

LEITZ INVESTIGATED BY BRITISH INTELLIGENCE 1946

After WWII the Americans & British sent a team into the Leitz factory in Wetzlar to examine construction techniques of the Leica camera. The British party took away the Leica IIIb drawings & then produced the Reid camera to that design. Taylor Hobson manufactured the lenses and Sigrist & Reid the body. This is the account of their findings. :

B.I.O.S. FINAL REPORT No.1436 ITEM No.9

THE "LEICA" CAMERA

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BRITISH INTELLIGENCE OBJECTIVES SUB-COMMITTEE

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THE "LEICA" CAMERA

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PERSONNEL of TEAM

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THE "LEICA" CAMERA

Reported by:-

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BIOS Trip No:- 2858

BIOS Target No:- 9/14

Dates of Investigation.

19th.November 1946

to

25th.November 1946.

BRITISH INTELLIGENCE OBJECTIVES SUB-COMMITTEE

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1. The purpose of the investigation was to examine the methods of manufacture and constructional details of the Leica Camera with particular reference to finish, assembling and testing. It was not intended that the team should cover the manufacture of the lenses, although some details of the construction of lenses were noted and are included in the report.

One member of the team examined the microscope manufacturing side of the business but was unable to add any useful information to that already obtained.

Details of Journey.

2. The Team left England on the 15th November, 1946 and returned on the 28th November, 1946. Of this period only that from the 18th to 26th November was spent in Germany and the investigation at the Leitz Works was carried out on 19th, 21st and 22nd November. Subsequent visits to the Leitz works were made by the Leader and one member of the team on the 25th and 26th November to collect documents for the removal of which permission had to be obtained.

Introduction.

3. Close co-operation with the U.S. Scientific Consultant Section was necessary and it was considered advisable that the team should be accommodated at Hoechst, near F.I.A.T. Headquarters, and proceed by road to Wetzlar for each day of investigation. This proved to be a very happy arrangement and cordial relations were established with the U.S. Scientific Consultant Staff which were of inestimable value to both the Americans and ourselves.

4. Before the investigation at the Leitz Works was proceeded with the micro-films taken at the Leitz Works by a U.S. Army Micro-film Unit, and filed at F.I.A.T. Headquarters, were examined by one member of the team and it was soon established that these films were, from a practical angle, completely use- less. Although all drawings and documents at the Leitz works had been filmed they had been so completely mixed up that it would have taken a very knowledgeable Leitz executive many months to sort out those relevant to the Leica Camera.

5. At a meeting with B.I.O.S. and the U.S. Scientific Consultants Section it was agreed that the team should be author- ised to remove copies of the drawings for the Leica III B and III C or, alternatively, that another micro-film unit should be sent to the Leitz Works to take a fresh set of films, under the direction of a member of the Team. The U.S. Scientific Consult- ants Section also indicated their interest in the investigation at the Leitz Works and decided to send a team to join forces with the British Team.

6. The investigation, therefore, proceeded as a joint Anglo- American investigation although members of each team made their own notes and reported to their own team leader. It is empha- sized that this report is the result of the investigation of the British Team and is not a joint report.

7. The British Team split at the works to cover various fields such as machining methods, assembly, testing, inspection and organisation. This report is a consolidated result of their findings.

8. The persons interviewed were;-

Herr Ernst Leitz (Senior). Chairman

" Ludwig Leitz Technical Director

" Dumur Commercial Director

and various members of the technical staff of

E. Leitz

We received every help and courtesy from these persons and a considerable amount of assistance from Mr. Dumur.

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General Description of Factory.

9. The Leitz Factory, situated at Wetzlar, comprises a number of buildings built over a period of years. In consequence some of the departments are old-fashioned and badly lighted whilst others, notably the new eight-storied building standing in the centre of the factory site, are modern and well lighted.

10. The plant and equipment varies similarly but is all well maintained.

11. Besides the main Leitz works, the firm of W. & H. Seibert, Instrument Makers, is owned by Leitz and they have a few dispersal works for pressings etc.

12. As the chief employees of labour in this beautiful little town, the Leitz Company can rely on continuity of service and have adopted a very sound policy of training young labour from apprentices. They take pride in the skill of their workers and have welfare and other schemes which help to this end. As a result there is a high percentage of skilled labour employed and the general labour is highly skilled in the particular operation.

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Leica Camera - Manufacturing Processes.

13. The Leitz Company is now producing only the Model III C Leica Camera, this having by development, superseded the Model III B. The Model III C differs from the III B in several aspects, although it is functionally similar. It is approximately 1/8" longer, it has an integral top plate and range finder cover, and the main body is now a single pressure die casting, which together with two other pressure die castings for the top and bottom of the unit forms a complete chassis for the assembly of all the other component parts. In the later models the focal plane shutter blind rollers have been fitted with ball bearings.

14. The outer case of the Leica although 1/8" longer is formed from extruded tube as was the case in the III B and earlier models.

15. The coupled range and view finder has not been altered in any way.

16. Leitz make in their own factories practically all their requirements, including the leather cases for cameras and accessories.

17. Of the items bought out, the castings come from Mahle of Stuttgart, slow speed shutter mechanism from Gauthier of Calmbach, shutter tape from Soenecker & Pfaff of Wupperthal Barmen, and blind material from America through their associated company in that country.

Machine Tools and Methods.

18. In the machine tool side the following machines were noted:- Steinel Drilling Machines, Lindner Thread Grinder, Deckel Engraving and Horizontal Milling Machines, Lorch Lathes, Sooda Automatics, Mikron Gear Hobbers and Hauser Jig Borer. The chasing lathes were by Hille.

19. The general machining of small precision parts followed very closely the usual procedure in this country.

Cutting Multiple Threads.

20. The cutting of the multi-start thread in the focussing mount of the Sumitar and the Elmar lenses was carried out on a converted Lorch Lathe. The conversion of this machine by Leitz was extremely ingenious. The component to be screw-cut was screwed on to an attachment on the head-stock of the lathe by a chucking-thread already cut in it. A single tool was employed in the tool post. The whole head-stock was then caused to oscillate backwards and forwards by a thread attached to the back of the head-stock engaging with a chasing nut which was in turn engaged and disengaged at the end of each stroke by a yoke which also operated four glass-mercury switches. These switches operated a solenoid attached to the drive counter shaft which, in turn, operated a reversing clutch in the drive.

The head stock was caused to rotate for some ten revolutions in a clock-wise rotation which moved it forward by the chasing thread on it engaging with the chasing nut. At the end of this forward stroke the chasing nut disengaged and then re-engaged with the next thread, the counter shaft also re-versing, causing the head-stock to rotate in an anti-clockwise direction on the back stroke for some ten revolutions. As the head-stock oscillated backwards and forwards at each successive movement it engaged with a conveniently disposed paul which engaged with a ratchet connected to the feed on the tool post and at each backward and forward stroke the tool was automatically fed in. The extent of this was shown by a clock indicator attached to the tool post slide. The device worked well and was almost "fool -proof" to operate.

21. The male 5 start thread was cut first on one lathe of the type just described. The female member was cut in an identical manner but to suit the male thread. A certain amount of play was purposely left between the two, when dry, but after both had been well washed out in paraffin a liberal application of special grease was applied and they were assembled together.

The special lubricant caused them to have a very fine "velvety" feel when moved in or out. As male and female members are machined to suit one another it is very doubtful if any two complete units are dead alike as regards inside and outside diameters of threads. Mr. L. Leitz agreed that this was so but added that once a lens focussing mount was assembled it became a unit for good and it did not need to be interchanged with parts from another complete lens mount.

22. The pitch of the 5 start thread in the focussing mount of the Sumitar was 6.210 mms., but in the case of the Elmar pitch of 6.00 mms. and also 6.138 mms. was employed.

To ensure lineality between movement of the lens and the coupled telemeter a slight cam is machined on the end of the male member of the multi-start thread which engages with the roller which actuates the swinging prism of the telemeter. The greatest depth of this cam face does not appear to exceed .007".

Optical Manufacture.

23. The manufacture of small prisms as used in the tele- meter were by mouldings cemented in fours and then gang-milled by diamond milling tools. They were then taken apart and milled to the other face. Diamond tool milling machines are used for slotting the hypotenuse. Smoothing and polishing was achieved by normal type poker-arm machines. Edging was carried out on small lens in the telemeter by diamond wheels. These wheels are made for Leitz by Jung of Berlin.

24. The small reflecting mirror in the range finder is very lightly alluminised, the degree of deposit being just sufficient to give an equal degree of brightness to both the directly and indirectly received images when seen through the range finder eyepiece.

Satin-Chrome Finish

25. The satin-chrome finish on external metal parts was obtained by the following process:-

26. Sandblast, hot cleaner without current, cold cleaner with current, warm rinse, followed by cold rinse, hydrochloric dip, copper flash, cold rinse, sulphuric dip, cold rinse, bright nickel-plate, warm rinse, hydrochloric dip, bright chrome, drag-out rinse, cold rinse, hot rinse, and dry.

27. All articles were jigged on racks and the racks were screened to obviate side-throw.

28. The bright nickel tank was approximately 6' x 2' x 21/2', six depolarised anodes being employed. The volt-meter and ammeter on the resistance control board were all moving coil pattern and the tank was worked at 2 volts, 25 amps. No agitation of the electrolyte was employed.

29. The chrome tank was approximately 4' x 2' x 21/2', twenty-eight strip anti-monial lead anodes being employed. Moving coil volt and ammeters were also fitted in the resistance board and the tank was worked at 5 1/2 volts, 300 amps.

30. It was particularly noted that the time allowed for a satisfactory chrome deposit was exactly three minutes. All the plating equipment was spotlessly clean.

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Assembly and Testing

31. The Model III C takes longer to assemble than its predecessor, 33 hours as compared with 29 hours, but there is no doubt that as an engineering job it is far superior.

32. Sub-assemblies were batched in tens and assembly practice was very similar to that employed in most instrument factories.

Special jigs, fixtures, and tools were employed where-ever possible to assist rapid and accurate assembly. Female labour was used for the minor assemblies, the male labour being employed mainly on shutter and range finder assemblies and on testing.

Shutter

33. The main design of the shutter is in no way basically changed; only slight modification of various components to suit the new assembly. In the assembly of the shutter fast- range escapement one component after another was tried till one was found that worked in a fairly satisfactory manner and then various minor alterations were made to it by filing, and in some cases, a light tap with a small watch-makers hammer. The skill of the operators was undoubtedly the chief asset in the efficient assembling of this shutter.

34. The slow speed escapement of the shutter is made by Gauthier of Calmbach.

Shutter Timing.

35. The timing of the fast range of the shutter is carried out with the aid of a stroboscope of somewhat antique design. By means of this the 1/200, 1/500 and the 1/1000 speeds are

checked. The stroboscope consists of a revolving drum placed horizontally, with 33 horizontal slits in its surface, illuminated from inside by a lamp of approximately 20 watts. The drum is driven by a belt from an electric motor which may be controlled by a rheostat. The drum is also coupled to a speedometer in order that its speed may be set. The correct speed for the drum to rotate at was 280 r.p.m. The camera is held on a wooden block in such a manner that the light from the rotating drum falls on the blinds of the focalplane shutter. The shutter is then fired and a series of stroboscopic lines are seen in the aperture. If the shutter is correctly set these lines appear vertically but if the shutter is incorrectly set the lines will curl down either to the left or to the right according to whether the shutter is set too slow or too fast.

36. The checking of the lower speeds was only carried out on the 1/20 second and 1/4 second

settings by means of a revolving series of lights. The various speeds of the shutter were not accurate to the measurements on the shutter control knob and this fact was acknowledged by the Leitz executives. who pointed out, however, that the results obtained were quite good enough for all general requirements.

37. A metronome was used in checking the one second escapement.

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Shutter Blinds.

38. The fixing of roller blinds and tapes on the focal- plane shutter was carried out on a very ingenious fixture.

The body of this fixture is all metal and accommodates the two roller blinds and tapes on pivots ensuring that the blinds and tapes are of the right length and fixed at exactly the right distance apart. After the blinds and tapes have been stuck to the rollers they are allowed to dry for at least 48 hours before being assembled into a camera. In every possible operation special jigs and fixtures are used to increase speed and uniformity of production.

Lens Flange.

39. The checking of the lens flange of the focalplane for squareness is carried out by a focalplane collimator which is located by the lens flange and directs a beam of light on to a polished reflecting surface which is located on the focal plane. Lack of squareness and an accurate measurement of the extent of the error is at once visible on the graticule of the collimator. When correction is necessary a specially adapted vertical milling machine is used to correct the orientation of the base of the camera body which corrects the lens flange.

If small errors in squareness occur which are not sufficient to warrant machining, the lens flange is packed with a small shim. The correct distance from the front of the lens flange to the film pressure plate, located at the back of the focal plane is 28.80 mms. which is the equivalent to 1.134".

40. Checking of the measurement was made by a special fixture and a clock indicator.

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Setting Telemeter

41. The setting of the position of the telemeter prism to correspond to infinity is carried out by the aid of a rotating disc fitted with alternate colour filters which are illuminated from behind, the whole being fixed in the roof of the assembly shop. The measurement from the lens flange to the centre of the telemeter actuating roller with the telemeter set at infinity is 0.750 mms.

Testing of Lenses

42. The Sumitar lenses were tested for definition by projection at a focal length of 51.68 mm. and were stopped down to 3.2 aperture throughout the test. The total backward and forward movement was also checked by a clock coupled to the lens mount by a pivoted lever movement. The amounts shown by the clock were very closely checked with the readings of the footage scale engraved on the focussing mount. The projection test was in the form of a fine interlaced vertical and horizontal graticule, interspaced with fine figures and letters which were compared with a known standard engraved on a vernier attachment mounted on the screen on to which the image of the graticule was projected.

Final Test.

43. Each completed camera is tested finally by taking a number of black and white photographs between 1.25 to 10 metres.

The result is checked with individual lens, a standard speed film and a metol hydroquinone developer being used. The tests are compiled for lens performance reference.

Drawing Office

44. The office was well organised and was scrupulously clean. The equipment appeared to be new and included about 50 drawing boards, 12 printing machines and the usual accessories. The filing systems for finished drawings was excellent. The quality of paper was, of course, poor.

Research and Development.

45. Leitz have a well organised research department with an impressive staff of scientists, physicists, mathematicians, optical computers and chemists.

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Labour.

46. The labour is drawn from Wetzlar and neighbouring towns and the continuity of service helps to ensure a steady skilled craftsman basis on which the whole works is built. The labour force, which was nearly 5,000 in early 1939, consists of 2,453 men and 428 women of whom 357 males and 81 females are members of the staff.

47. The industrial labour force is made up as follows:-

Born between Years	Skilled Worker	Semi-skilled Worker	Unskilled Worker	Female	
				Assistants	Apprentices
1875 – 1922	673	678	158	137	
1923 – 1925	92	25	29	72	
1926 – 1928	63	23	45	77	
1929 – 1932		74	47	39	
1928 and the following years					256
	828	733	279	325	256

48. It will be seen that the skilled labour percentage is very high and the apprentice training scheme is devised to en-sure a very steady flow of skilled labour.

49. It was very noticeable that men between the ages of 20 and 40 were very few, a fact which of course is attributable to the War. Of the Leitz employees who were in the fighting forces 400 were killed and 300 are still prisoners of war.

Working Hours.

50. The factory is at present working a week starting at 6.45 and finishing at 4p.m. with one hour for lunch. The standard week at Leitz in normal times is 48 hours.

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Wages.

51. A new wage system has recently been introduced, after agreement with Trade Union, which divides the men in to 8 groups and the women into 6, each group being graded according to skill. This grading is carried out by the management in consultation with the workers' representatives.

52. In each grade the rate is made up of the basic rate, for which normal (and predetermined) output is required, and an addition for output about the standard. Details of these systems are given in Appendices "A" and "B".

53. Wage rates are practically the same as before the War and are low compared with British standards. Production per employee is now only 50/60% per hour of pre war and this is attributed to re-action from War, insufficient food lack of purchasable goods.

Production and Costs Etc.

54. In November 1946, the production of Leica Cameras was 1100 per month of which 89% was allocated to the American forces, 6% for French forces and 5% for German sales. A small proportion of the American 89% was available for the British forces in exchange for Rolliflex cameras.

55. Although the the camera was in great demand production was limited owing to shortage of materials, particularly optical glass. Stocks of brass and other metals appeared to be high.

56. Through the shortage of optical glass, lens manufacture was confined to the f/3.5 5 cm. (standard) and 3.5 cm. (wide angle) and the f/4.9 cm. and f/4.5 13.5 cm. lenses.

57. The price of the camera with Elmar f/3.5 5 cm. Bloomed lenses and ever-ready case is now 40% above pre-war price with an addition of Rm. 30 for these models fitted with ball bearings.

58. This makes the German retail price of the camera as described Rm. 546.6

59. The body without lens or case would be Rm. 394

Other Products.

60. The main items of production at the time of inspection, besides the Leica camera, were binoculars, projection apparatus and microscopes. The microscopes included the H. Powder Binocular, Students, Panphot and Ortholux.

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General Conclusions.

61. The Leitz factory is a well-run happy organisation, this being due in no small measure to the family nature of the business and to its importance in the neighbourhood. Discipline is strict without being severe and one gets the impression of great interest by employees of every grade in the work being performed.

62. This pride in workmanship and the just pride all have in their world-wide reputation for quality work is the permeating spirit of the place and helps greatly to offset apathy caused by the present dismal state of the country.

63. The products coming from the Leitz works are equal to any turned out before the war although in some cases the finish is inferior due to poor materials, especially paints and enamels.

64. The team came away with the impression that the Leica camera is still worthy of its pre-eminent position and that the skill of the craftsmen is very much in evidence in the Leitz factory.

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WORKS NOTICE

No. 18. Dated 30.9.46

Group II - Wage Rates System.

Management Notice.

New Wages System.

After approval by the Works Council, the Metal Trade Union and the Hessen District Employment Office, Ernst Leitz Ltd. And W. and H. Seibert put into effect a new wages system from 1st

October 1946.

The New Wages System gives 8 wage groups for Men and 6 for Women and makes it possible to grade in our factory different types of work in the order of the skill required to do it.

This ensures a fairer method of payment than the previous system.

The grading of the works employees into the various Wage Groups will be carried out by the Departmental Manager, the Workers representatives and a member of the Time Study Office.

The new rate will be built up on the basic rate (G.L.) as shown in the attached chart "Wage-Groups with Age-Gradings for Men and Women". The Basic Rate is the minimum wage granted by the Company for which it expects normal output. As output increases so the basic rate is increased by 10%, 20% or 25% as the case may be; if output decreases the basic rate is reduced by 10% or 20%. The output grading of time workers will be done by the Departmental Manager in conjunction with the Workers representative: at fixed intervals the gradings will be re-examined and, if necessary, adjusted.

After this, the wage of each worker will be confirmed to him. In addition, the skilled worker will receive 10% , so that the addition for a skilled man, in Wage Group V with an output grade of 125% hourly wage, will be $25\% + 10\% = 35\%$ and he will, therefore earn $Rm\ 1.00 + 35\% = Rm\ 1.35$

The new rate of piece work is based on the piece work average. The amount of that rate is 15% higher than the basic rate and normal output is expected. Vf is the calculating factor, being earnings per minute. If work of varying skill, i.e. in different wage groups, is performed and the re-distribution of such work is impossible or unnecessary, the new wage will be fixed in the higher wage group.

If it is necessary, in exceptional circumstances to give a worker work covered by a lower wage group, the time worker will receive for equal output his average earnings in the higher grade and the piece worker the calculation factor of the wage group in which he has done most work.

The highest age stage has now been reduced from 23 years to 21 years and the classification of age grades has altered accordingly.

The basic rates for women over 21 years of age have been assessed at 75% of the corresponding mans rate in the equivalent wage-group.

In addition to the above the following agreements will be implemented. "Wage rates for the Iron, Metal & Electro- industry for the Economic District of Hessen" dated 13.4.38, clauses VI & IX and "Agreement covering Wage Rates in the Iron, Metal & Electro-industry of the Economic District of Hessen" of 1.7.40, clauses 9 to 12.

"B"

WAGE-GROUPS WITH AGE-GRADINGS FOR MEN AND WOMEN.

MEN

Wage groups	basic wage pfennigs	Over 21 years 100,00%		Over 19 to 21 years 90,00%		
		piece work average	per minute	basic wage pfennigs	piece work average	per minute
I)	70	81	1.34	63	72	1.21
II)Unskilled	77	89	1.48	69	79	1.32
III)	85	98	1.63	77	89	1.48
IV)Semi-skilled	92	106	1.77	83	95	1.59
V)	100	115	1.92	90	104	1.72
VI)Skilled	107	123	2.05	96	110	1.84
VII)	114	131	2.18			
VIII)Exceptional	122					

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	basic wage	Over 17 to 19 years 75,00%			
		Over 18 years		Under 18 years	
		piece work average	per minute	piece work average	per minute
I)	53	61	1.01	66	1.10
II)Unskilled	58	67	1.11	73	1.22
III)	64	74	1.23	80	1.33
IV)Semi-skilled	69	79	1.32	86	1.43
V) Skilled	75	86	1.44	94	1.57

