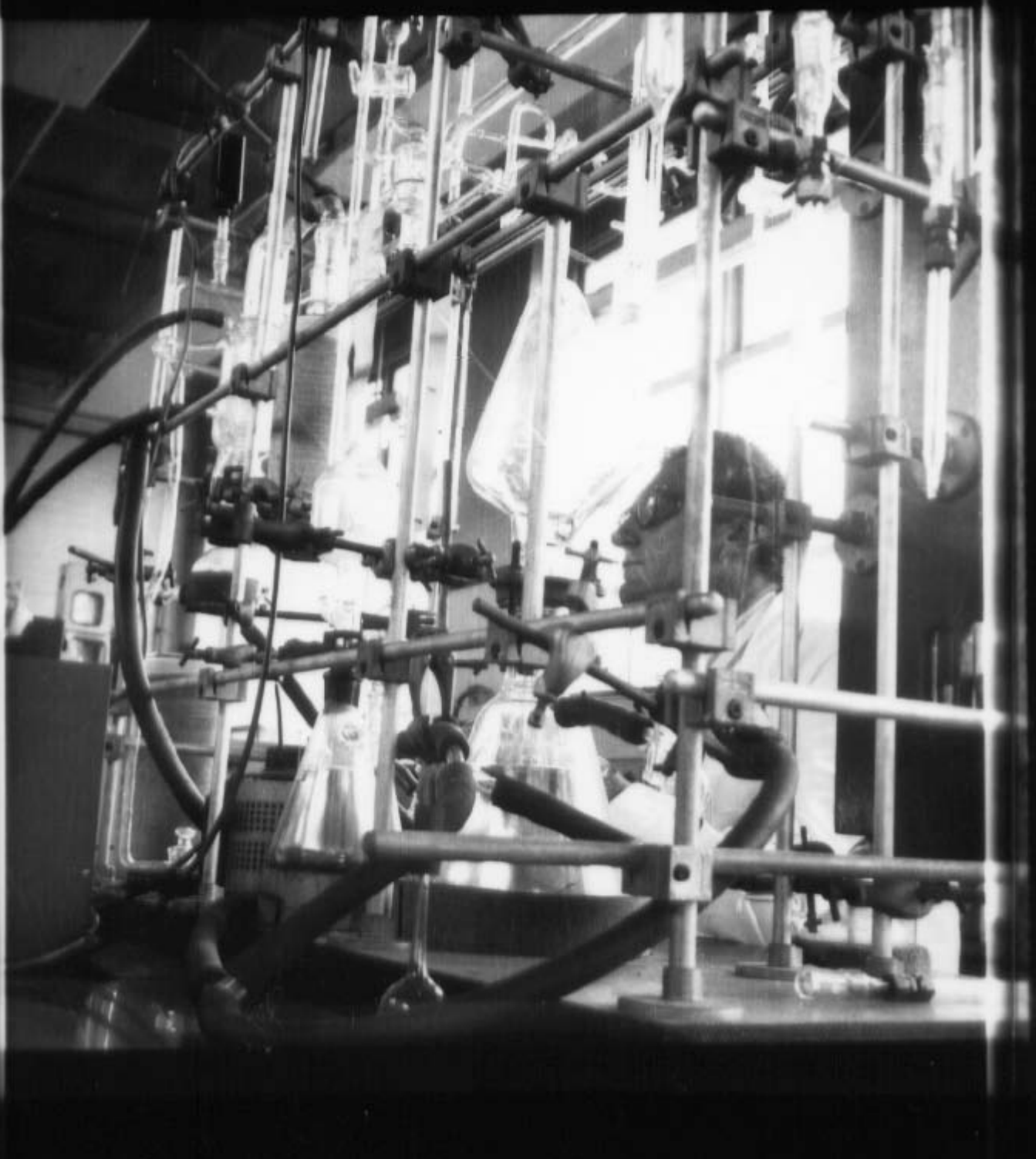

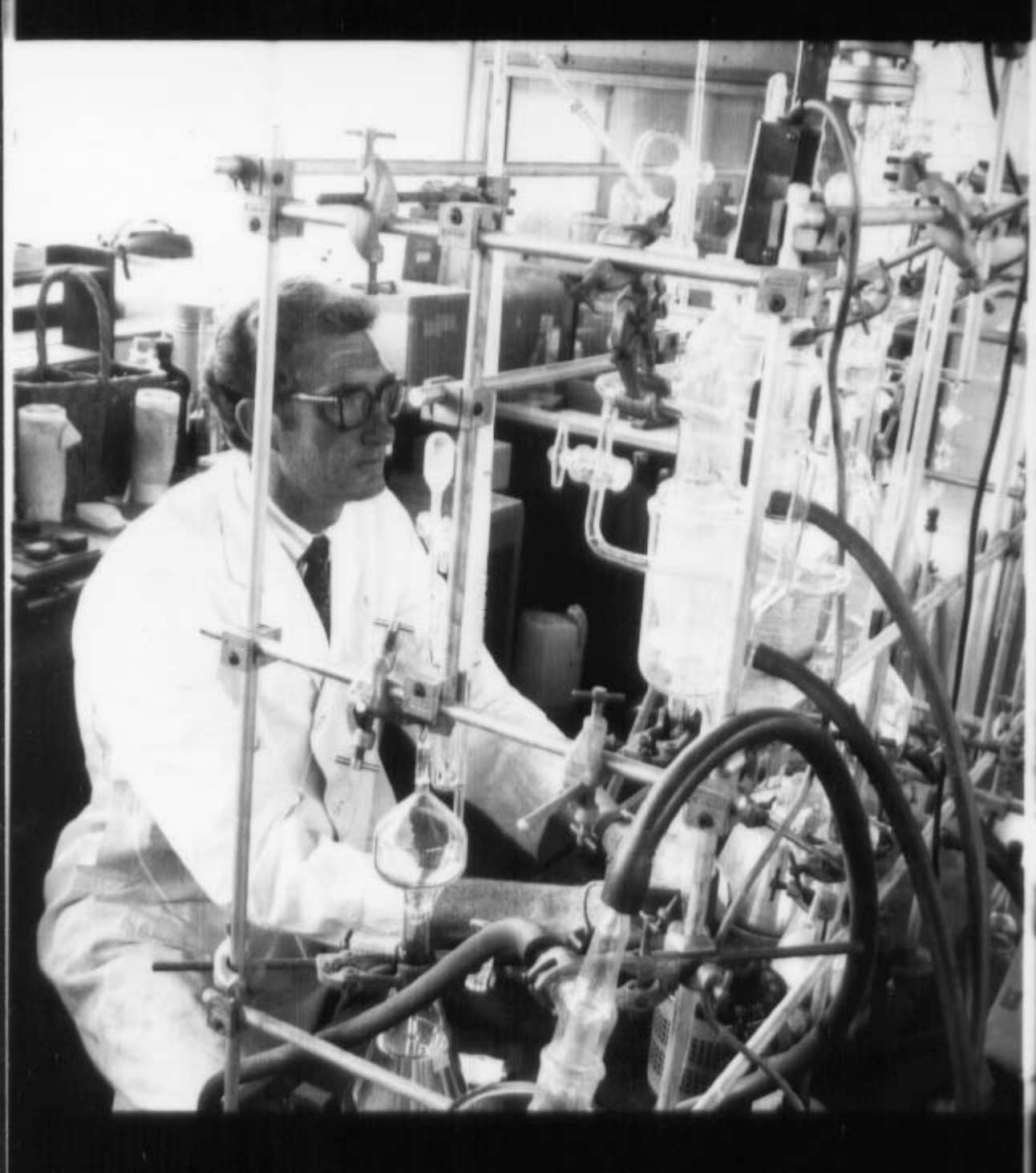

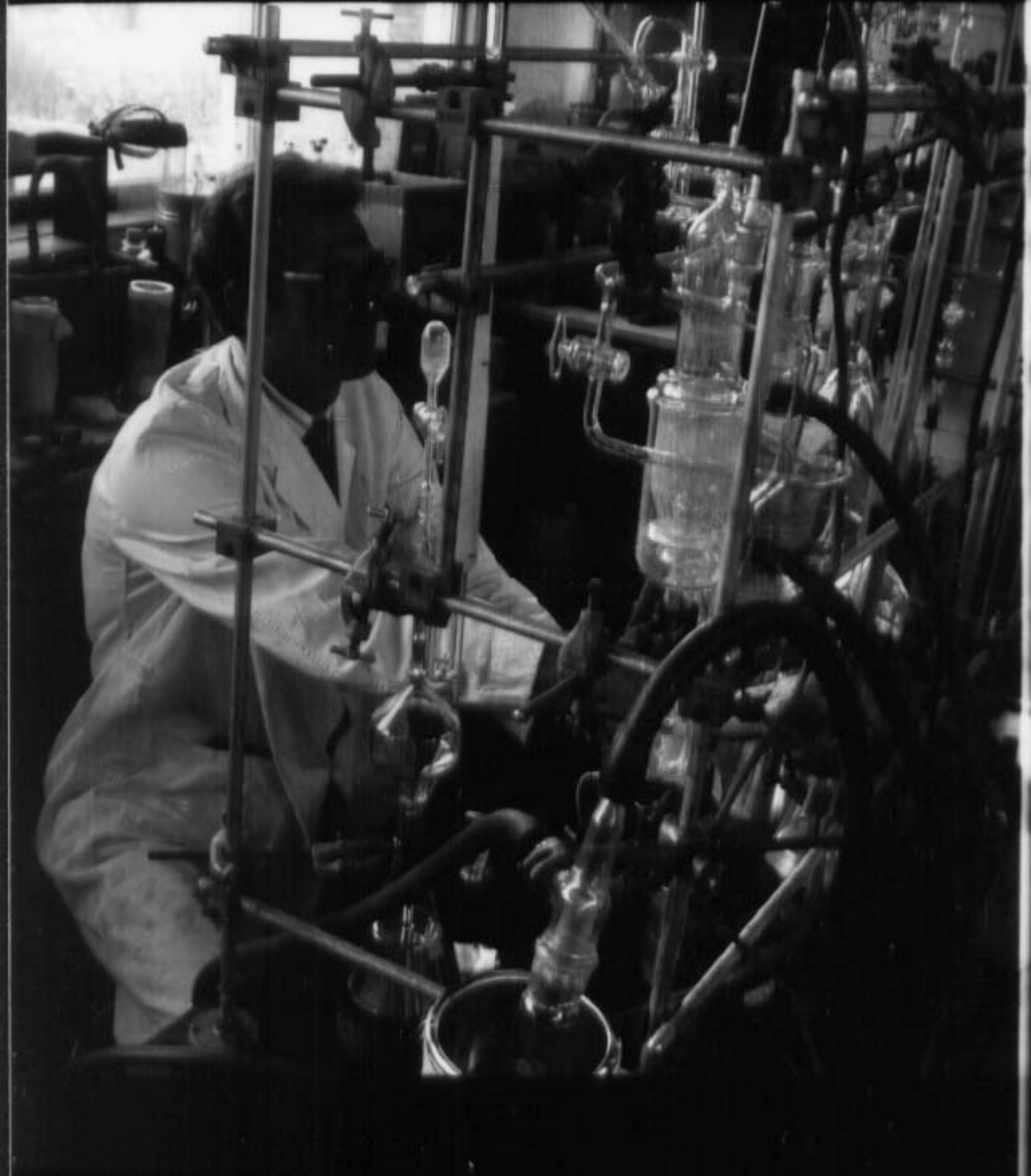

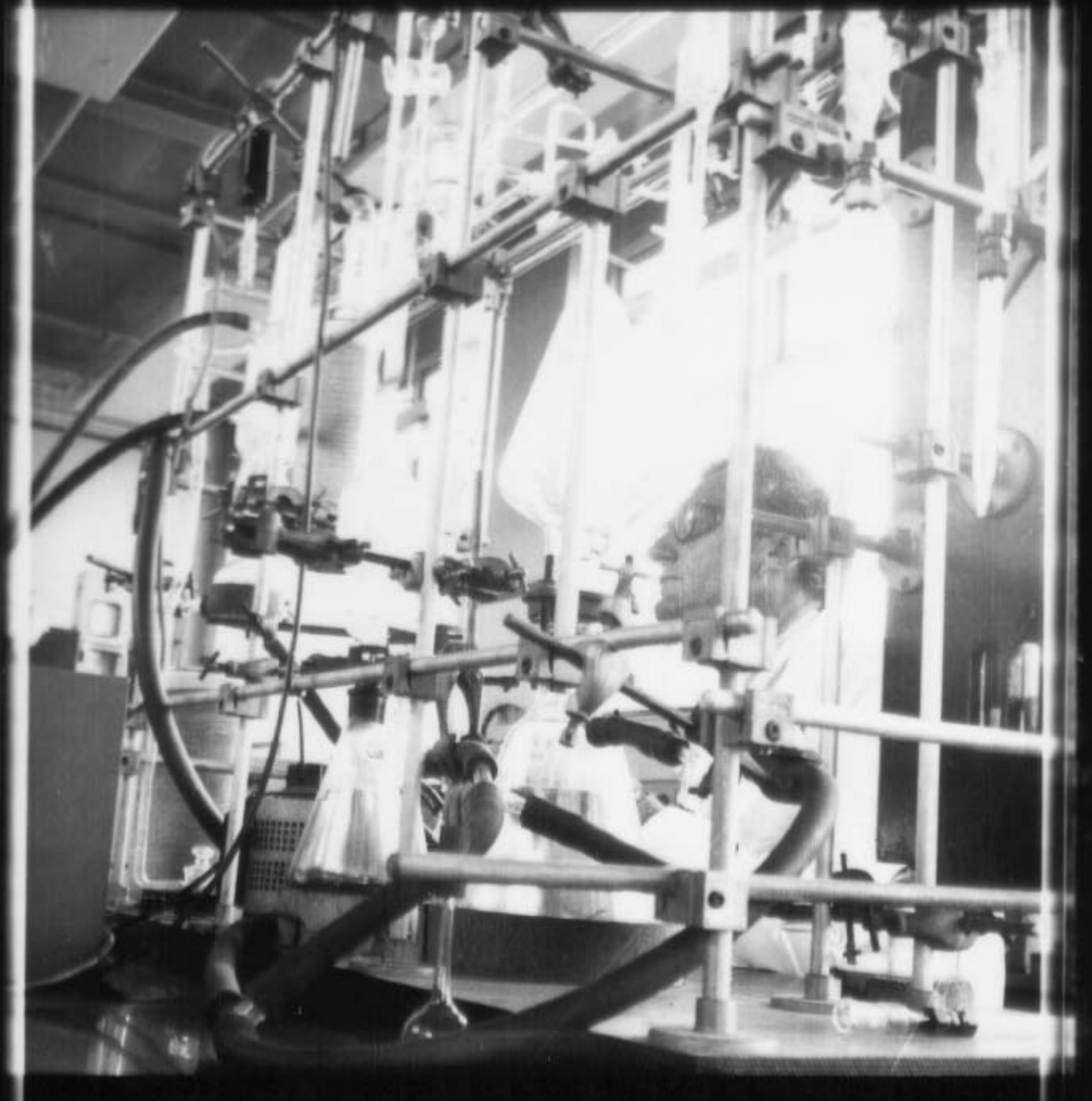

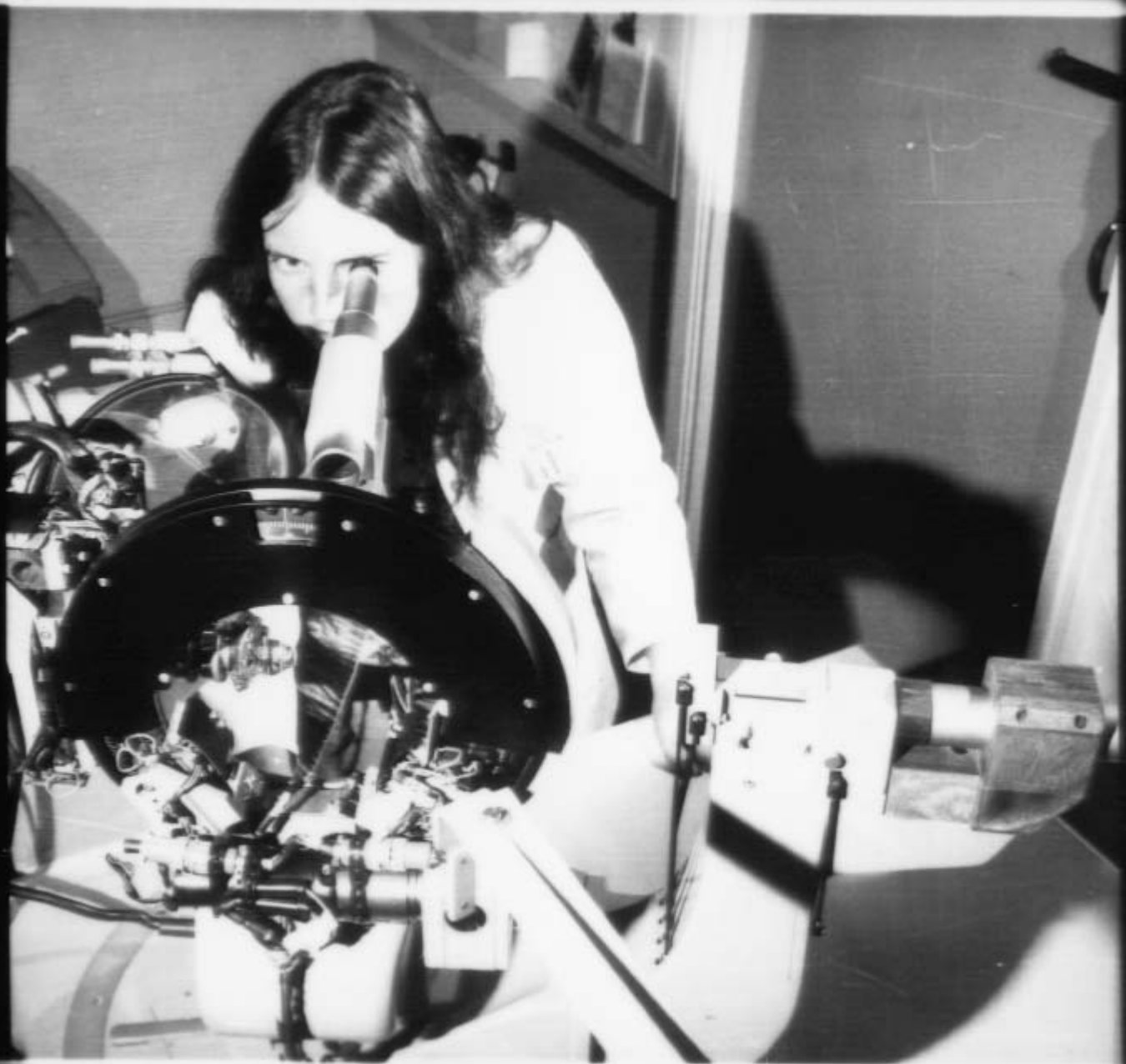

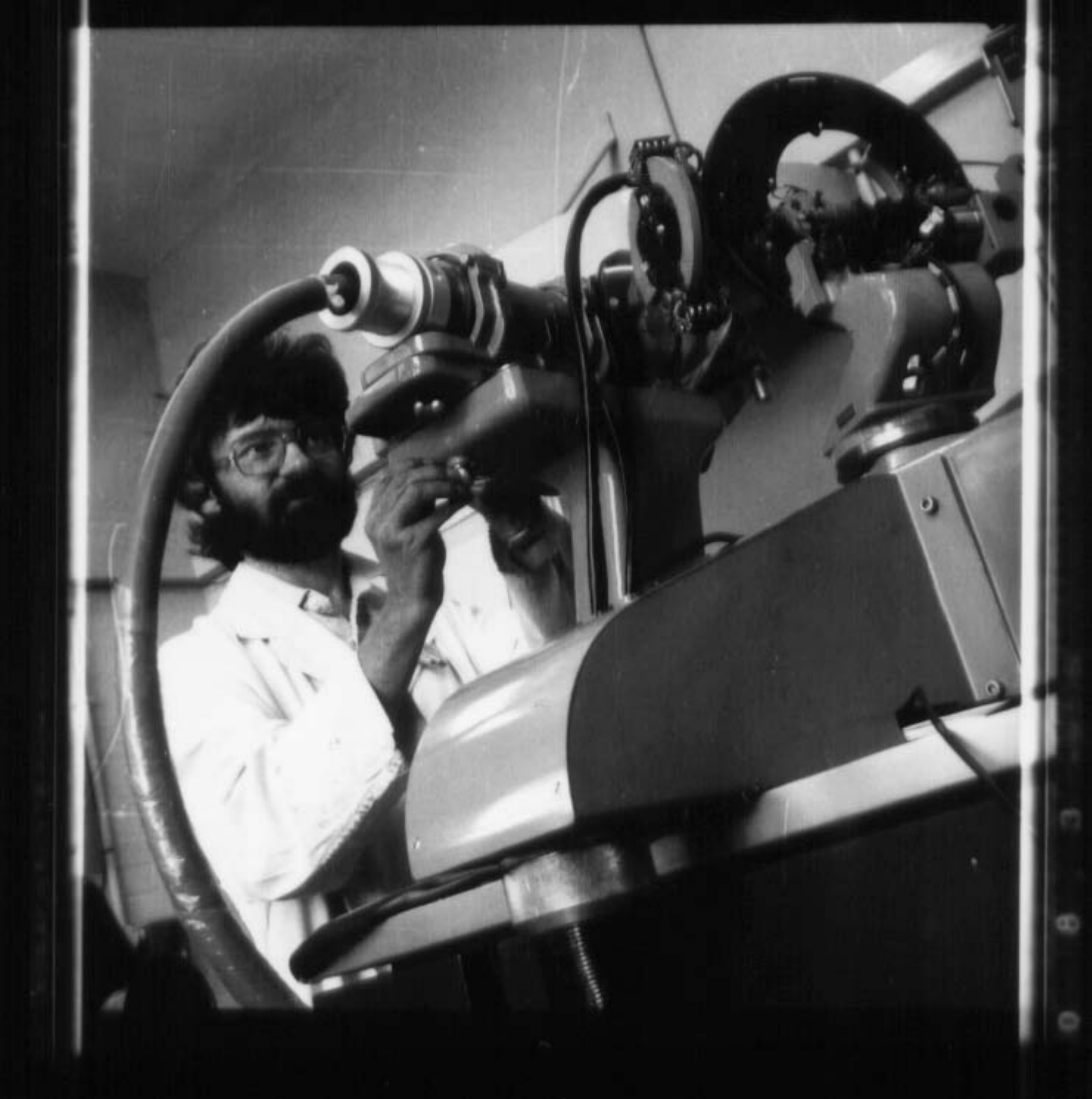

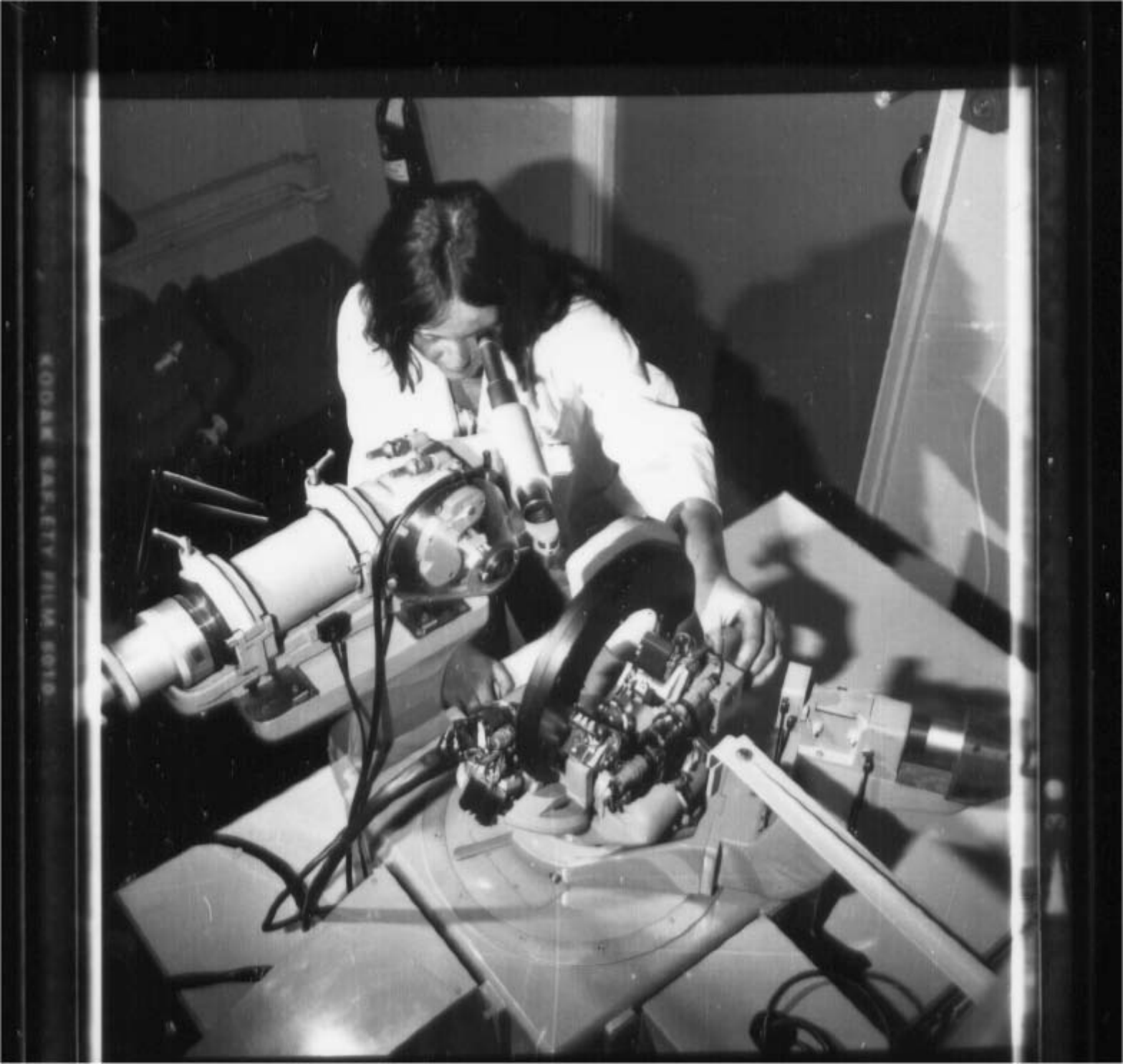

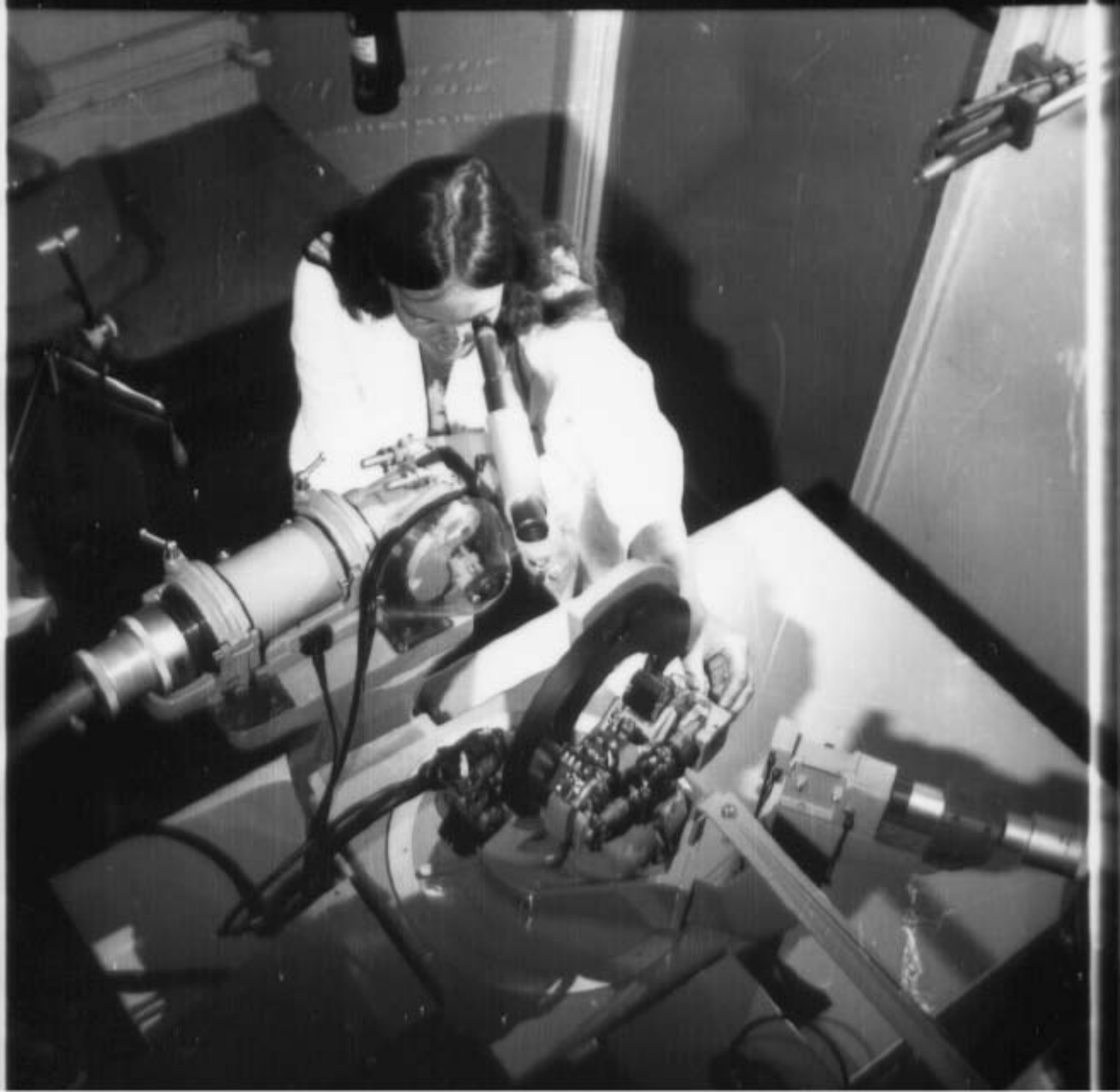

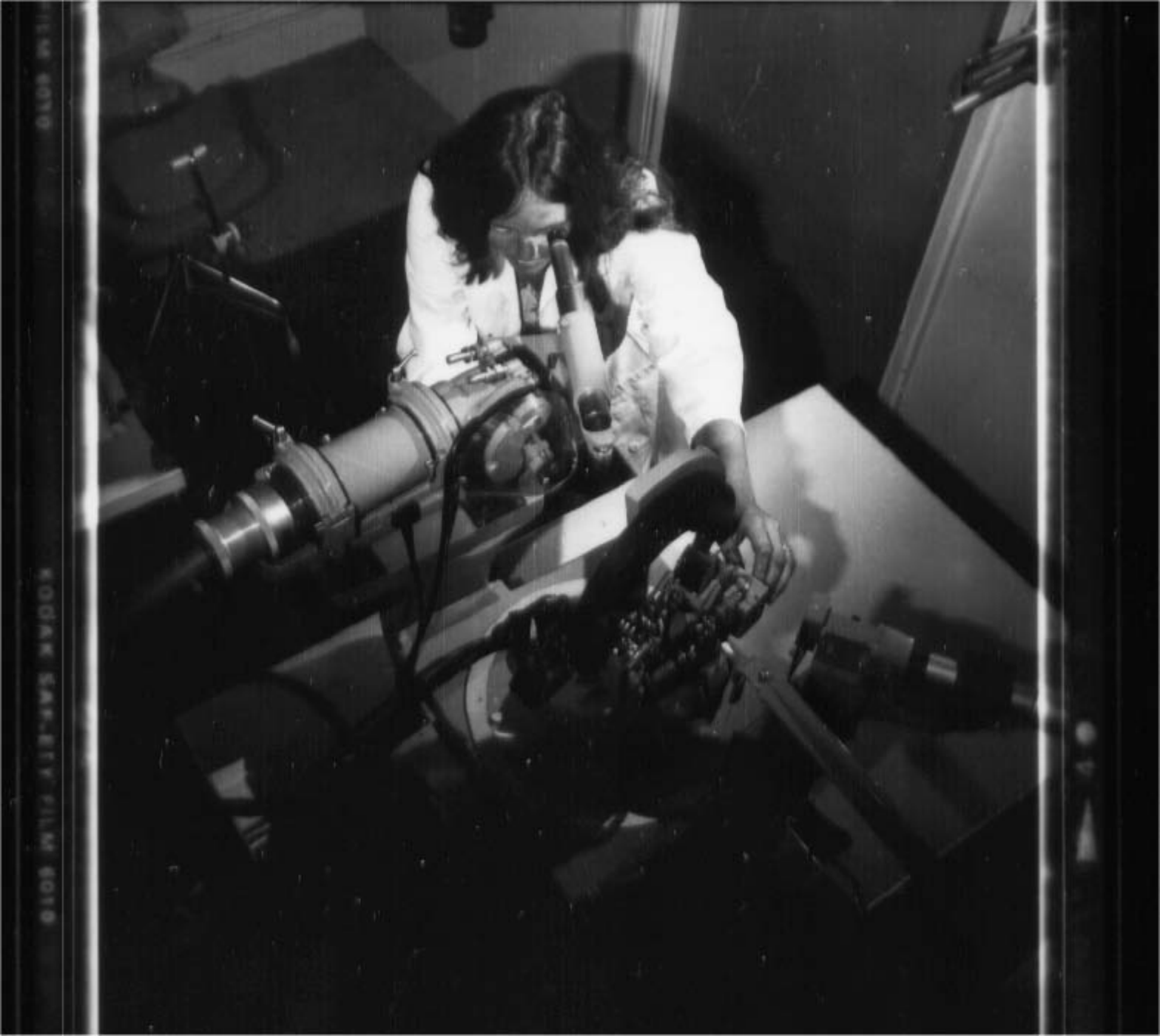


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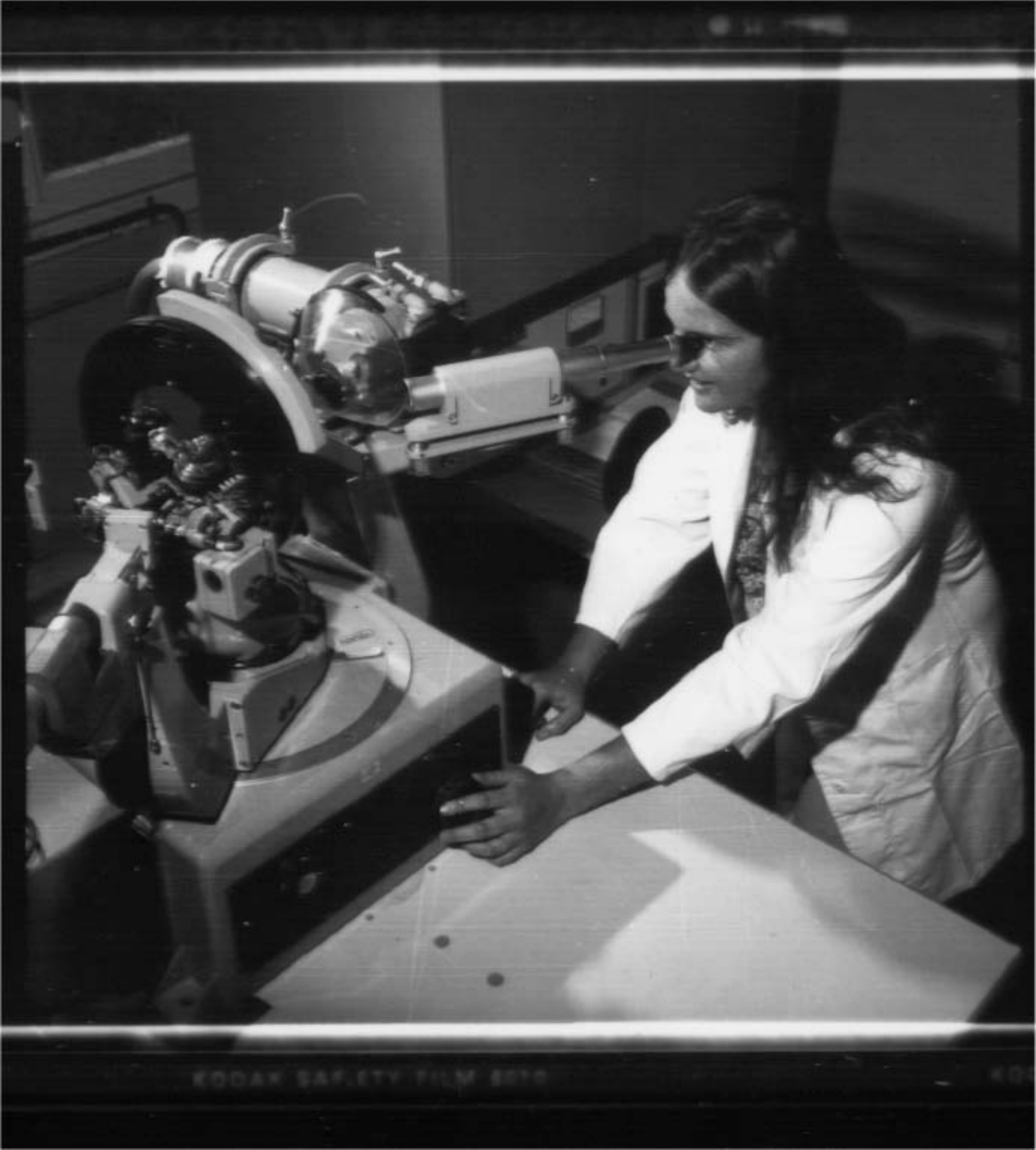

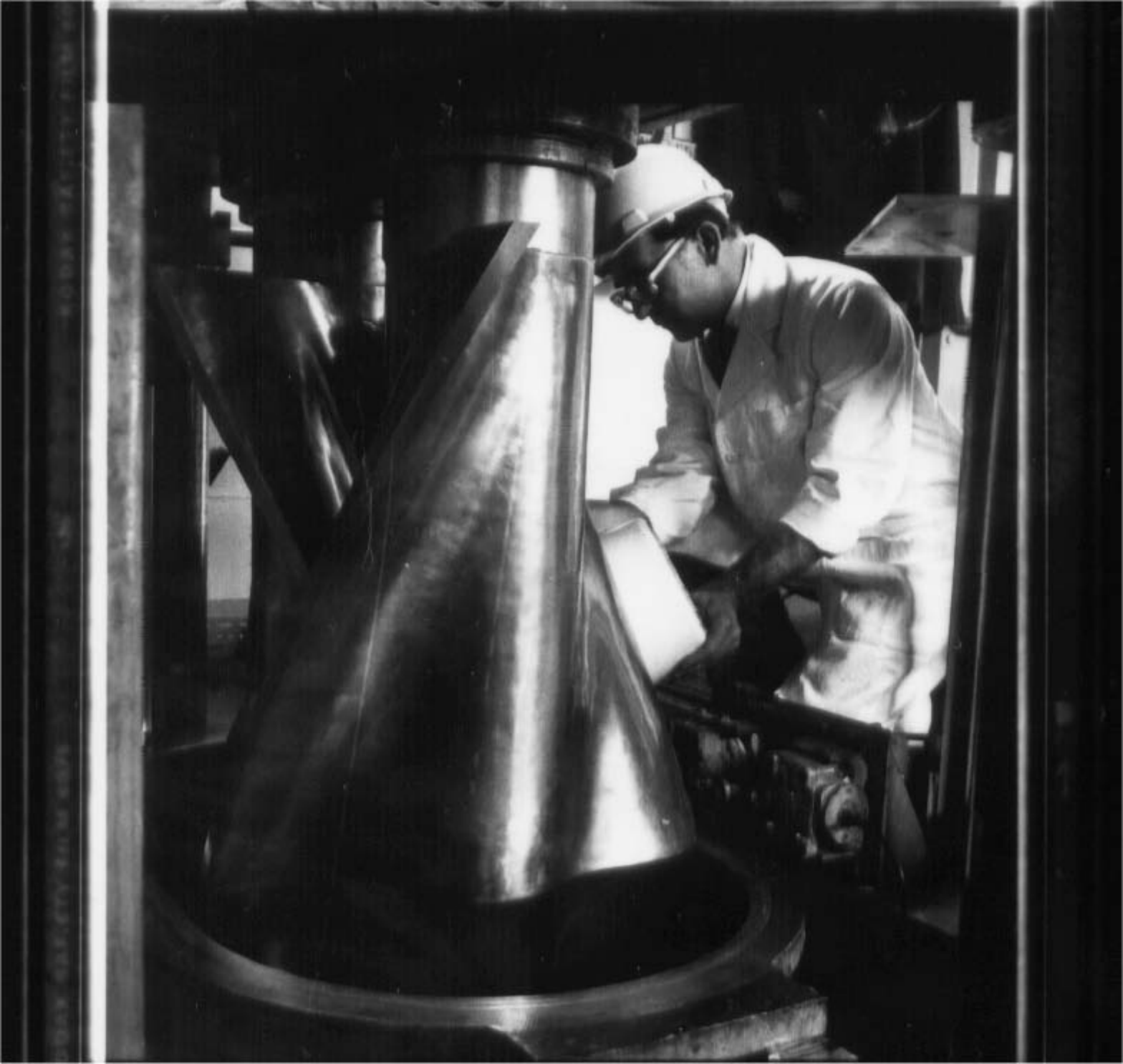

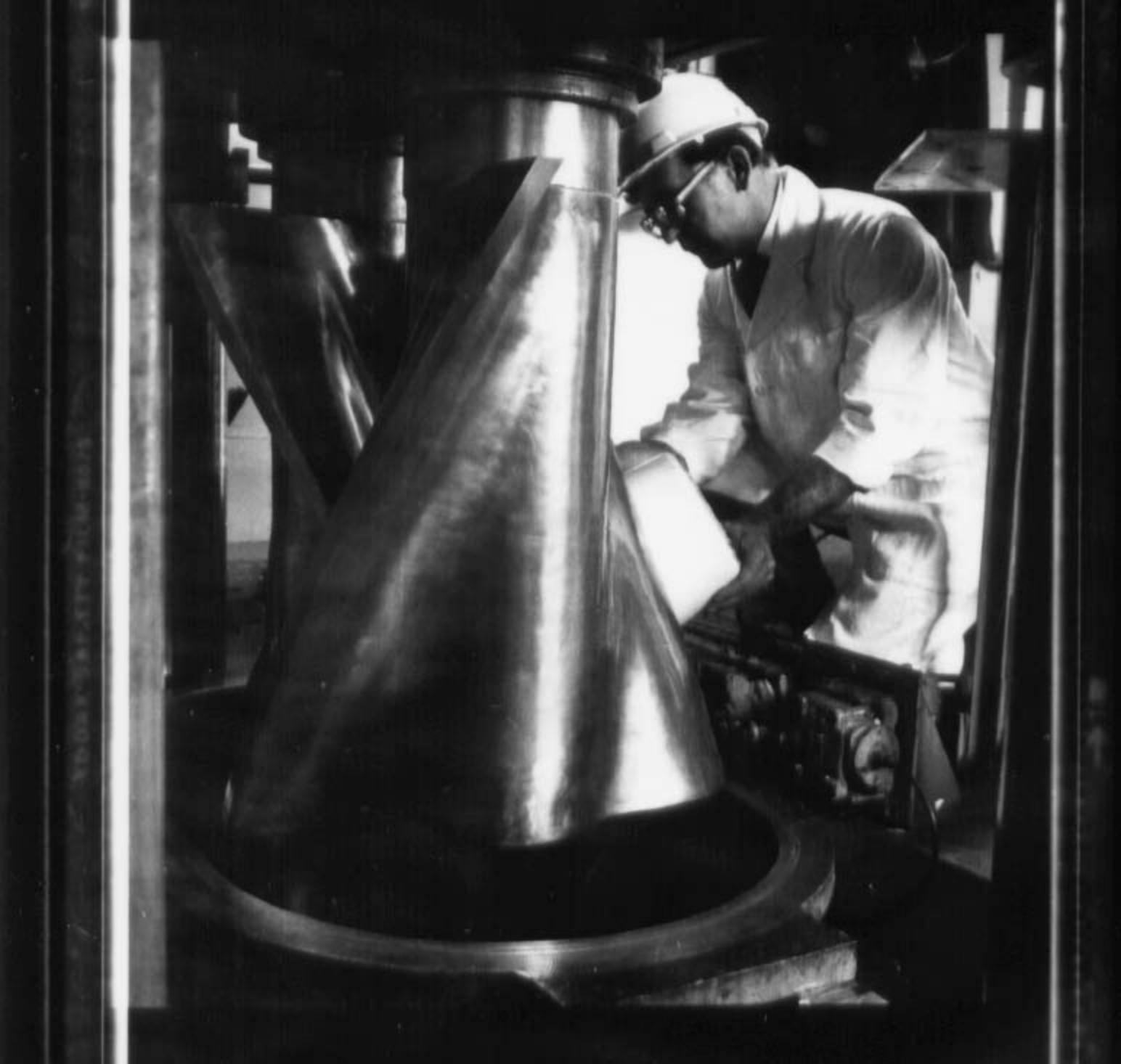

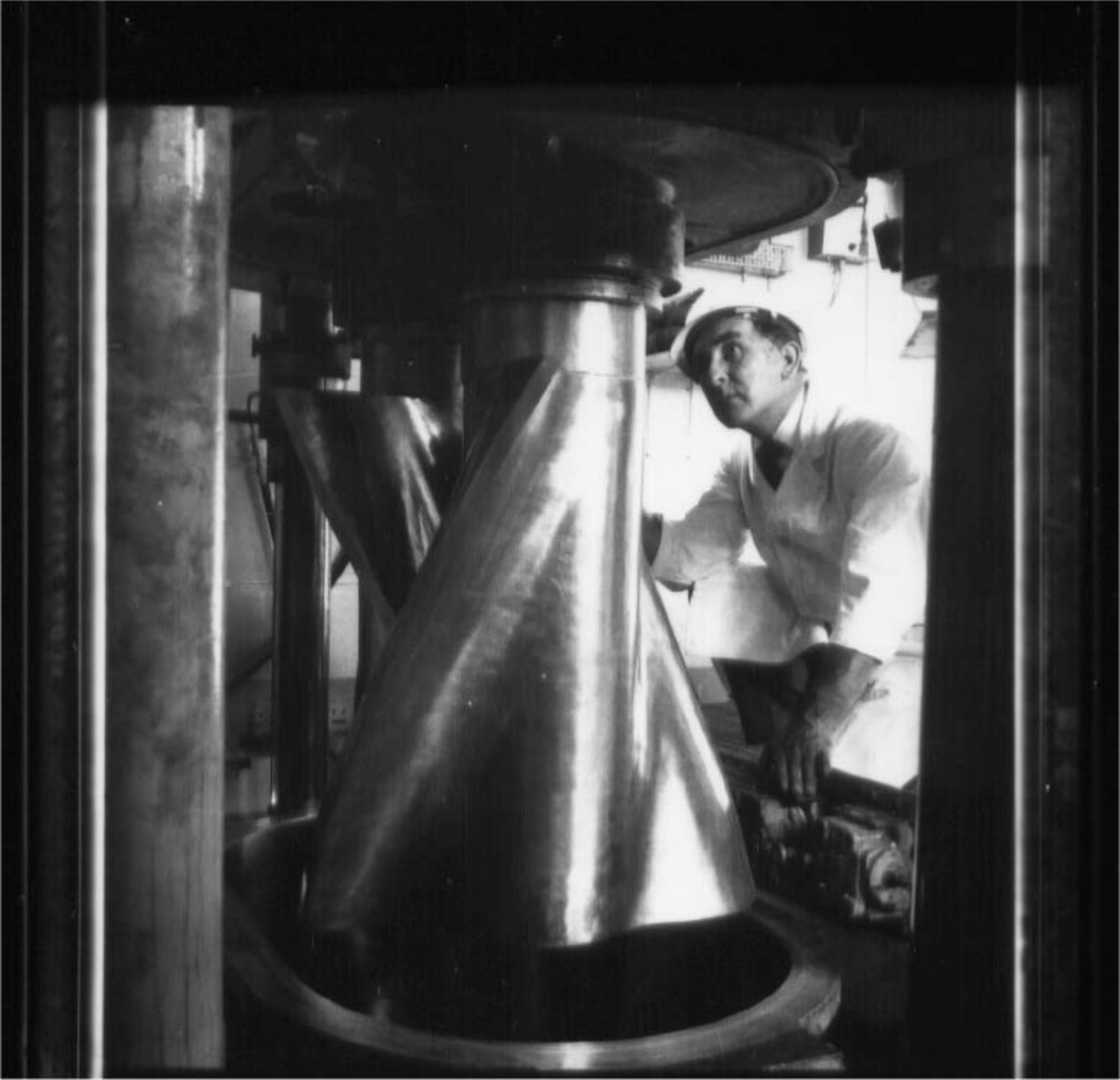

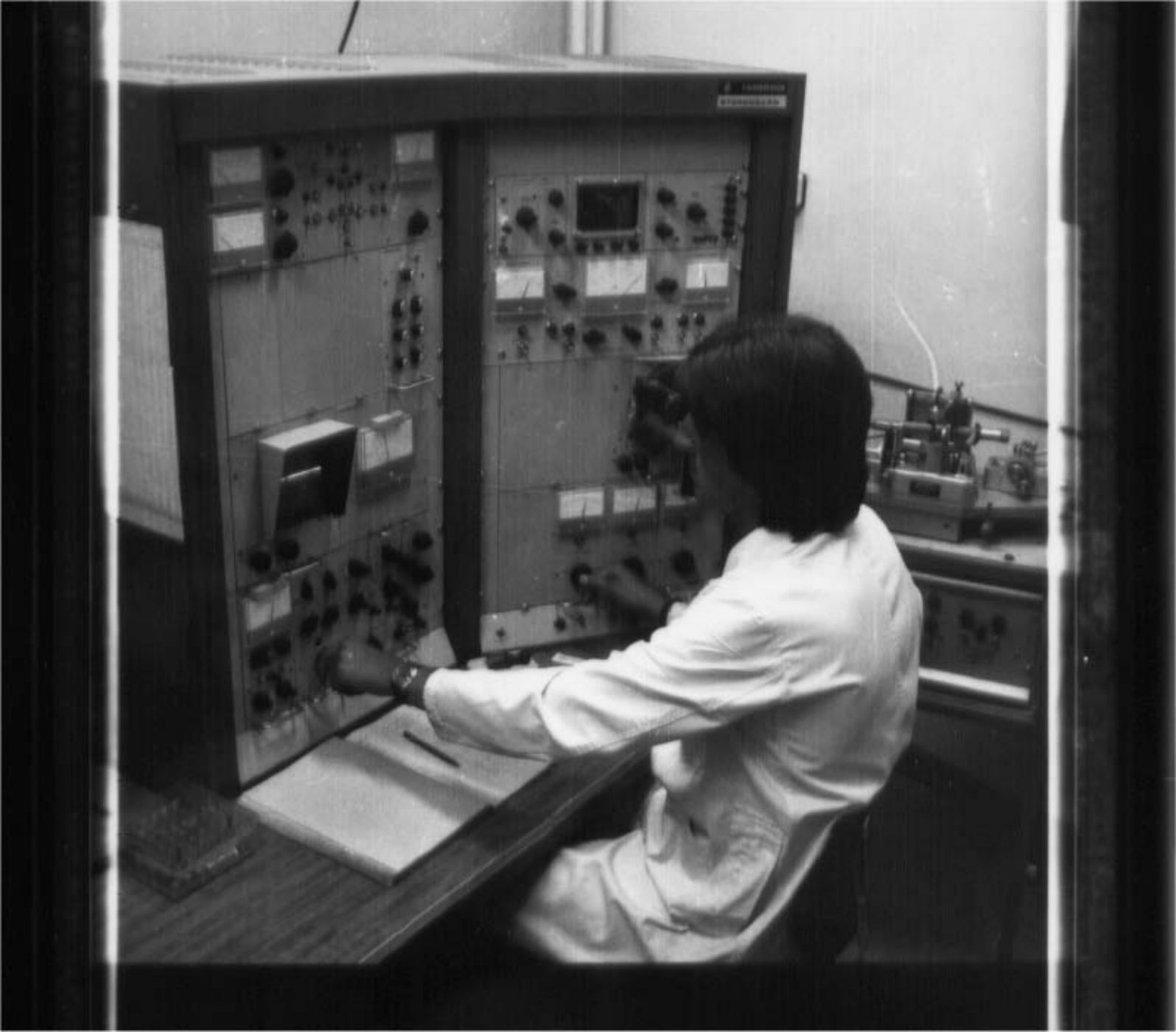


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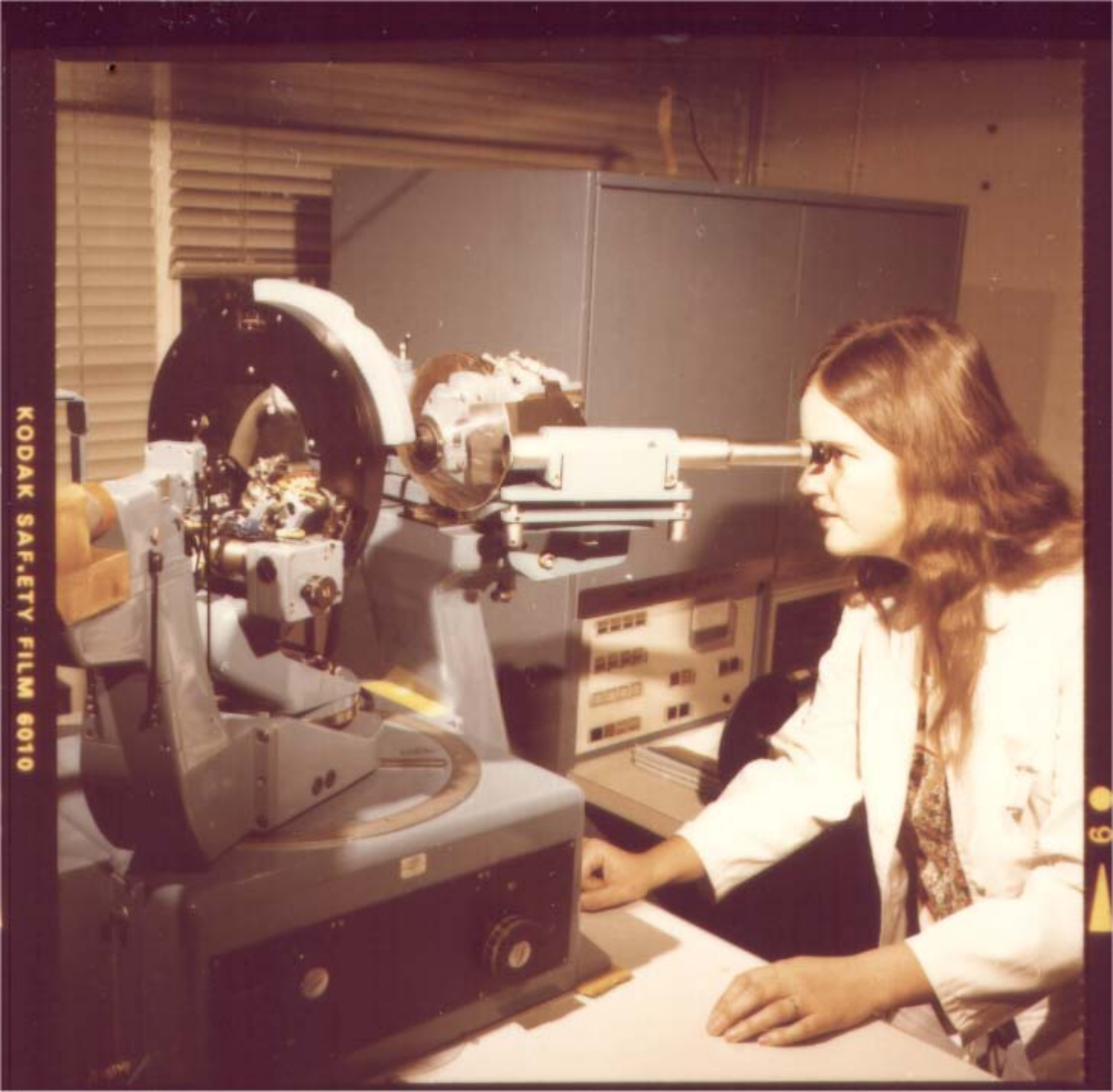
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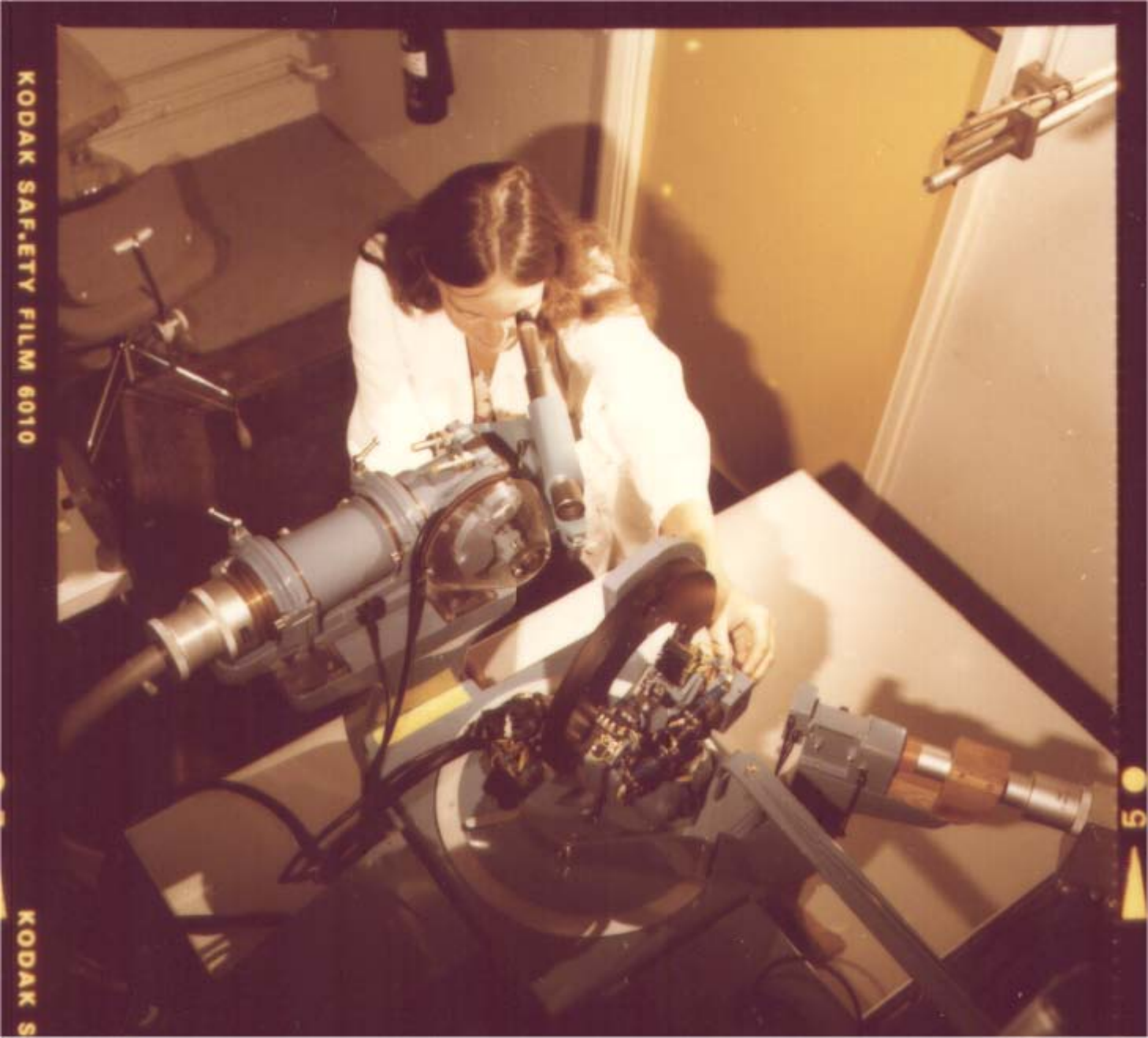
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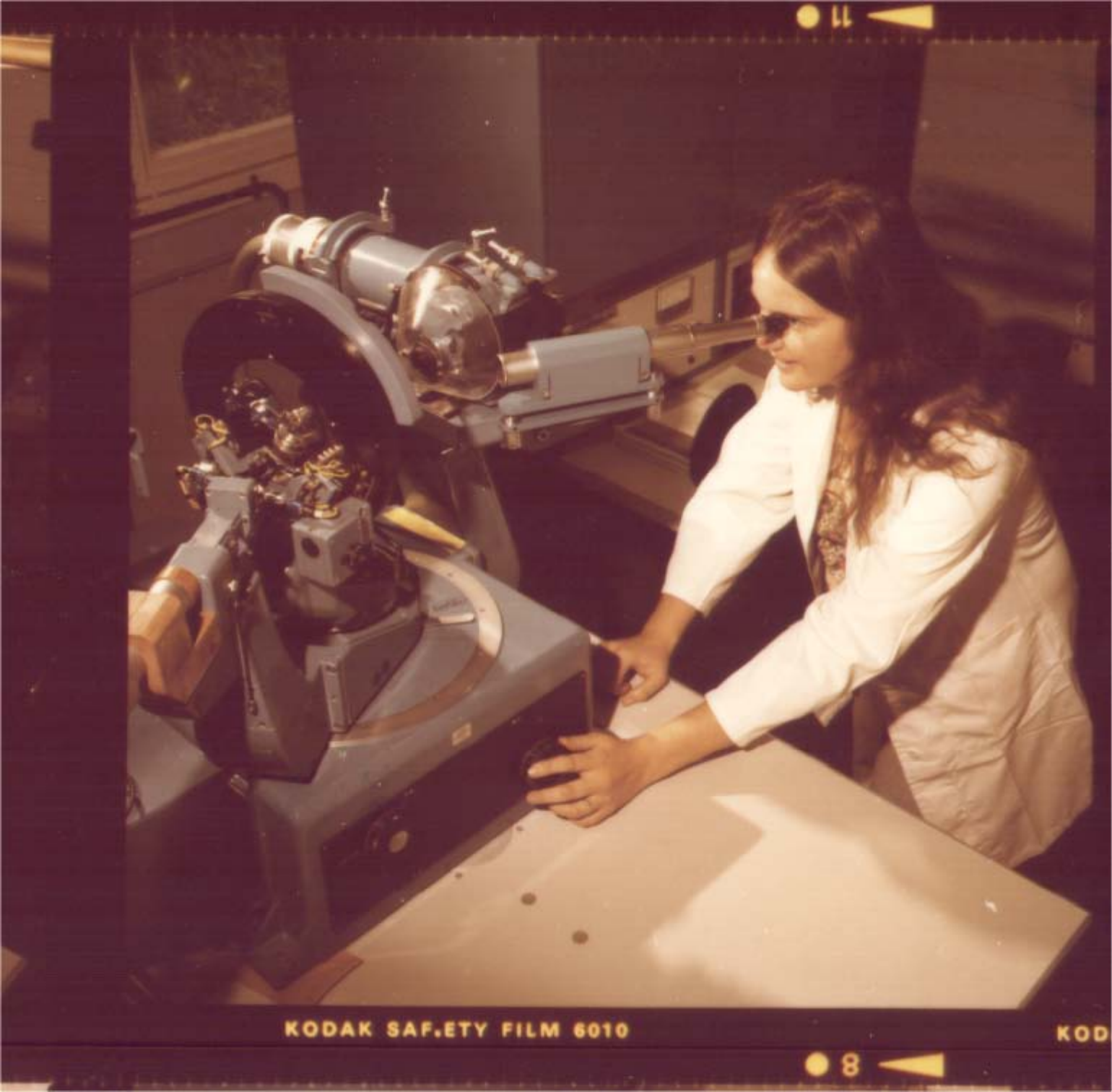
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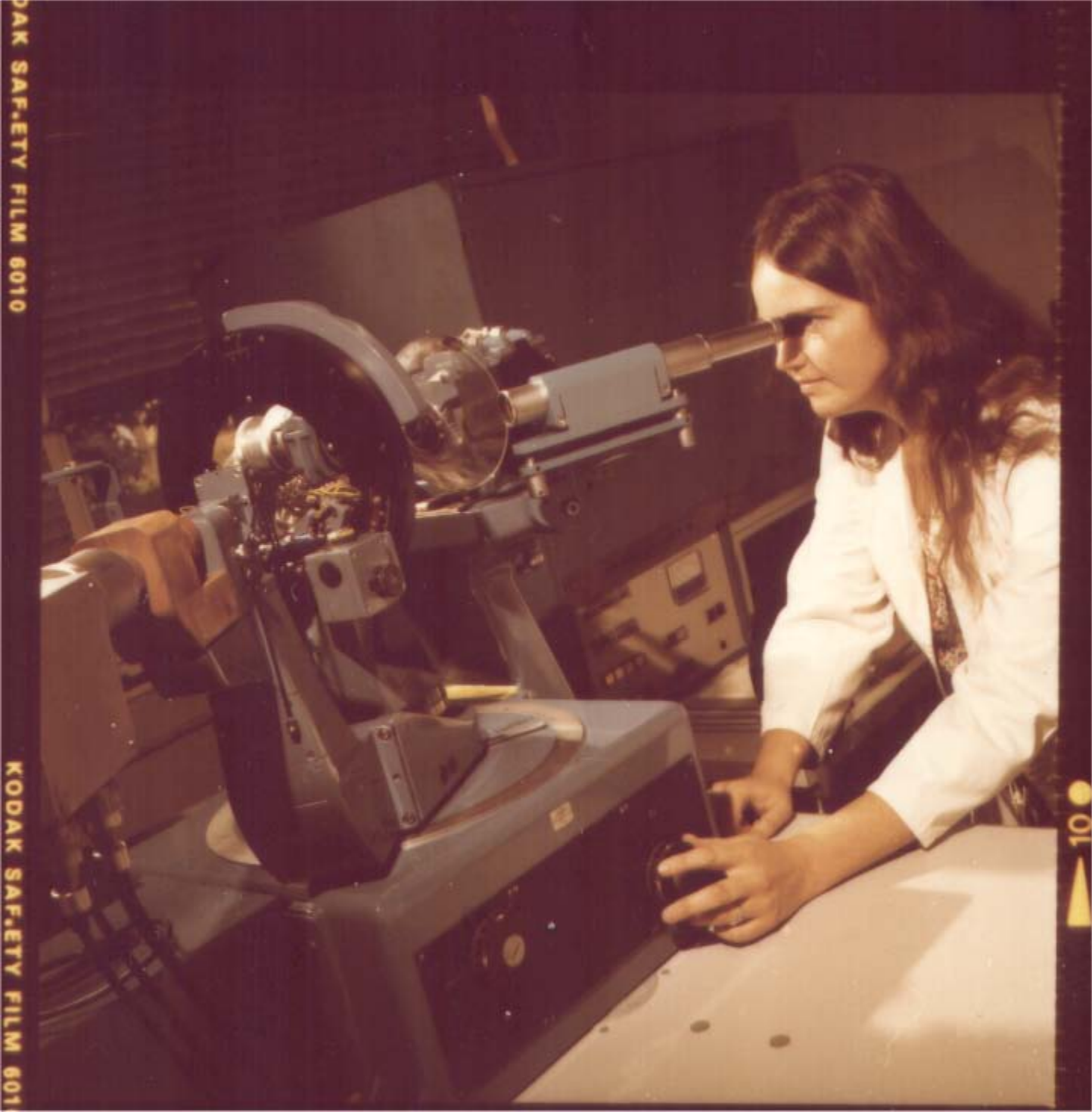
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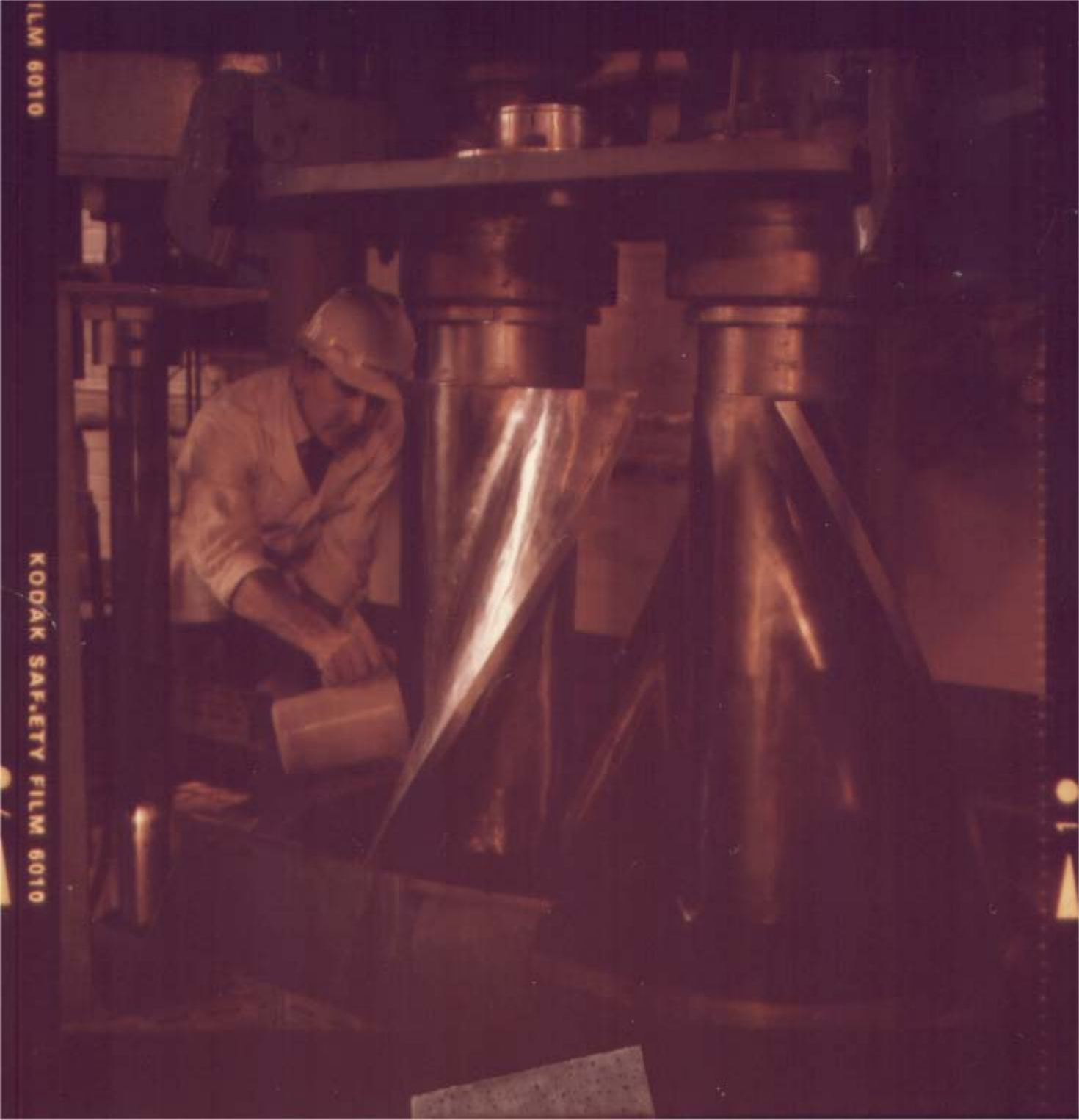
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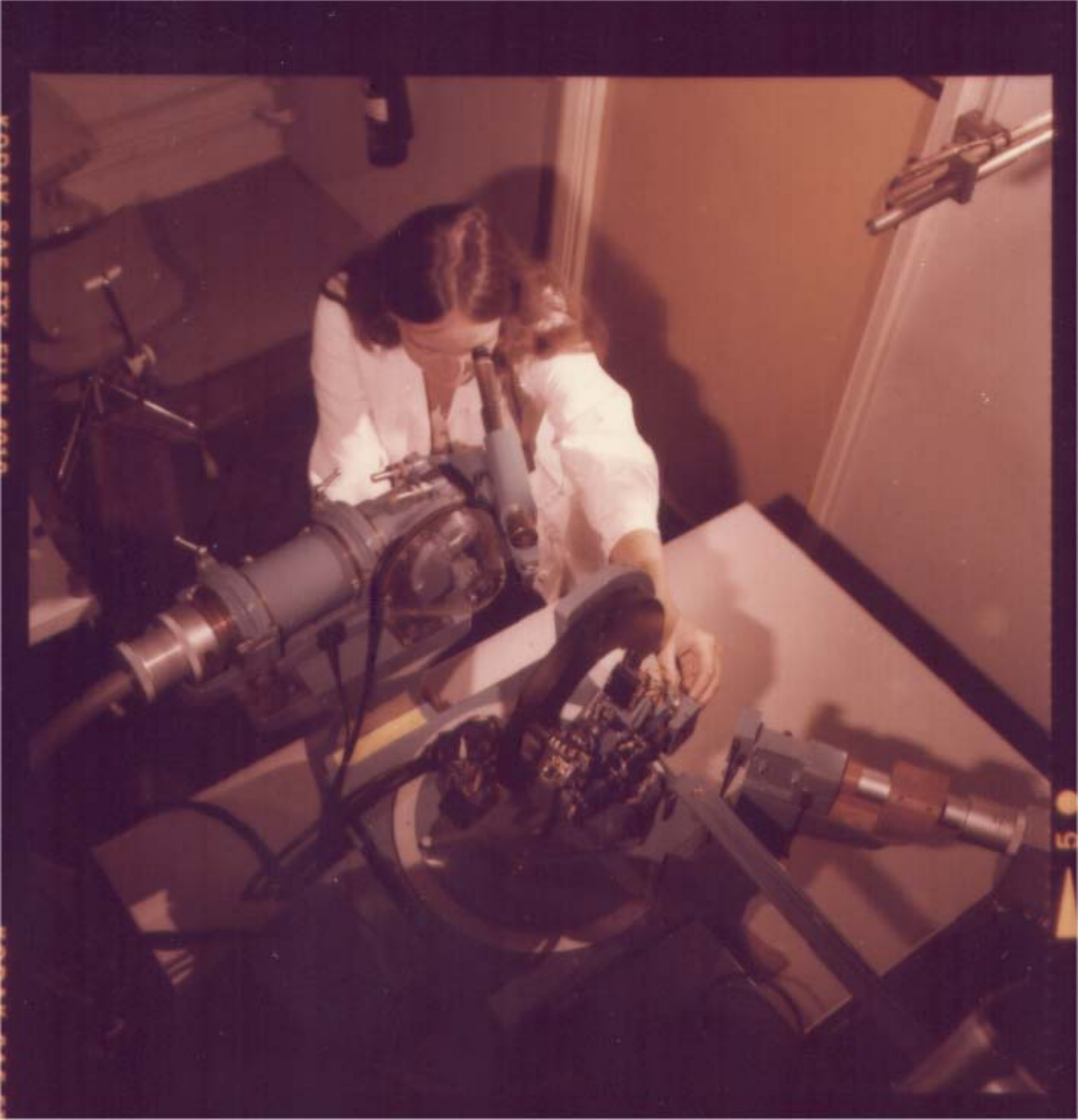


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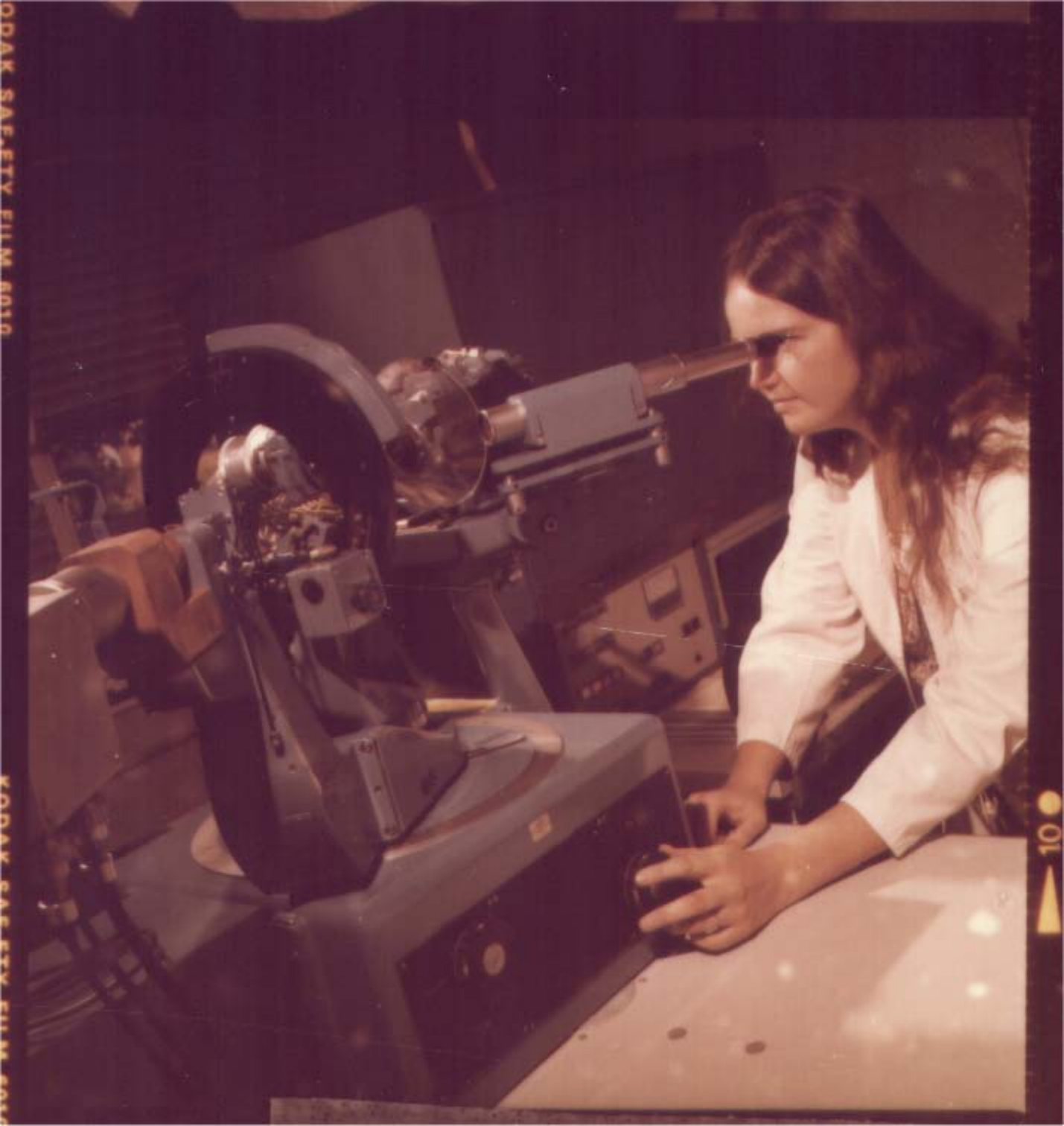


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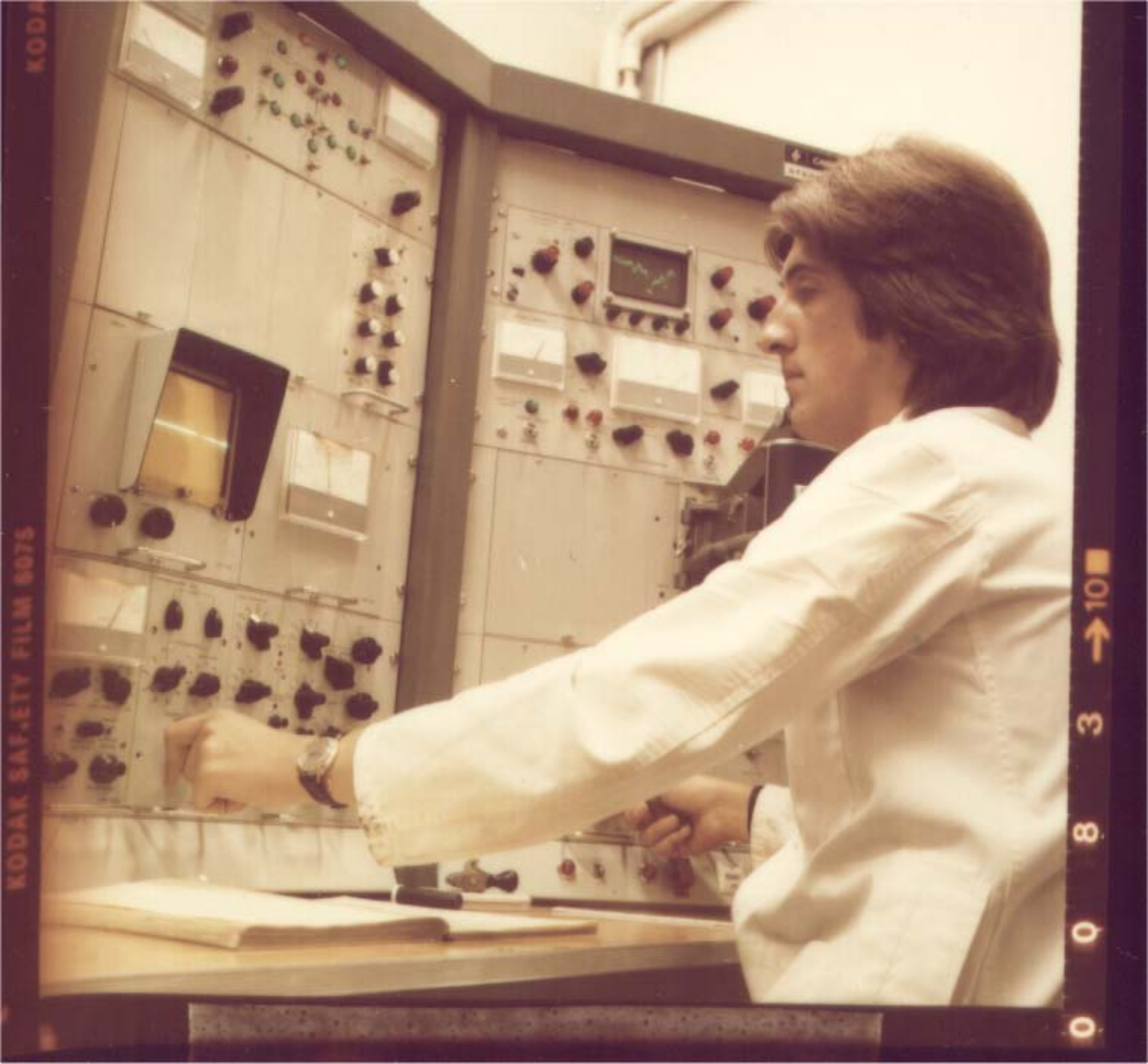
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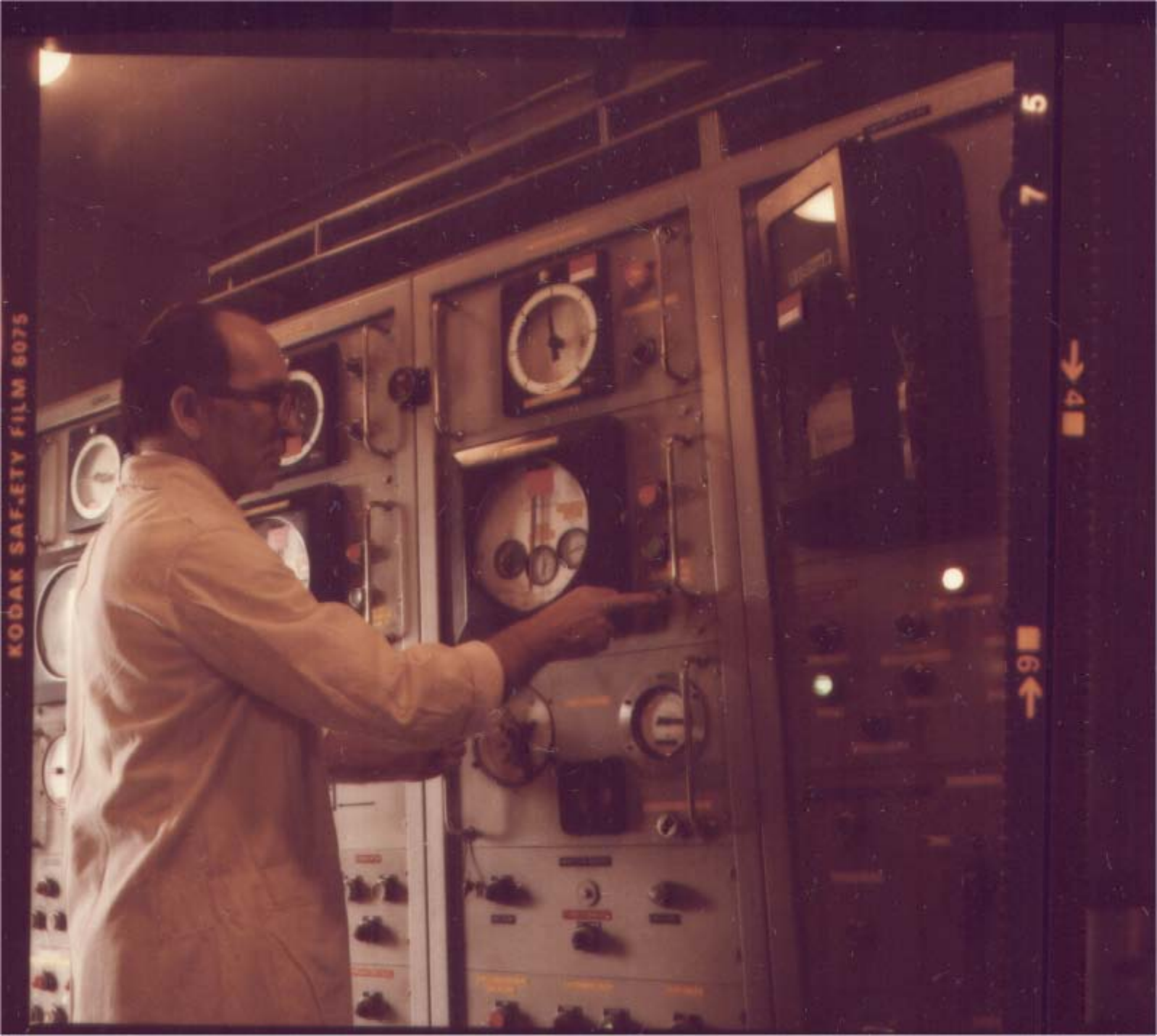
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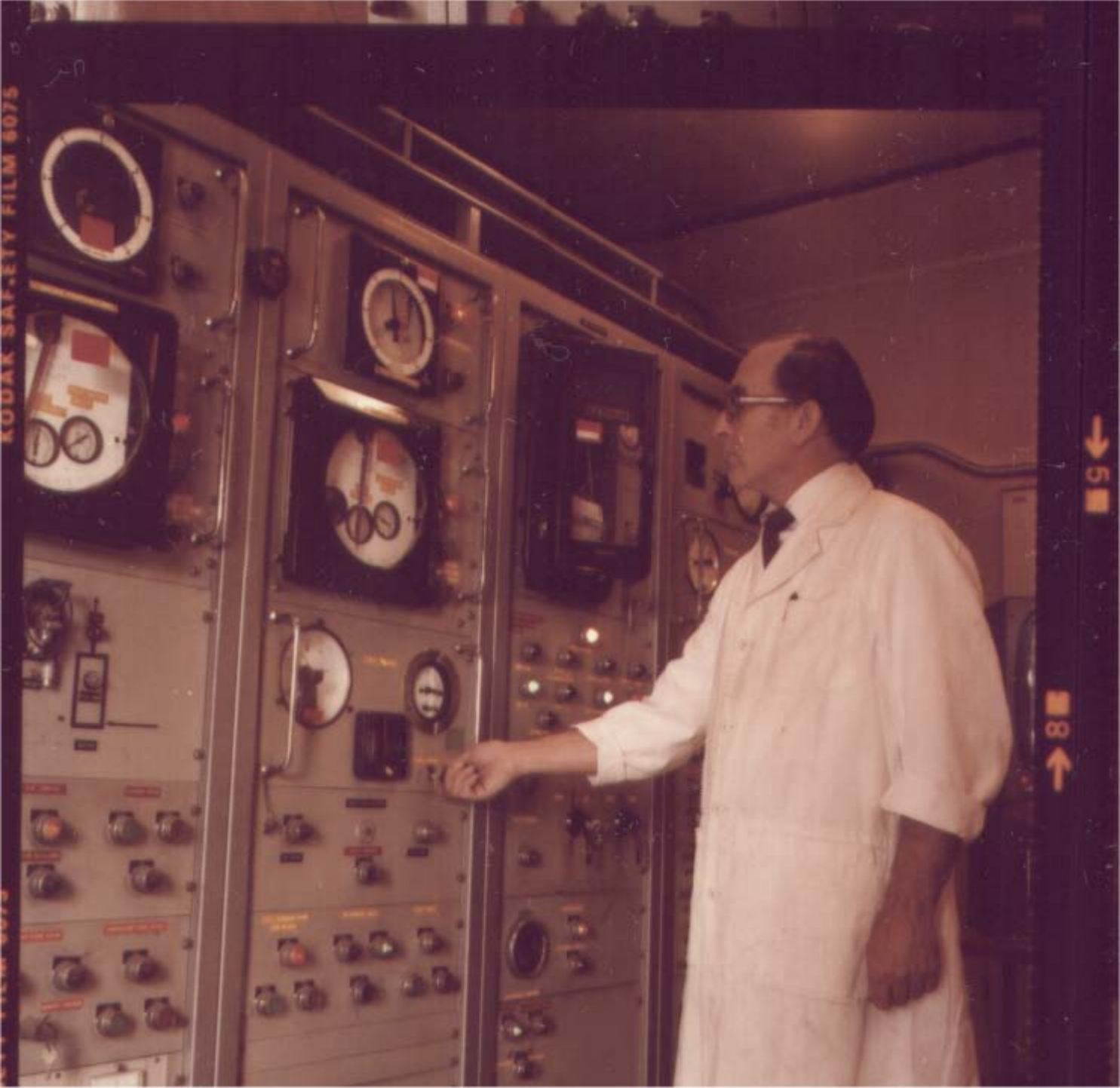

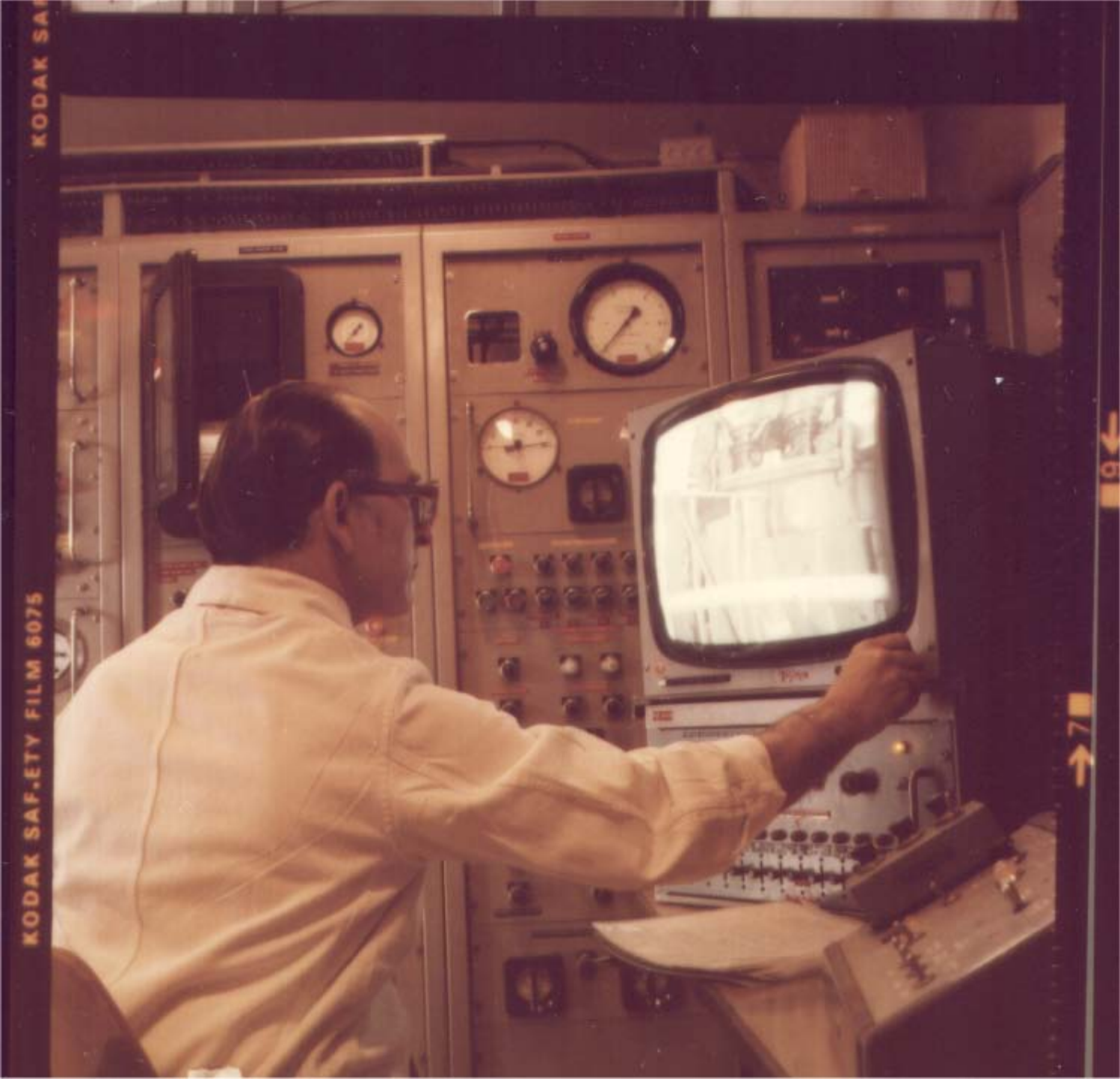
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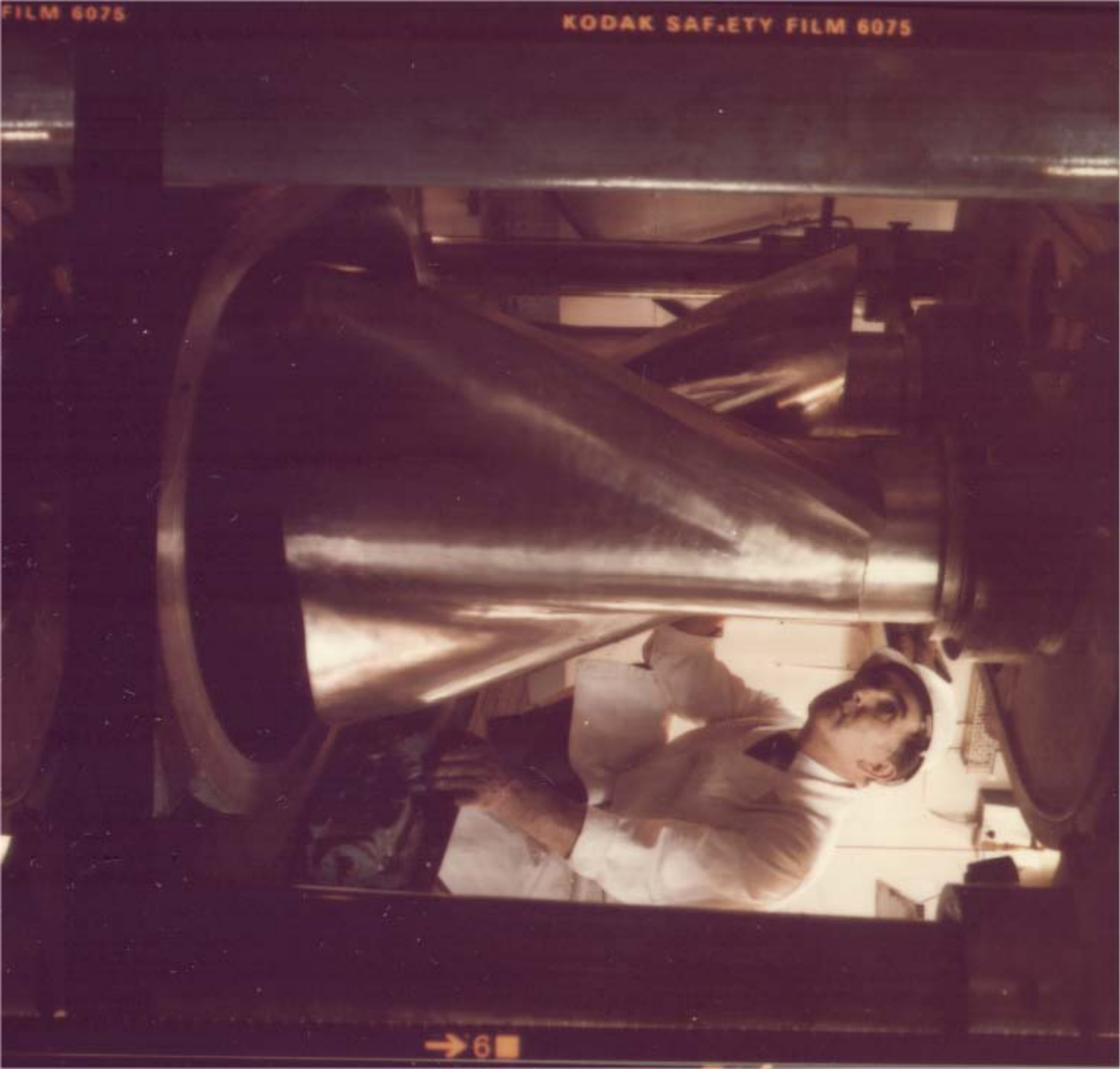
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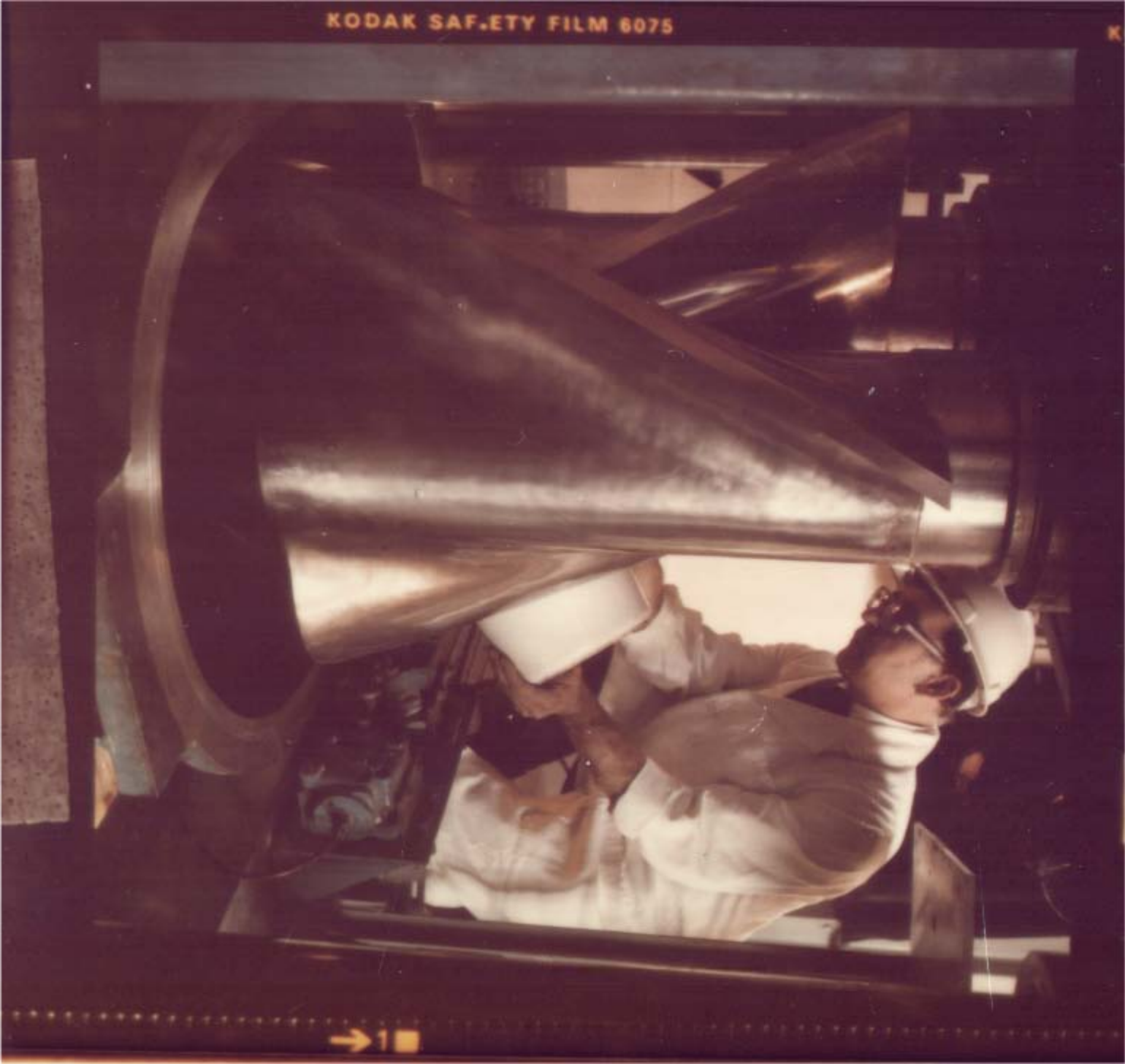
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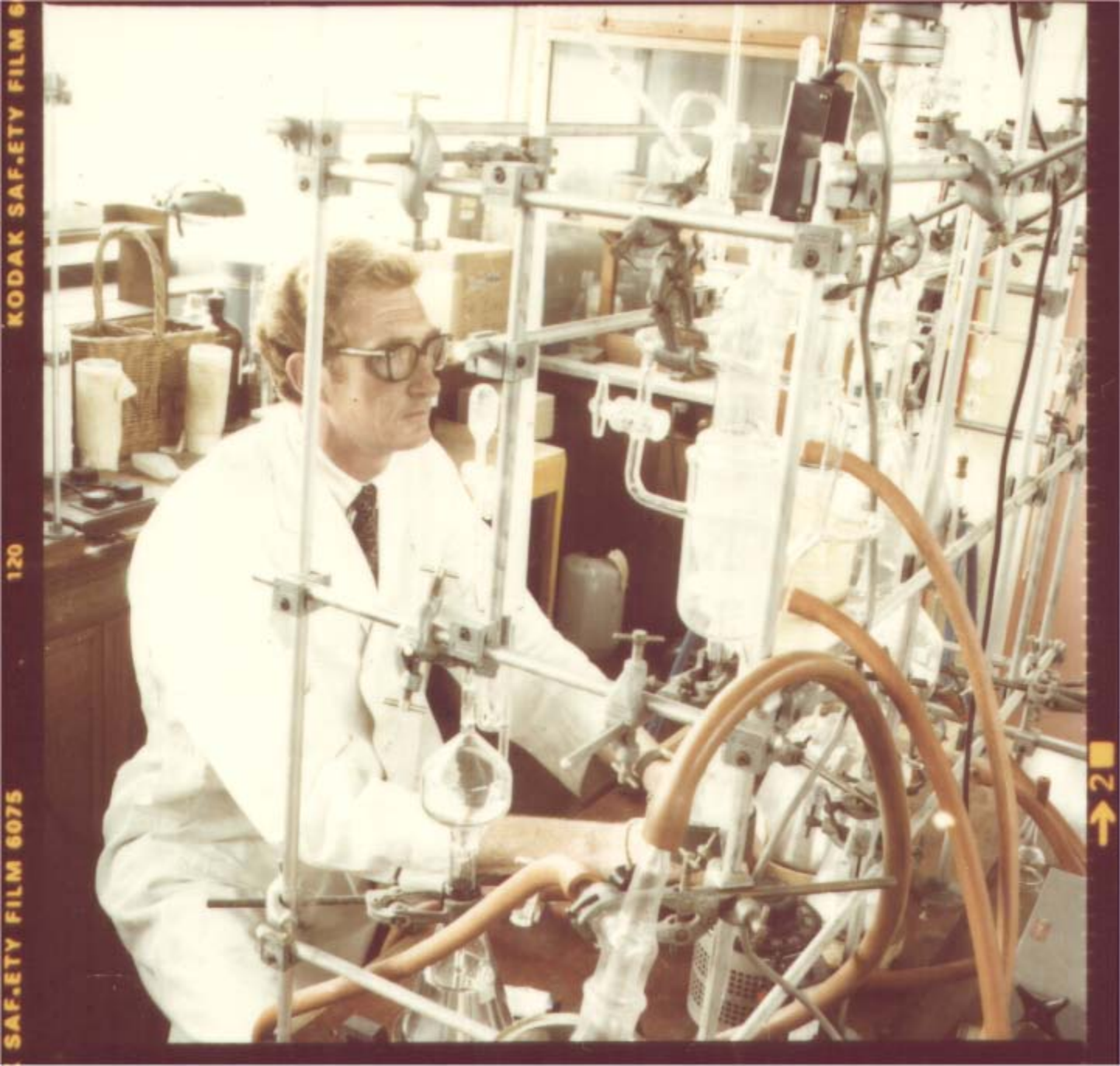
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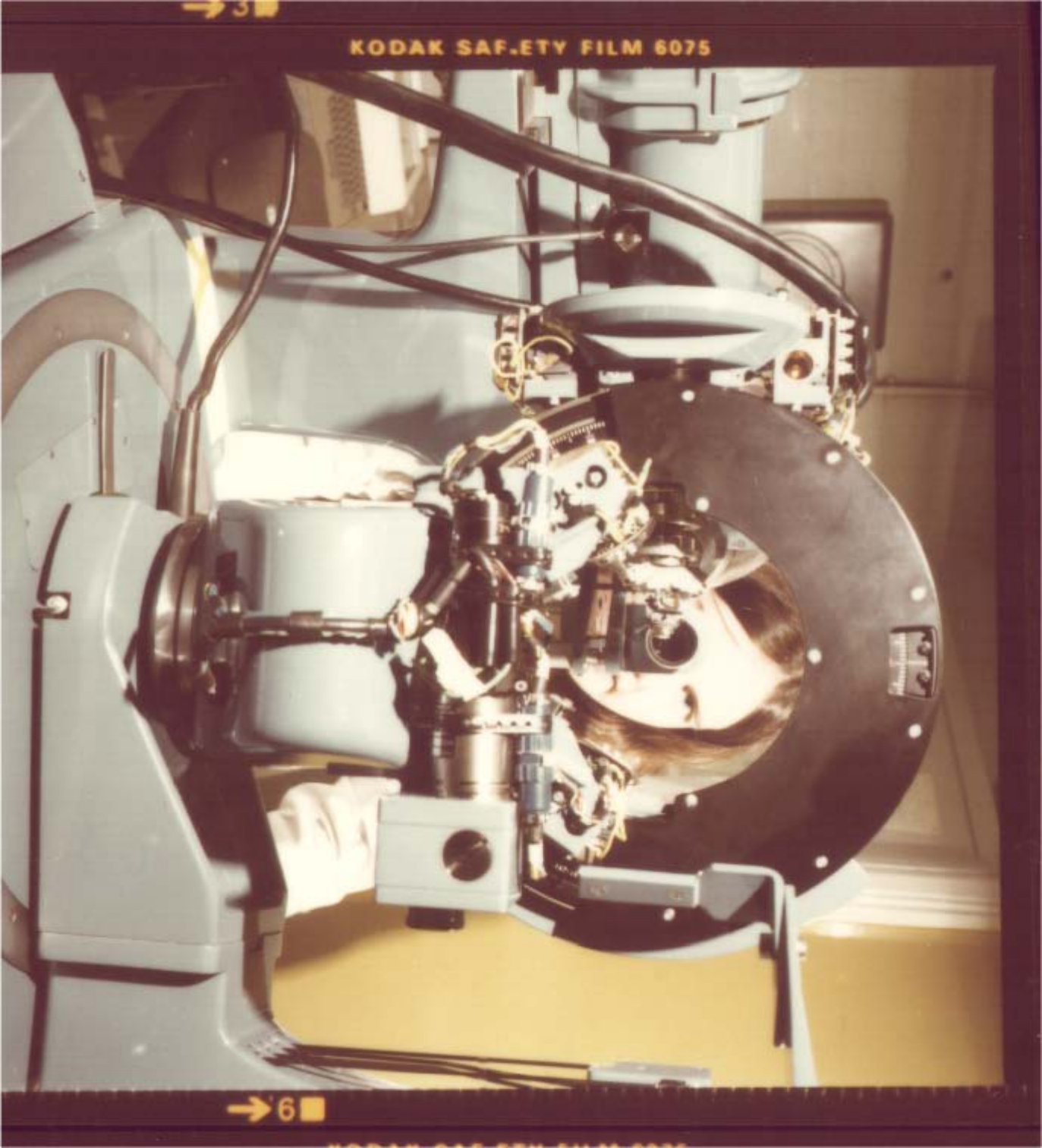

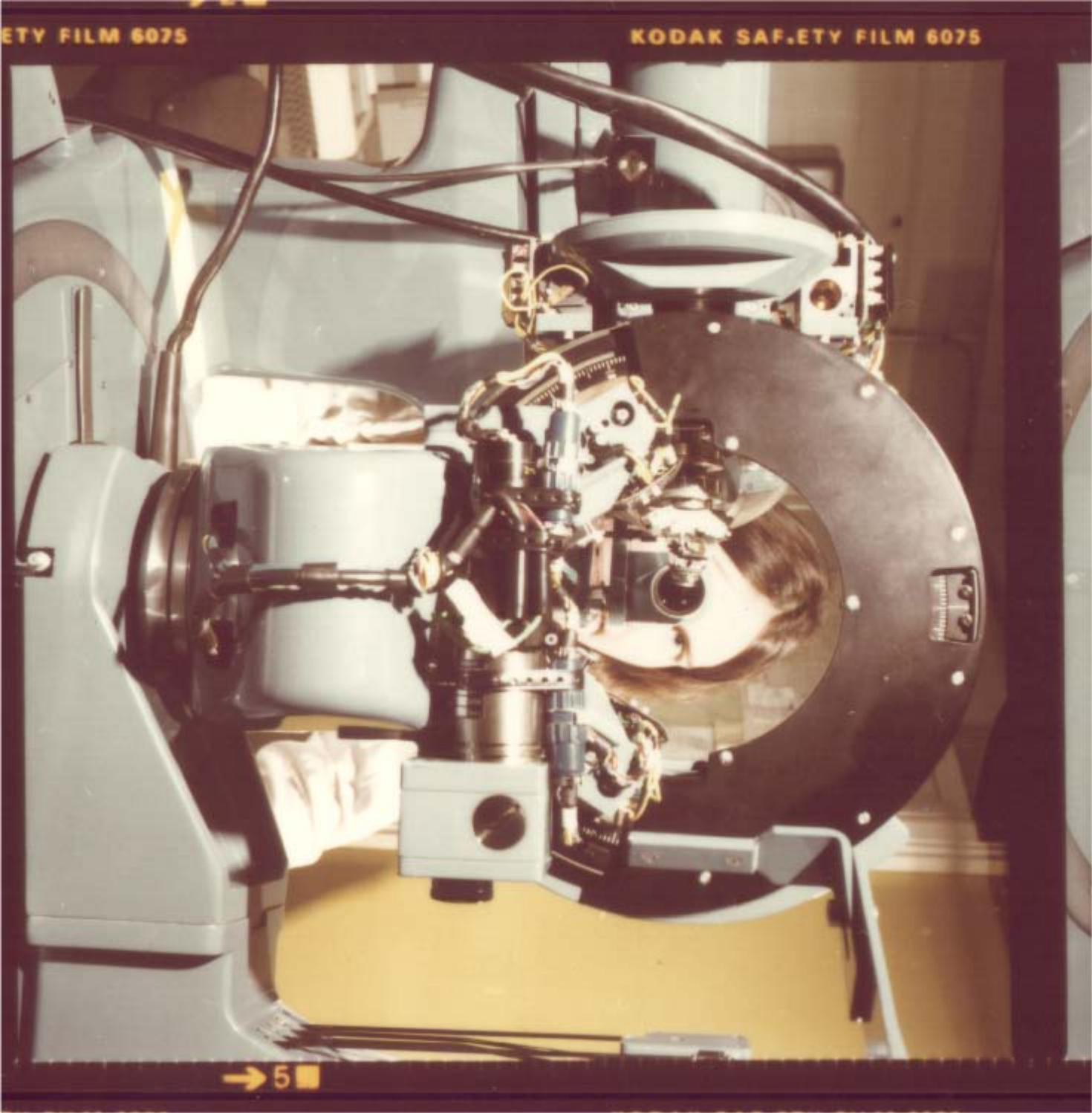
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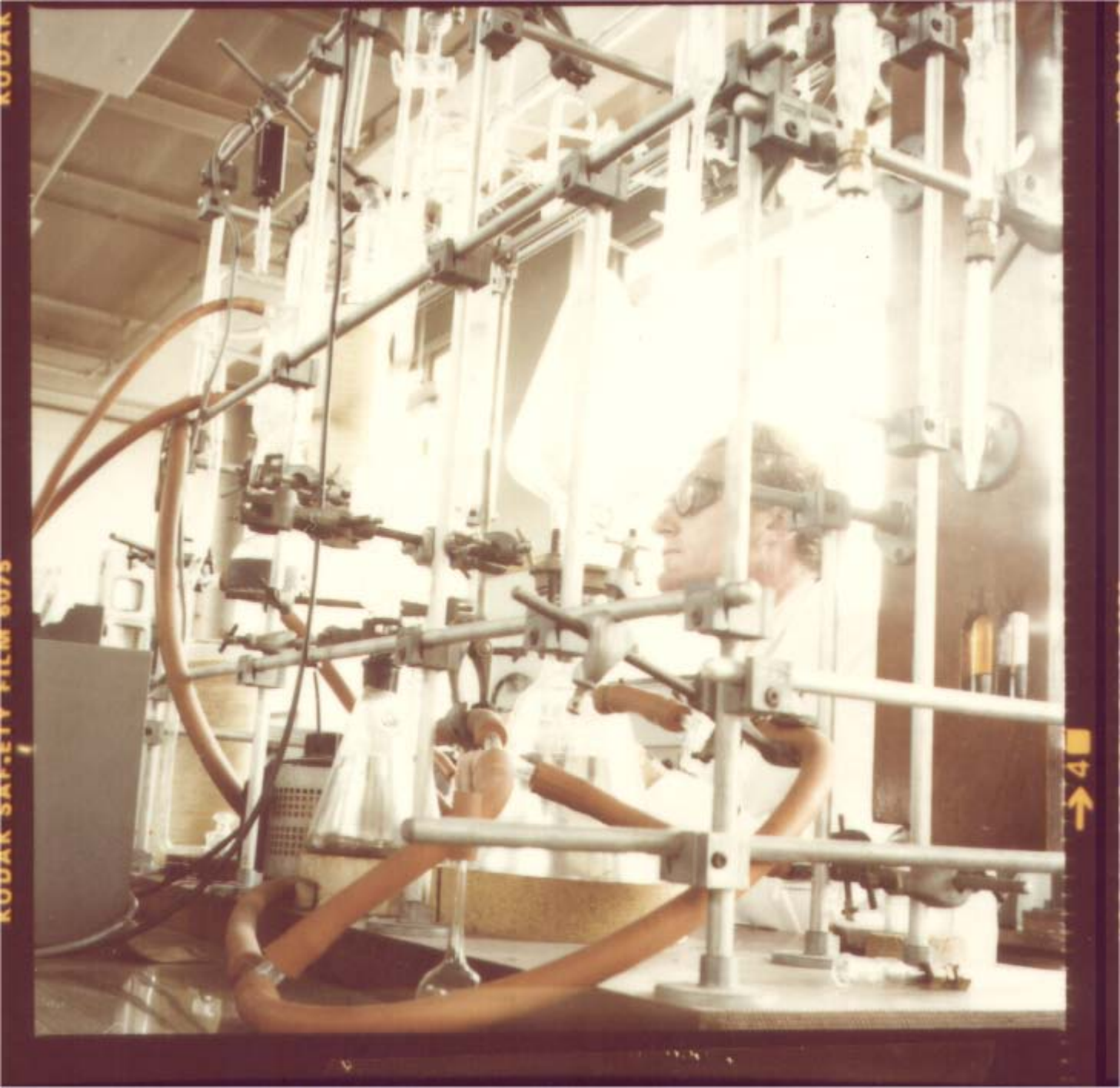

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