The main factory of Ernst Leitz, GmbH, at Wetzlar with the Kalsmunt ruins in the background. Photograph by J. Behnke.

A Visit to the Leitz Factory

By F. Neumann
Presented by ERNST LEITZ GmbH, WETZLAR (Nr. 92-100-181/Engl.)

For many of the thousands of visitors who come every year to Wetzlar, the name of this ancient free imperial city is bound up with the conception of Leitz and the Leica—symbol of precision optical equipment.

It is therefore not surprising if the Leitz factory exerts greater attraction than the slate-covered old town buildings around the venerable cathedral or the Goethe memorials.

We recently had the opportunity of taking part in a visit to the factory.

This may comprise a brief half hour's visit to two or three representative sections, but it may stretch over days where in special cases—e.g. for a news report—detailed Information has to be collected. The wide production programme, the extensive factory with its many departments, offer such an abundance of material that it is difficult for the reporter, as indeed for the guide in a conducted tour, to stick to essentials.

The visitor—and likewise the reader—will have each his own particular interests. All, however, must commence their tour at the same spot, the progress "from glass block to Leitz objective"; for glass is the essential element in all Leitz products. Whether as prism, mirror, or lens, high quality glass is worked into a high grade optical system in the form of an objective, a prism combination for a rangefinder or an illuminating system. In combination with delicately fashioned mechanical components it constitutes the very heart of the opto-mechanical precision instrument.

From glass block to finished lens

In the glass store

We begin our round in the glass store. This contains more than 200 different types of glass, all needed in current manufacture. From them are made, as components in manufacture, about 5000 different types of lenses and prisms. Well over 1000 types of lenses and special instruments go to make up the manufacturing programme.

The glass is stored in the form of large square or rectangular blocks.

Picking up two such blocks of about the same size, one may be struck by a very great difference in weight. We are told that the heaviest glasses are also the most expensive, and that the various types differ widely among themselves both in their characteristics and in their stability to outside influences. The glassworks also supply optical glasses in the form of rods from about 5 to 25mm diameter and also as moulded blanks (for large scale series production) already shaped to the form of the finished lens or prism.

Slitting

From the glass store we proceed first to where the glass blocks are cut up. Diamond saws slit the blocks into plates of the required thickness. The plates are then ground plane parallel with abrasive powder and cut up.

Edging

The individual cut-up plates are cemented together in a stack and edged circular on special grinding machines. Bar mouldings simplify this first working process, because they can be slit right away to the blank thickness.

Surfacing

In the next process the circular discs are shaped in the milling machine to the rough shape of the lens. The moulded blank is already supplied in this form, and so eliminates the slitting, cutting-up, and edging processes. Unfortunately for high grade lenses or for small series, or for very small lenses, moulded blanks cannot be used.

Spherical and plane surfaces

The next stage in the manufacture of lenses is machining to radius and thickness, and in the case of prisms, facing and machining to angle and dimensions.

1 A glimpse into the glass store showing some of the glass blocks. Works photograph. 2 The diamond saw has penetrated the glass block and is cutting it into plates of the required thickness. 3 The plates cut from the block are cemented into a stack and edged on a corundum wheel edging machine. Works photograph.

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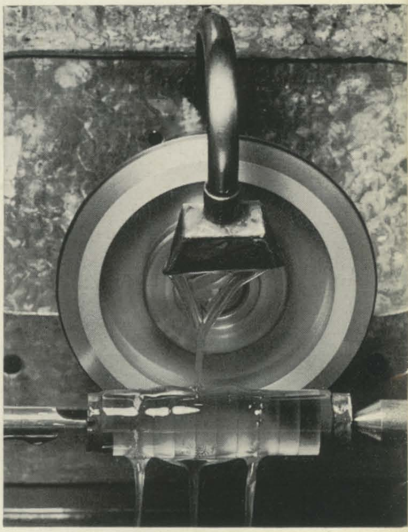

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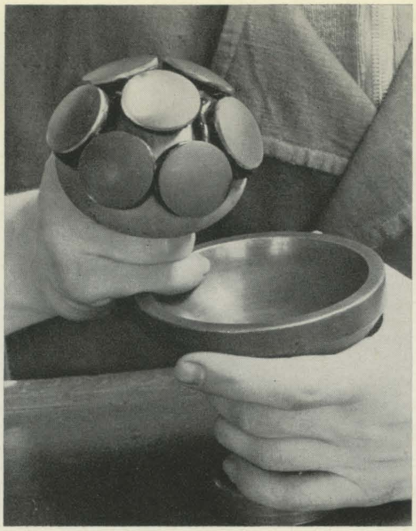

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4 Grinding glass plates plane parallel. 5 The block of lenses is removed from the polishing tool. 6 The blocks of lenses are smoothed and polished on a multi-spindle polishing machine. Works photographs.

Grinding and polishing

The first stage in surfacing lenses is to cement them on a blocking tool with adhesive foil or sealing wax. They then go through a succession of stages of smoothing, using special moistened abrasives. Depending upon the radius of curvature and size of the lens a great variety of tools may be employed. In the case of the very smallest lenses, as for instance the front lens of an oil immersion objective, the most skilled hand work is called for. Years of experience and an innate delicacy of touch are prerequisites for this highly specialized work. This is equally true of the final stage in the production of prisms of the highest precision.

The term highest precision here means that its assessment is beyond the scope of any mechanical method of measurement, and can be achieved only with the aid of optical phenomena (e.g. interference).

What is meant by highest precision ?

To take an example, the polygonal prisms required for technical measurement purposes must be accurate to one second of arc. This means that the surfaces must be flat to within limits corresponding to a radius of curvature of 30,000 metres. To give this more practical significance, imagine a traffic policeman in Paris standing with outstretched arms at the Place de la Concorde, and lines drawn from his fingertips to London, meeting on the face of Big Ben. The angle formed by these two lines, 400 km long with a base of only 2 metres, will be one second of arc.

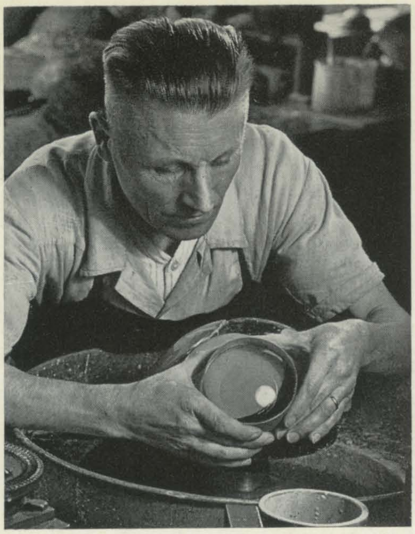
Prisms from crystals

Infra-red spectrographs incorporate dispersion prisms with a base of 150 to 170 mm. The requisite crystals are grown in the Leitz crystal laboratory. Crystals of such dimensions and of the necessary purity are rarely if ever found in nature. Among such artificial crystals are sodium chloride, potassium bromide, and caesium bromide. The optical working of such crystals makes the utmost demands on technical and manual skill, because by reason of the hygroscopic properties of the crystals any careless handling, for instance, would leave behind blemishes which could be removed only by long and tedious work.

It is therefore understandable that entry into the specially air conditioned and dust protected room cannot, regrettably, be permitted.

Machine working

In the manufacture of large series, a high degree of automation and rationalization is achieved by the use of multi-spindle grinding and polishing machines. A



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8a

7 A test plate, polished to the prescribed curvature, is brought into contact with the surface of the lens under test. The configuration of the Newton's rings formed indicates any deviation from the correct curvature. Correction is then applied in further polishing until the rings disappear completely. 8 Testing prisms. 8a Testing thickness of lenses with a dial gauge. Works photographs.

high pitched monotonous whistling and squeaking sound assails our ears, while our eyes are hypnotized by the unceasing rhythmic motion of the tools. The ever watchful eyes of the operators are fixed on their machines. When the grinding or polishing operation is nearing its end, the block of lenses is removed. Carefully, almost lovingly, the experienced hand of the expert operator strokes the surface of the lenses as with critical eye he judges how far the process has progressed.

Testing

In between the individual working stages repeated progress checks are made to establish surface quality and maintenance of lens thickness and diameter. The quality of surface is checked with a test plate. This is polished with extreme accuracy to the prescribed curvature, and for the purpose of the test is brought into contact with the lens to be tested.

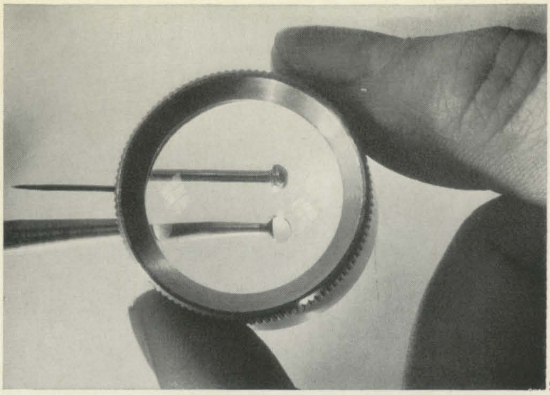
If the curvature of the lens is not identical with that of the test plate, interference bands, commonly known as Newton's rings, make their appearance. Their number and regularity provide a reliable indication of the quality of the surface. Next follows testing of the surface for freedom from blemishes and the presence of bubbles, measurement of thickness, and of interfacial angle on the autocollimator. When one sees how many individual operations every lens, every prism, has to be put through, one can readily appreciate that it is a long, long way from glass block to finished objective or prism combination. There is an enormous range from the smallest to the biggest lens. Lenses used in microscope objectives are scarcely larger than a pinhead, while the condenser lens of a large projector measures twenty inches in diameter.

Centring

The polished lenses are then centred on the centring bench and then on the edging machine edged concentrically to the required diameter.

Coating

One important operation still remaining is coating. In the Coating Department is installed high vacuum equipment with which certain substances are coated on to the glass surface to form a thin reflection preventing layer. This reduces reflections at the glass-air interface to a minimum, thereby considerably increasing the transmission, and therefore the effective speed of the lens. A still more important function of this layer, however, is its effect in minimizing scattered light due to surface reflection, which has the effect of reducing image contrast. Coated surfaces produce practically no scattered light, and the contrast and brilliance of the image is in consequence greatly improved.



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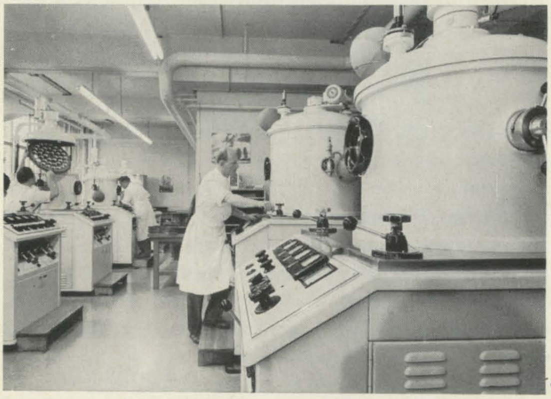

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In the cementing shop

One of the last processes the lens has to go through before mounting in its metal mount is seen in the cementing shop. Both flat-surfaced and spherical surfaced optical parts in some cases have to have their surfaces cemented together; hot cementing is done with canada balsam, cold cementing with Araldite.

Mounting

When the sets of individual lens elements have completed their passage through the optical workshops they pass through into the mounting shop. Here they are mounted up at their prescribed separations in accordance with the working drawings. The ready prepared mounts are given their finishing cut, the lenses are inserted, and centred by the reflected image method: they are so adjusted that their centres of curvature all lie on one straight line, the optical axis of the lens.

Diaphragm ring, distance scale, and depth-of-field ring complete the outer mount of the finished camera lens.

Behind closed doors

As we are standing at the bench where the 50mm Noctilux lens is assembled, a visitor asks about the machines on which aspherical lenses are made. In a moment we are plunged into an interesting conversation. We gather, however, that for security reasons it is impossible for our guide to show us these machines. The quantity production of aspherical lenses for use in the construction of extreme wide aperture lenses is, we are told, the most important advance that has been made of recent years.

9 Examining the front lens of an oil immersion microscope objective with a magnifier. Works photograph.

10 & 11 Two views of the lens coating department. Works photograph.

12 Preparatory to cementing a pair of lenses the lower component is coated with slightly warmed canada balsam. Works photograph.

From raw material to precision instrument

Metal working is a process with which we are all familiar. Almost everybody at some time has had an opportunity of taking a look inside a fitting shop. Lathes, milling machines, lacquering shops, modern automatic machinery for dozens of different working processes—all these are to be seen in the reports on all manner of industrial plants brought to us daily since cinema and television have made audio-visual communication so easy. Nevertheless an actual conducted tour of a factory remains a special experience. Nothing can rival its immediacy. The sounds and odours, the atmosphere of the work bench, these things can only be fully appreciated by an actual visit to the scene.

Similarly it is impossible to convey by mere description the quality of precision mechanism such as is embodied by long tradition in Leitz instruments. For this we must stand side by side with the precision mechanic, bringing, however, to the occasion a degree of sympathy and openmindedness.

Our guide is well chosen: he is well versed in his subject, for he was for many years himself employed as production engineer. He leads us through labyrinths of countless departments so that in the end we really come to believe that we have completely got the hang of the factory set-up, and have in our mind's eye a complete picture of the whole production scheme.

In the materials stores

In the materials stores we see the raw materials of manufacture: steel, brass, bronze, aluminium, and plastics. In Store I are housed the castings. We examine the numerous housings and components; we learn how the machine produced casting is better from the finishing point of view than the hand casting, for it is important in precision mechanical work that the rough casting should have as clean a surface as possible. In this department we see quite small castings, as well as castings measured in yards, as used for building the bulky measuring microscopes and big projectors.

In the semi-products store are sheet material, tubing, rods, and other profile material. We soon discover certain parallels between this tour and our visit to the optical workshops:

Grinding and annealing

Here, plate shearing takes the place of the slitting of the glass blocks. Glass rod becomes here metal profile, and moulded glass blanks have their equivalent in metal. First we follow the casting through its successive operations. The first process, in the grinding shop, is to clean the casting inside and out. Next it goes into a large furnace, in which it is annealed to remove any internal stress. We are told that this annealing process is repeated a number of times during the course of machining, because complete freedom from internal stress is essential to high precision.

In many cases the precision mechanic also carries out inspection, and his work bench is accordingly equipped with the requisite instruments. As in the optical branch there are many such measuring and checking instruments, and these are made in the Leitz factory.

The workpiece becomes an individual

Right in the first stages of finishing we witness what our guide terms "the birth of the individual", and we very quickly come to realize an important fact, namely that from now on the workpiece must be carefully handled as the individual that it is. Storage and transport are just as important as the work itself. In the next room it is

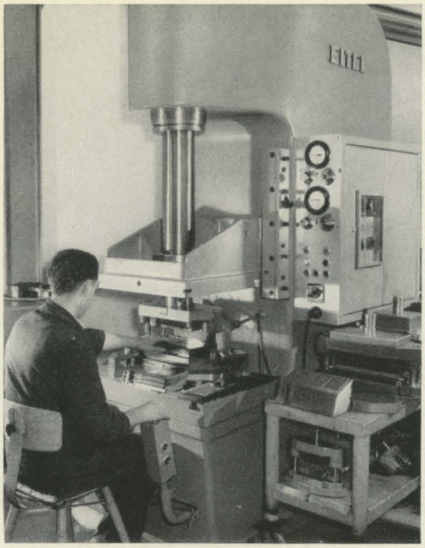


Fig. 1.
60 ton hydraulic press in stamping shop.

literally a case of holding one's breath—we are only admitted because we are a small group. Any surface contamination, even the moisture of one's breath, would lead to malfunctioning of this delicate measuring equipment, with consequent expensive reworking. One of our group was a very devoted photographer. His remark was: "I quite see what he means; if anyone were to bend over my unglazed transparencies I would instinctively hold my breath for him".

In the turning section

Before proceeding to the heavy component section, we take a look in the turning section. We have already referred to semiproducts, and here we can see for instance how in a semi-automatic lathe a steel rod in a matter of seconds is first cut off, and the cut-off section is from the other side provided with a variety of profiles and screw threads.

One other thing we notice in the turning section: a small chart such as is to be seen hanging in every other department. At first glance it seems to contain only a few numerical data. Nevertheless behind them is a carefully worked out system of production control.

We are told that years ago Leitz adopted a policy of leaving virtually nothing to chance. It is not enough to buy good materials, process them accurately, work exactly to plan.

Fig. 2.
Turner at lathe.

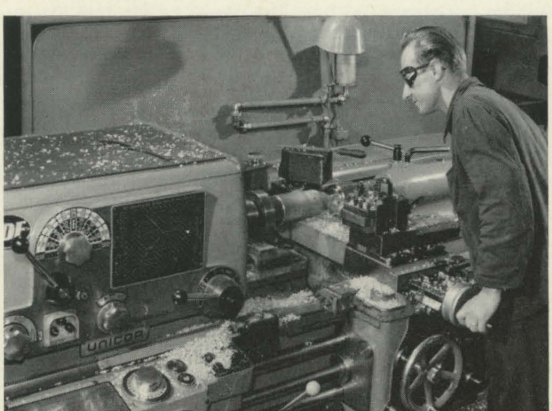
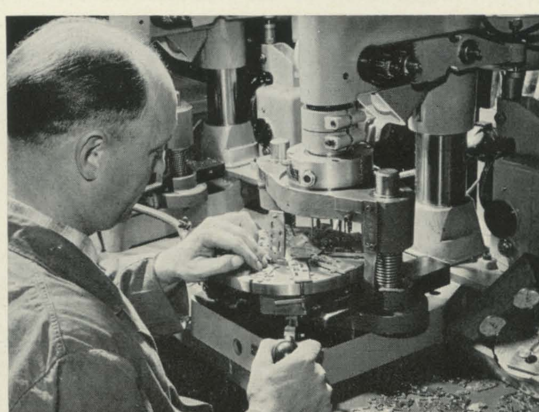
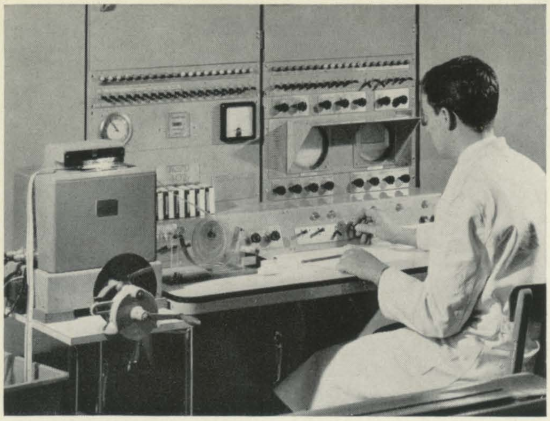


Fig. 3.
Plates for the Leica shutter being drilled and countersunk on an automatic multi-spindle drilling machine.





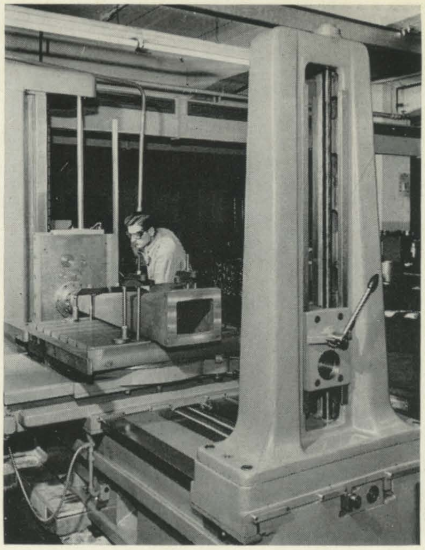


Fig. 4.
An automatic computer.

Fig. 5.
A milling operation on a Leitz Profile Projector.

Production control picks up every error, records it on punched cards, assesses precisely its significance, and can then quickly and effectively eliminate the cause. And not only does it thus deal with errors, it also assesses efficiency. At the end of the month it pays out in hard cash if a team has exceeded its "qualitative" norm.

Human skill and automation

A few steps further and we encounter a fully automatic machine and take a look at its interior. The programming strip reminds the older among us of the earlier electric pianos. This not surprisingly lands us into a philosophic discussion. For anyone with imagination must realize the enormous extent and diversity of the technical progress involved.

A fully automatic machine of this kind not only performs its various tasks automatically, it does so with high precision. On the other hand one of the more striking convictions we came away with from this visit was that man of the future was not destined to degradation to the status of machine minder.

What a miserable existence such a robot must lead without its master. He it is that must be responsible for keeping it up to date; he works out the programmes without which not a wheel can turn. Man must remain indispensable, not only intellectually, but also by virtue of his manual skill. To this, the precision mechanic is an eloquent witness.

The computer

Just as we had got on to the subject of "electronic brains" in general, our guide tells us that we happen to be quite close to a computer. So his suggestion that we should have a look at it is enthusiastically received.

Our guide explains that we are not going to the data processing department, but to see how computers are used by those responsible for the design of Leitz lenses and optical systems. Calculations which formerly not only used to occupy weeks, but which also had to be restricted to within a much less comprehensive scope, today are carried out by computer in minutes. Thus quickly and precisely—for the machine operates just as efficiently after eight hours' work as at the beginning of the day—it is possible to verify whether one is on the right track or whether and where corrections will be necessary. Without the use of computers the results of the research into high performance new optical glasses could not have been exploited to maximum advantage. We were permitted a look inside the machine. The technician in charge explained to us what are the important things to bear in mind in operating and servicing. We leave the room convinced that a modern lens, and its continual improvement, is the result of glass research and optical calculation.

Finishing large components

A few minutes later we are on our way again "from raw material to precision instrument". In the large component finishing department we see once again various

Fig. 6.
Lacquering the framework of the Optical Master Dividing Head.

housings which we have already met with on numerous occasions at various stages: the support for the large projector, the modern "angular" housing for the microscope, the classical curved stand.

Leica and Leicaflex production

We ask about projectors, about the Leica and Leicaflex, and are told that this work is carried out in other shops or other factories.

At the railway station factory is the assembly line for the Pradovit Color and Pradolux miniature slide projectors.

In the new Weilburg factory we are shown the finishing of the aluminium pressure cast body of the Leicaflex: modern production lines, multiple spindle drills with which some 65 holes can be drilled at a single operation.

Surface finishing

The next basic process after the large component finishing process is surface treatment. The moment we enter we are struck by a typical odour; this is where electroplating, anodizing, lacquering are done. The components or housings to be treated are suspended on frames which are then immersed in the chemical solutions contained in large tanks. Immersion, removal, and further transport are all performed automatically.

As in all the production, everything here has become a matter of rationalization. The flow pattern must be as smooth as possible. That is why visitors to the factory present something of a problem. The floor is always

Fig. 7.
In the electroplating department.

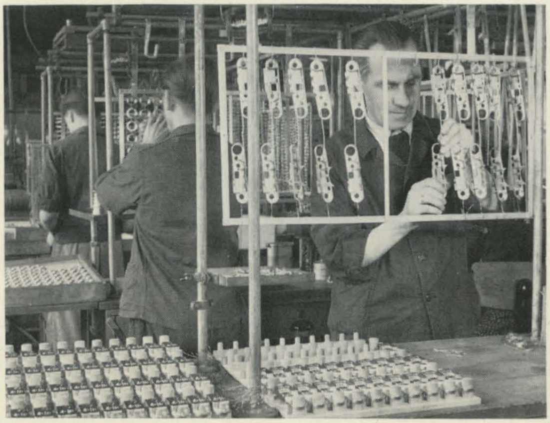


Fig. 8.
Conveyor belt assembly of the camera shutter.

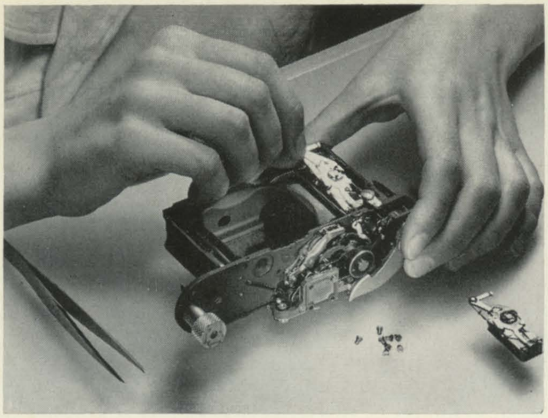


Fig. 9.
Mounting the self-timer in the Leica.

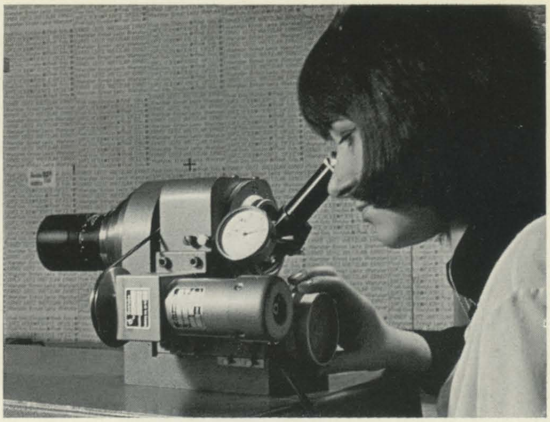


Fig. 10.
Optical set-up of the LEICAFLEX-lenses is being checked.

Fig. 11.
The pressure-cast aluminium body of the Leica on the production line. Altogether 274 operations are carried out on it by milling, drilling and screw cutting machines.

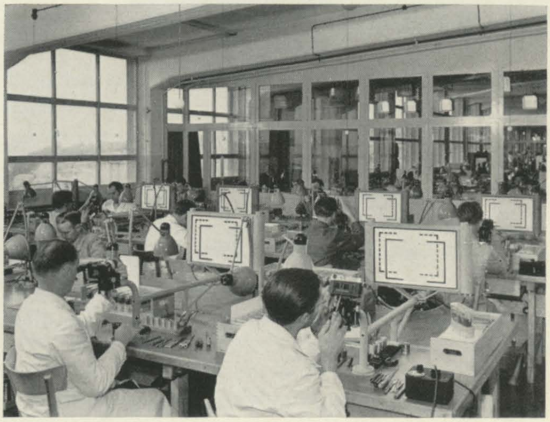


Fig. 12.
Testing and adjusting the reflected image of the Leica bright-frame view- and rangefinder.

Fig. 13.
Dust-free packing of the Leica.

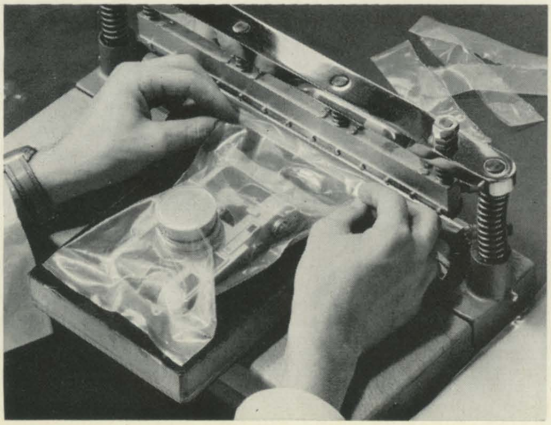
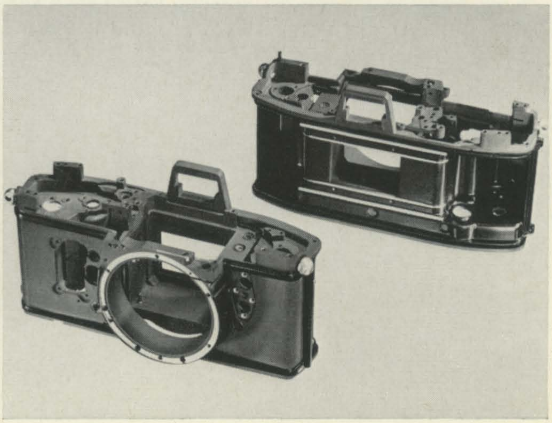


Fig. 14.
The Leicaflex body consists of a light metal casting completely resistant to distortion. This guarantees, among other things, perfect parallelism of lens and film planes.



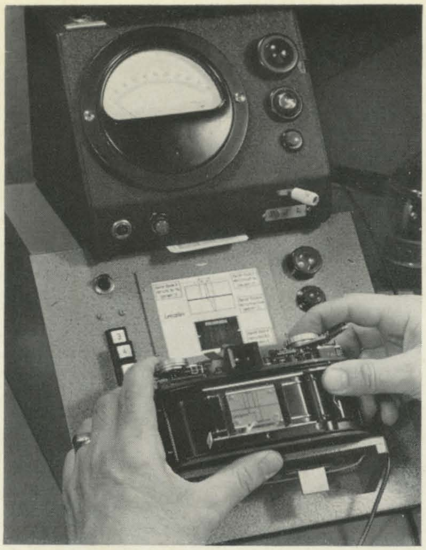


Fig. 15.
Testing the adjustment and functioning of the flash synchronization of the Leicaflex.

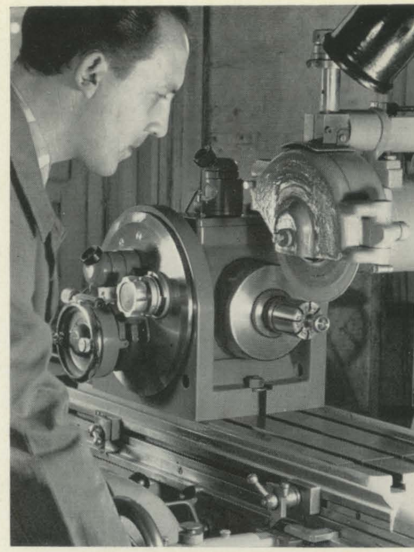


Fig. 16.
Using the Optical Master Dividing Head on a surface grinder.

moistened again immediately, for dust is the greatest enemy. Not everything is automatic; there is also hand work, individual work, according to the nature of the operation. This is, after all, not a car factory, but a section and individual working. Here hundreds, thousands of different components are manufactured. Consequently, notwithstanding all the rationalization and simplification of manufacturing processes it is almost impossible to carry out all the operations of manufacture from raw material to final assembly on a conveyor belt.

"Unfortunately" says one—"fortunately" another.

Precision grinding

Only after the completion of the surface treatment is precision grinding carried out, on grinding or lapping machines or by hand scraping. This is the last stage before the metal components meet their optical counterparts. "You see now" says our guide, as in the materials store of the assembly department we continue our conversation about the essentials of opto-mechanical precision instruments, "why the mechanical components must be made with the same precision as the optical parts ?"

Assembly

A chain is only as strong as its weakest link. In assembly, therefore, quality and precision are of the utmost importance. For this is where optical and mechanical parts are assembled so as to become one unit. The "optical axis" must not be distorted. The assembly process is not just a matter of adding component to component on the unit construction principle: frequently it is possible by setting one manufacturing tolerance against another, and by making final adjustments in assembly, so to improve performance that plus and minus errors are mutually balanced to zero.

The Optical Master Dividing Head—to take once more an instrument which is manufactured to the highest standards of accuracy with corresponding precision of performance—is finally reground ready mounted in the position in which it will later be operated. Incidentally this Optical Master Dividing Head has played an important part in the development of space travel. It is used to orient the control platform.

Assembly might be basically divided into three stages: subgroups—groups—final assembly.

How many parts are assembled at any one time is of course very different with different instruments.

Routine production controls particularly attracted our attention. As photographers we are often more intrigued by portraits of these specialists than with what they are doing.

Every now and again we see a team working in a "glass case". Here there must be neither dust nor too much or too little humidity, the temperature must be

Fig. 17.
Portrait of the adjuster.

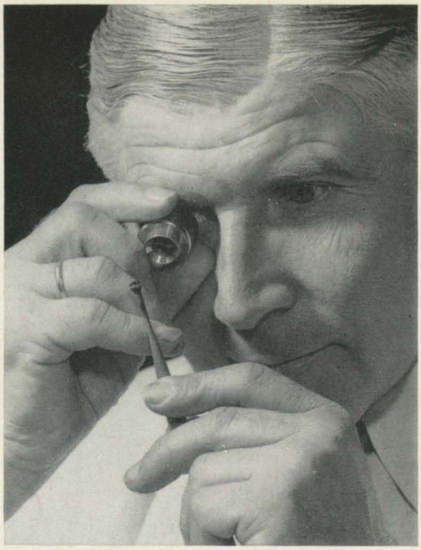


Fig. 18.
Portrait of a microscope objective lens examiner.

rigidly controlled, and the room can only be entered or left through an air lock.

In Photographic Assembly we once again gather around a large glass enclosure. Here is to be seen a complete Leica dismantled into its components: a graphic recapitulation of our tour and a convincing documentary display.

We discuss the problems of distribution of production and manufacturing preparations; how extensive is the necessary organization to ensure that all the components required reach the assembly point in the right numbers and at the right times so that, for example, in accordance with the production schedule Batch 284 can be assembled in the 27th week and is ready for dispatch according to contract in the 34th week.

A hundred years ago—a retrospect

It is appropriate here to take a look back at what things were like a hundred years ago, and with what slender resources Ernst Leitz in 1869 started his small factory.

The first inventory:

"Four lathes, two of them of iron, the other two wood. Four bench vices. Four racks for files and chucks. Seven oil lamps, five hammers, two screw calipers, two dies, two hand drills with drill bows, pliers, files, saws—one small and one large bottle of varnish".

Today

Today the factory turns out more than 5000 saleable articles. Today it is not sufficient to look through the microscope: quantitative measurements are demanded. To every "scope", or observation instrument, there is a corresponding "meter". But even measurement often does not suffice; permanent records are wanted, so the "graph" has to be added. Deviations have to be corrected, and inevitably we reach the point where the measuring instrument itself makes the correction. Thus is born the "stat" which maintains conditions constant. Finally the "mat" brings in automation to raise the instrument to its highest developmental plane. Such is the long, but systematic path from the first great advance in design, the orthoscopic eyepiece, to the fully automatic photomicrographic camera, the Orthomat.

Many factors played their part in this:

For the manufacture of high performance microscopes, instruments of high precision were needed for measurement and materials testing. They likewise had to be designed and manufactured. The materials used had to be tested for quality before they could be used, and from the outset the opinion was held that quality control was a practical proposition. So Leitz became at the same time manufacturer, buyer, and customer. Their customers throughout the world are beyond count.

This too is Leitz

Leitz not only manufacture their products: they also test them with special equipment largely developed by themselves. This constitutes a double, a triple guarantee of highest precision and quality.

The testing system

The testing system of modern precision manufacture is a quite specialized domain. It is independent of the development and manufacturing departments, and has two tasks to fulfil:

1. Evaluating and testing out new developments
2. Final testing of all products.

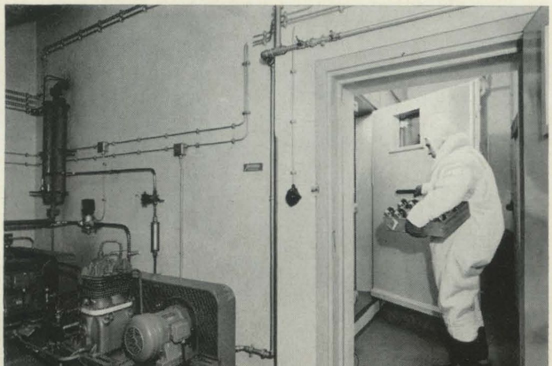
This applies to every department of manufacture: microscopy, metallography, photography, projection, measuring equipment, etc. Special laboratories, with equipment for research and testing are at the disposal of all branches of the factory. A great responsibility falls on the optical laboratory for the testing of lenses. This is where the optical data of lenses are determined and their entire performance investigated. Electric and electronic constructional elements and equipment are tested in the electrical testing room and photographic equipment in the testing laboratory. Among the facilities available to the testing department are large refrigerated testing rooms down to —60 °C, accessible to inspection, refrigerators down to —80 °C, air conditioned containers for the maintenance of any desired climatic condition, fog, spraying, and sprinkling devices, jolting machines, and vibration, shock, and pressure testing machines.

And so this widely extended, skilfully coordinated testing organization provides the sound basis for the Leitz guarantee of consistent quality and reliability of all its products.

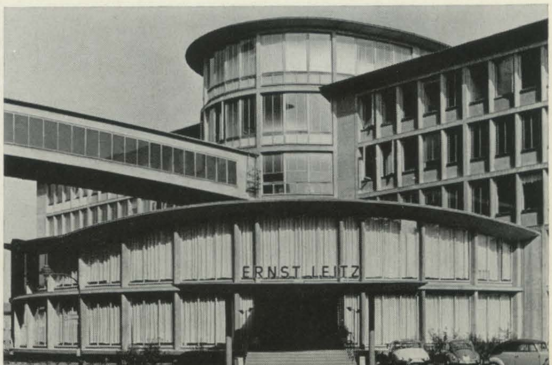
It is characteristic of Leitz production that besides a great deal of very successful commercial apparatus, other products have been developed the idealistic value of which counts more than material success.

Thus adequate motive for the development of trichinoscopes, Tyndalloscopes (dust counters for mining, etc.), and other special scientific instruments existed in this spirit of awareness to have resulted in valuable contributions to the welfare and health of millions and fundamental advances in scientific research.

Refrigerated for testing Leica and Leicaflex functioning under arctic conditions.



The administration buildings of the firm of Ernst Leitz GmbH, in Wetzlar.



Electronics

Leitz recognized the fact that optical apparatus without the use of electronics was unthinkable in future development, and since 1950 therefore they have systematically built up their electronics laboratories. Fully automatic photomicrography, for example, demands an electronic control system. As realized in the Leitz Orthomat, it has permitted deeper penetration into the domain of subjective observation in microscopy. In 1972 a European communications satellite will be responsible for the dissemination of news of the Olympic Games events. Leitz are helping to ensure that this system will function reliably. For Leitz also construct the optical sensors for automatic orientation of satellite transmitting antennae.

In the administration building

Following our tour of the skyscrapers and adjoining departments we pass over a bridge back into the administration building, by the "higher executives' route" as they say at Leitz. We see the exhibition cases which, as the beginning of a great Leitz museum, bear witness to the past history of the firm, rich in tradition. Old microscopes and telescopes, the original Leica and projectors lead us back to the manufacturing programme of the past decades. Needless to say, medals and awards are not lacking.

For the benefit of clients the administration building houses classrooms and laboratories. Leica courses and courses in microscopy, as well as individual instruction, have been in operation for decades.

A modern electronic data processing installation is a necessity, as is also a pneumatic tube communication system, the apprentices' workshop, and the work-doctor; as also a sickness insurance scheme and the pension scheme.

A large scientific library is available to everybody, as is also a comprehensive lending library comprising both educational and light literature.

A house magazine brings regular reports of events at the works, and the Leitz-Mitteilungen für Wissenschaft und Technik provides clients with information in the scientific sector.

If you leaf through the telephone register you will encounter hundreds of telephone numbers in the many departments, all of which are essential to the success of a great organization.

An apprentice on his first entry who with the good wishes of the personnel manager takes his first steps—pass photograph—engagement interview—canteen . . . many well think that it must take years before you know everything and everybody. In fact, even a few years in a modern large scale factory is but a short time. Here one reckons staff service in decades, and the celebration of an employee's 25th jubilee with the firm sounds to the veteran who can look back to his 40th or 50th like a protracted probationary period. On the other hand there are the opportunities open to employees. Anyone who really wants it will certainly find the great opportunity of his youthful dreams:

As salesman or technician on month-long journeys to all parts of the world, for there are Leitz agents and Leitz customers in every country.

As a research worker in the scientific departments.

As a senior draughtsman in the drawing office.

As foreman in the big workshops.

Part of the microscope laboratory.

Students taking part in a course of microscopy at the Leitz Works.

Only the future can show how far we can go with rationalization, with the more intensive use of electronics, with still more extensive data processing.

In the elevator we travel down to the lowest floor of the administration building. For if you are as fortunate as we are you even get to see the great air conditioning plant which, deep in the basement, carries on its unspectacular but none the less important function. But it is all part of the organization, for the whole vast complication of a great factory can often only be glimpsed through apparently quite unimportant details, as for instance when one passes thousands of cartons.

Despatch

Hence a glance too at despatch, which is housed in a branch factory near railway station. The ordinary cartons as used for air transport, crates and timber one seeks here in vain. Special cartons, protected for sea transport against the action of seawater by a layer of bitumen, is today the answer to almost every despatch problem. Not even a hammer is to be seen.

Instead we have compressed air in every corner. Outsize wire stitching, plastic strip in place of wire.

Customer service

The service department too is housed separately in a neighbouring factory building, and is notable for the ready accessibility of the spare parts in its stores. The Leitz guarantee is a world-wide guarantee, hence the continual expansion of service centres abroad, precise repair instructions—everywhere the same tools and test equipment.

Personnel

Only a little over a third of the employees live in Wetzlar. The majority have a more or less considerable distance to come to work. From places as far as some 150 to 75 kilometres distant the stream of busy people pours every morning into the city. As though attracted by a magnet they stream into the Leitz factory, the name of which, steeped in tradition, has become an international symbol of precision and optical performance.

With its more than 6,000 employees, Ernst Leitz GmbH, Wetzlar, can claim to be not only the oldest, but also the greatest manufacturer of optical and precision mechanical equipment. Tradition hand in hand with progress, craft skill and scientific efficiency, have been the determining factors in the long history of the development of the undertaking.

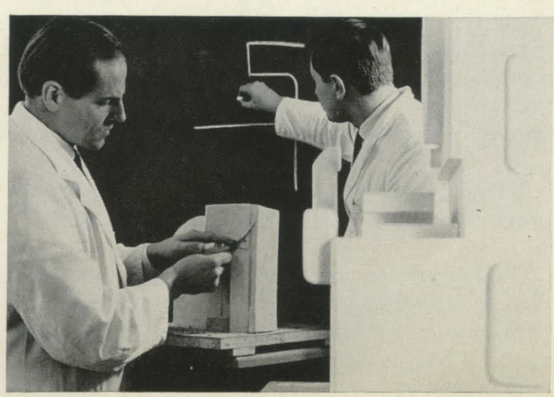
Apart from the main factory there are in Wetzlar four other factories in addition to a branch factory in Weilburg, one in Rastatt, and the Ernst Leitz (Canada) Ltd. organization in Midland, Ontario. A well organized network of Leitz representatives with authorized servicing departments spans the whole world.

The production programme

The traditional manufacture of microscopes and supplementary microscope equipment is the cornerstone of a widely extended programme. An important field, besides microscope manufacture, is that of optical precision measuring and materials testing equipment for industrial purposes. Leitz precision measuring equipment is used in general engineering construction, in precision

Part of the construction design section of the Leitz Works.

In the design section.



construction technique, and in transistor manufacture equally as in heavy engineering or in locomotive, marine and aircraft construction in testing room and workbench.

Outside the fields of science and technology, the name of Leitz is widely regarded as identical with Leica. We frequently receive letters in Wetzlar addressed to the "Leica works".

Today, the proportion of production which goes through the specialist dealer sector in the shape of the Leica, the Leicaflex, and the Leitz projectors, enlargers, and binoculars represents about 40% of the total production. The proportion of all equipment manufactured which goes to export is over 60%.

The management

The management of the family business is in the hands of the three brothers

Dr. h. c. Ernst Leitz
Dr. h. c. Ludwig Leitz
Günther Leitz

The activities of the business fall into the following categories:

Scientific section and developmental work
Purchasing and production organization
Production
Sales
Finance and accounting
Administration
Personnel

The story of the Leitz Works begins in 1849

In that year the young mathematician Carl Kellner founded an "Optical Institute" in Wetzlar with the object of acquiring a workshop of his own in which to give practical effect to his scientific experience in computing and improving optical systems. While most optical workshops of his time still manufactured telescopes and microscopes according to traditional rules, Carl Kellner was already in a position to calculate the optical systems mathematically, thereby evolving new ways of improving optical performance.

Thus it was that his very first creation, the "orthoscopic eyepiece" was acclaimed by the experts of that time.

Carl Kellner was not destined to complete his life's work. A few years after his untimely death, Ernst Leitz took over the workshop and continued to carry it on under his own name. In the course of the years he spent in travel he had learned the manufacturing methods of the Swiss clock industry and proceeded to apply it to the manufacture of microscopes, which had previously been built by hand. Thereby he laid the foundations for the development of the works which, through the combined efforts of himself, his sons and grandsons have grown to a business of world wide importance.

From the outset the original Optical Institute in Wetzlar had maintained direct contact with universities and experts in the field, who used the products of the firm in their research work.

By the end of the last century Leitz had become internationally famous in the manufacture of microscopes. Their 50,000th microscope was supplied in 1899. In order to keep pace with the growing demands of the scientific world, the business was reorganized. The instruments were given a more attractive, more contemporary form. Rationalized production methods replaced individual hand construction. The former methods of manufacturing lenses, based though they were on mathematical computation, no longer sufficed.

In 1887 the scientific department of Ernst Leitz was inaugurated, and a new era commenced for the undertaking.

Before the computation of lenses was understood they were simply tested, reground and tested again and again. Trial and error was the order of the day. Nevertheless, notwithstanding exact scientific methods, even today not everything can be calculated and programmed. So there still remains to this very day a certain amount of trial and error, something which amounts to an art, a matter of sensitivity and intuition which no mathematics can replace.

The scientific department of the undertaking has been continually expanded over the past 80 years; among other things a glass laboratory has come into being for the development of new optical glasses, an electronic computer put into operation for computing optical systems, new branches of manufacture opened up and working methods still further refined. 24 development and research laboratories are working on new developments in order to maintain the lead in the manufacture of modern equipment. Over and above the usual laboratories for physical and chemical investigations there are a series of special departments, ranging from the colour laboratory to the research group for electronic equipment. Everywhere the search is on for new knowledge, fresh improvements. Modern production methods and scientific research are the guarantee today that the experiences and successes of yesterday will lead to an assured future for the factory and its employees.