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U. S. NAVAL TECHNICAL MISSION TO JAPAN
CARE OF FLEET POST OFFICE
SAN FRANCISCO, CALIFORNIA

13 December 1945

RESTRICTED

From: Chief, Naval Technical Mission to Japan.
To : Chief of Naval Operations.

Subject: Target Report - Japanese Optics.

Reference: (a)"Intelligence Targets Japan" (DNI) of 4 Sept. 1945.

1. Subject report, covering Target X-05 of Fascicle X-1 of reference (a), is submitted herewith.

2. The investigation of the target and the target report were accomplished by Lt. Comdr. G. Z. Dimitroff, USNR, assisted by Lieut. W. D. Hedden, USNR, and Lt.(jg) L. A. Seymour, interpreter and translator.

C. G. Grimes

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Captain, USN

31768

RESTRICTED

X-05

JAPANESE OPTICS

"INTELLIGENCE TARGETS JAPAN" (DNI) OF 4 SEPT. 1945

FASCICLE X-1, TARGET X-05

DECEMBER 1945

U.S. NAVAL TECHNICAL MISSION TO JAPAN

SUMMARY

MISCELLANEOUS TARGETS

JAPANESE OPTICS

On the basis of study of the targets listed and examination of material left intact, the development of optics in Japan can be summarized as follows:.

1. In the past five years Japan has made a phenomenal growth in optical glass manufacture.

2. Japan has at present, fairly modern and efficient optical factories.

3 No spectacular optical developments have been made in Japan, but rather adaptions and modifications have been made of the optical systems used in German and U.S. instruments.

4. Japan has capable scientific personnel who understand modern optical requirements and are cognizant of the shortcomings in the Japanese processes of glass manufacture.

5. The Japanese exhibited a tendency toward large size (aperture) visual optical instruments, particularly in the field of binocular telescopes (80, 120, 150mm apertures). This tendency may represent a futile attempt to offset deficiencies in their radar development.

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Location of Targets:

Optical Factory near Submarine Base in Nagaura Harbor, YOKOSUKA - Evidence was found that lens coating had been carried on. A few samples of apparently experimental coatings and coating material were obtained.

Optical Factory at ZUSHI - This factory manufactured mechanical parts for midget submarines. Extensive caves had been dug into the hills, which appeared to be soft shale, and machines had been moved in, but no work had actually been done in the caves. One of the tunnels in the caves was designated for glass annealing, but was not completed. Machines and equipment for about 400 employees were provided. Plans called for enlargement to about double this size.

Optical Research Laboratory at KANAZAWA, First Air Technical Branch Arsenal - The greater part of the buildings had been destroyed by bombing and most of the equipment had been removed to KOMARIYA, near OSAKA. A display room contained some binoculars, bomb sights, and gun cameras and many signs indicating the places where lenses, torpedo cameras, Navy binoculars, sights, and other material had been arranged for display.

Nippon Optical Co.

Main Plant, Oimachi, TOKYO - Manufacturers of optical glass and optical instruments such as lenses, aerial cameras, range finders, periscopes, etc.

Hoyama Plant - Makers of aerial cameras.

Tokyo Optical Co. - Manufacturers of cameras, gun sights, bomb sights, binoculars, etc.

Konishi Roco

Main office at Nihonbashi 3 Chome, TOKYO

Yodobashi Plant near Shinjuku Station - Manufacturers of cameras.

Hino Plant - Manufacturers of film.

Odawara Plant - Manufacturers of paper.

Oyama Plant - Manufacturers of dry plates.

Hanno Plant - Manufacturers of cameras for the Army.

Riken - Institute of Physical and Chemical Research.

Japanese Personnel Interviewed:

Zinjiro DOI - Graduate of Technical School of Tokyo Imperial University, 1926; specialized in higher mathematics and studied optics independently; Professor of Higher Mathematics, Naval Staff College, TOKYO, for 15 years; optical design engineer at Yokosuka Navy Yard for past five years; was head of design section at the end of the war, had 25 computers under him at first, only five at the end of the war.

T. NAKAJIMA - Chief of design section, First Naval Air Technical Branch Arsenal; Graduate of Kyoto Imperial University; specialty, geometrical optics; was employed by Tsugami Co., at NAGAOKA, near NIIGATA in N.W. Japan, manufacturers of precision gauge blocks and measuring machines; left there nine years ago to come to Naval Air Technical Arsenal, where, at present, he is head of the optical computing section.

R. ARA - Worked on Schmidt type lens at the First Naval Air Technical Arsenal; as a student in Tokyo Imperial University, he was sent to the Branch Air Technical Arsenal to do some practical work and was given the problem of designing a fast camera for twilight photography.

Mr. ASHIDA (at RIKEN) - Designer of R Aero type lens, f:5.0, 50cm, Nippon Optical Co.

Kinichi EZUMI - Head of optical experimental laboratory at YOKOSUKA, associated with DOI, Zenjiro, at Yokosuka Navy Yard.

K. EZUMI - Engineer; director of periscope factory in ZUSHI.

Mr. FURUSAWA - First Air Technical Arsenal, KUMAZAWA.

K. HOTTA - First Air Technical Arsenal at KANAZAWA.

T. HENMI - Engineer at Zushi Periscope Factory.

F. KUBODA - First Air Technical Arsenal at KANAZAWA.

Masao NAGAOKA - Manager of glass works, Nippon Kagaku.

Seiji NAKAMURA - Professor of theoretical optics at Tokyo Imperial University; associate with Zenjiro DOI at Yokosuka Navy Yard.

Dr. SUGIURA - Research fellow in atomic physics at the Physical and Chemical Institute.

Lieut. TAKAGI, IJN - Optical Section, Navy Technical Department, Navy Ministry.

Pertinent NavTechJap Reports:

Japanese Naval Photography, Index No. A-39.

Japanese Infra-Red Devices, Article 1 - Control for Guided Missiles, Index No. X-02-1.

Japanese Infra-Red Devices, Article 2 - Heat Locator Equipment, Index No. X-02-2.

Japanese Infra-Red Devices, Article 3 - Research, Development, and Manufacture of Infra-Red Equipment, Index No. X-02-3.

INTRODUCTION

The aim of this investigation was to exploit optical developments in Japan from the standpoint of research and manufacture and their application to instruments for naval or military use. This was accomplished by a study of:

1. The Glass Making Industry
   - a. Methods of manufacture
   - b. Types of glass developed
   - c. Information received by the Japanese from Germany.
   - d. Research laboratories or institutions
   - e. Type of raw material
   - f. Special ingredients or substitutions
2. Optical Designs
   - a. Research in physical optics
   - b. Methods of computation of optical systems
3. Application of Light and the Optical Arrangements to Special Fields

THE REPORT

I. GENERAL

During the war of 1917-18, Japan found herself, much like other countries, completely dependent for optical glass upon imports from Germany.

In 1918, under the direction of a Navy captain, experiments in glass manufacture were carried out at the Tsukiji Arsenal, south of TOKYO. So far as could be ascertained, seven types of glass were manufactured during the following two or three years in quantities up to 300 kg melts.

After the big earthquake, the Navy Ministry arranged for the organization of the Nippon Optical Company. The chief chemist was a Mr. OHARA who later left the company and started his own optical plant near Omori, Kamata (TOKYO). This plant was destroyed by bombs.

Experimental work on optical glass manufacture was carried on during the war by the individual factories, among which there appears to have been keen rivalry.

Perhaps the most advanced experiments on a small scale were carried on in OSAKA by Dr. TAKAMATSU, who originally worked at a government factory but later became associated with "The Osaka Industrial Laboratory". The Nippon Optical Company had carried on research in optical glass manufacture since 1920, mainly in an effort to duplicate German glass and to gain control of optical constants which appear to vary markedly from melt to melt. The more recent experiments dealt with the developments of cadmium glass. No samples of this glass were available.

In 1942 there occurred a great expansion in glass production. This was carried out, according to Nippon Optical officials, under governmental pressure New buildings, optical shops, machine shops, etc., were started. No sooner were they completed than the company was ordered to move the machinery to plants in the interior of Japan. Shortly afterwards, this order was rescinded. Later it was expected that the plants would be moved to Manchuria. In fact, some of the equipment (film coating machines) of the Fuji Optical and Photographic plants in ASHIGARA was sent to Manchuria, but was lost when the ships carrying it were sunk.

It was during this period of expansion of the optical industry that the Fuji Optical Company plant in ODAWARA, which originally manufactured photographic chemicals for the sister plant in ASHIGARA, began the manufacture of optical glass. Beginning on a small scale, the plant increased its production to 30 tons of optical glass per year and was still expanding when it was bombed on 14 August 1945.

The ultimate expected capacity had been 120-150 tons per year.

For the purpose of illustrating representative methods of glass making, the Odawara plant of the Fuji Optical Company was photographed in some detail (see Figures 1 to 12). A comparison with installations in the optical cave in SASEBO, which had been explored previously, revealed that practices in optical shops were fairly standard.

II. POT MAKING

Pots usually employed are of one ton capacity. More recently, however, the Fuji Optical Company adopted a pot of two tons capacity and had begun large-

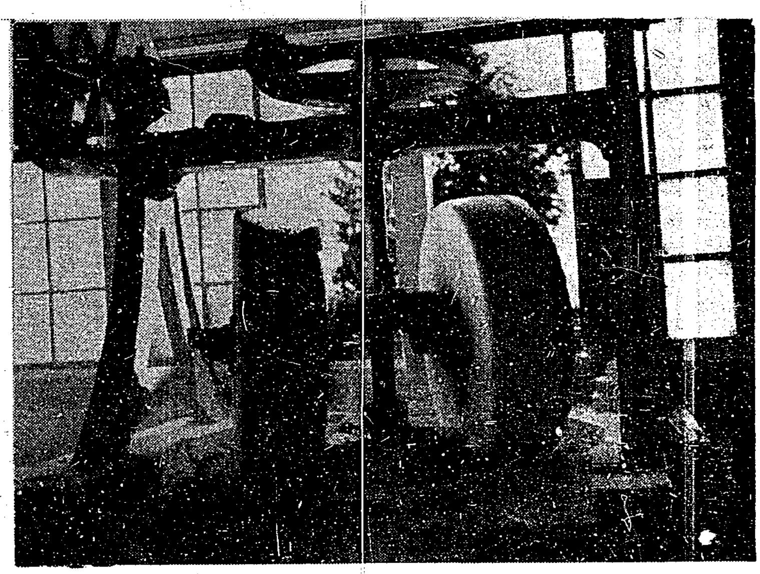

Figure 1
EDGE RUNNER MILL FOR GRINDING THE CLAY IN POT MAKING

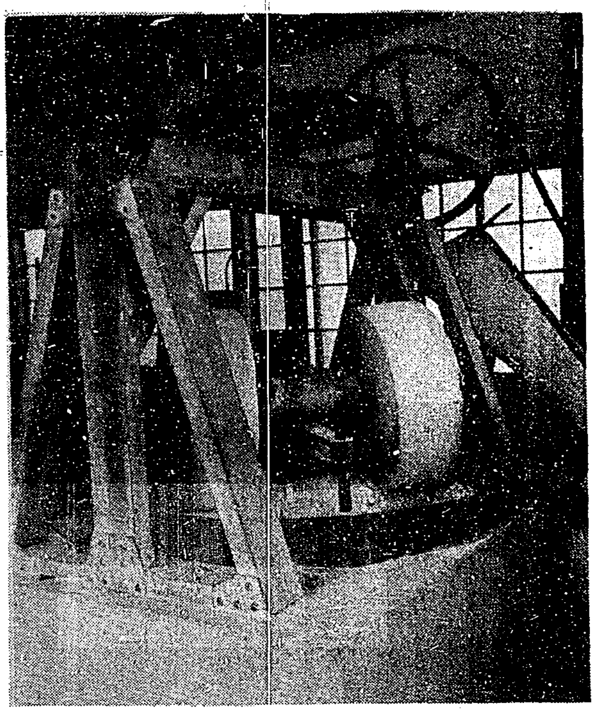

Figure 2
EDGE RUNNER MILL

Figure 3
"CONTROLLED DRYING" ROOMS FOR POTS

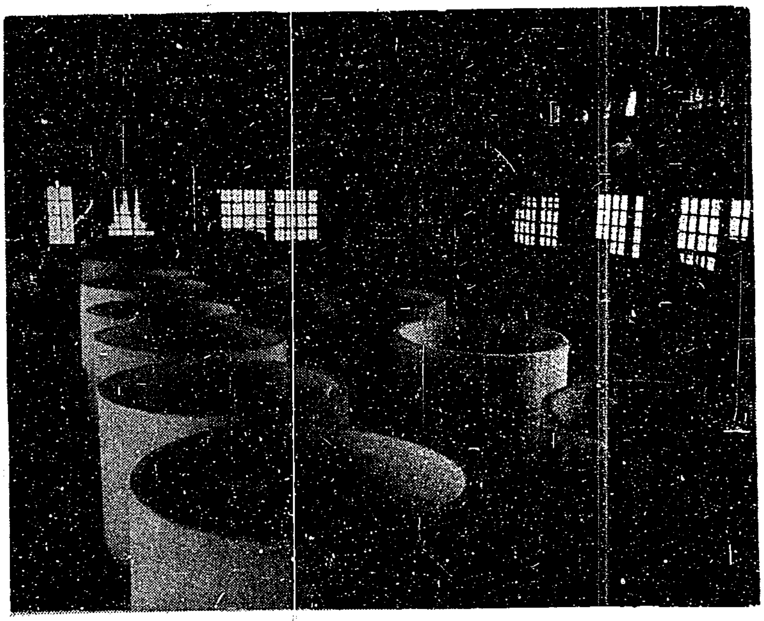

Figure 4
STORAGE ROOM FOR FINISHED POTS

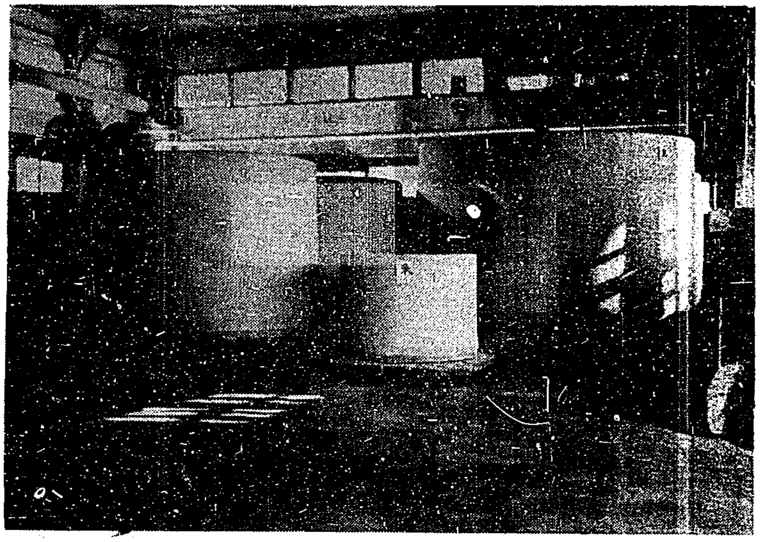

Figure 5
ONE-TON, ONE-QUARTER-TON AND TWO-TON GLASS POTS

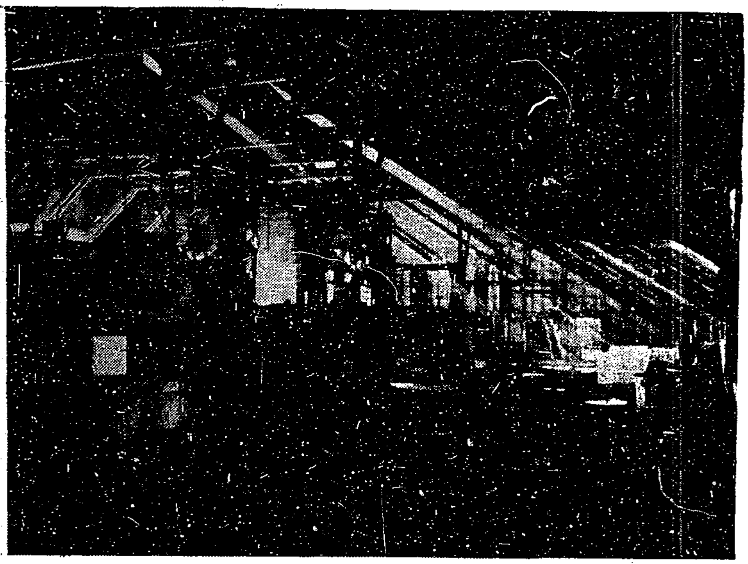

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Figure 11

ANNEALING OVENS AND TEMPERATURE RECORDING INSTRUMENTS

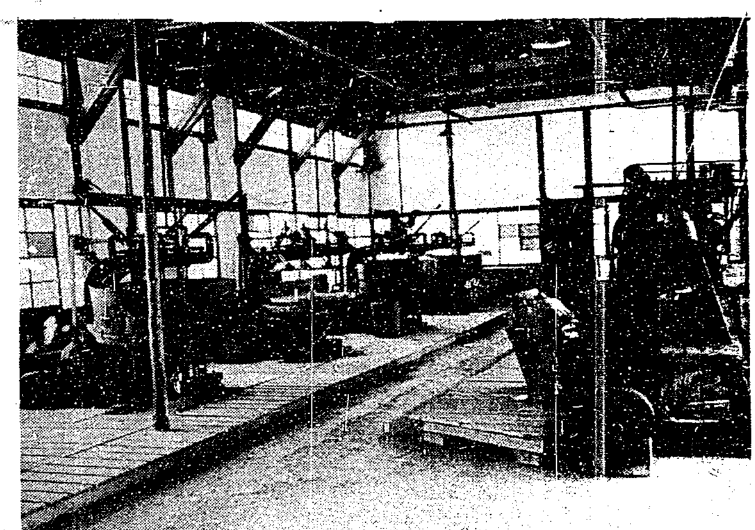


Figure 12

MACHINES FOR POLISHING GLASS BLOCKS FOR EXAMINATION scale construction of such pots. Smaller pots of one-quarter ton capacity and laboratory pots of 10 pounds capacity are also used.

A. METHODS OF POT CONSTRUCTION AT THE ODAWARA PLANT OF THE FUJI OPTICAL COMPANY

Pots are made by two methods, one is the hand method and the other is the slip casting method. (The Nippon Optical Company has experimented in making pots by "dipping" the mold into liquid clay mixture. Satisfactory pots up to 60cm diameter were obtained.)

1. Hand Method, or Building-Up Method

a. Raw materials for pots:

(1) For ordinary flint glass or crown glass melting:

(a) For the body of pots (outsides of pots):

Honyama clay	24%	(Passed 40 mesh)
Pyrophyllite	36%	(Passed 30 mesh)
Chamotte	12%	(25 - 40 mesh)
Chamotte	12%	(40 - 80 mesh)
Chamotte	16%	(80 - 200 mesh)

(b) For lining of pots and for inside of pots:

Honyama clay	25%	(Passed 40 mesh)
Pyrophyllite	37%	
Chamotte	36%	(Passed 40 mesh)
Feldspar	2%	(80 - 200 mesh)

(2) For barium crown glass melting:

(a) For the body of pots: The same as above.

(b) For lining of pots:

Honyama clay	25%	
Pyrophyllite	20%	
Diaspore	45%	(Passed 40 mesh)
Feldspar	10%	

(3) For dense barium crown glass melting:

(a) For the body of pots:

Honyama Clay	22%	
Pyrophyllite	18%	
Diaspore	40%	
Chamotte	20%	(Passed 40 mesh)

(b) For lining of pots:

Honyama clay	22%	
Diaspore	40%	
Pyrophyllite	18%	
Chamotte	20%	(Passed 40 mesh)

(4) Clay: Impurities are removed from the raw clay by hand picking. To facilitate this process large pieces are broken with a hammer. Afterwards the clay is laid outdoors to break down, thus increasing the plasticity.

In order to remove iron, quartz, mica, and organic substances from raw clay without impairing its plastic properties, the elutriation method is adopted.

After weathering or other purifying treatment, the clay is dried, crushed in jaw crushers, and ground in edge runner mills. Clays of different quality are then blended.

(5) Chamotte: The clay for the chamotte is fired to about 1450°C, and burnt thoroughly. Then the lumps of clay are broken down in jaw crushers, ground in edge runners and finally screened.

b. Building up of pots: The pot-maker takes the clay, which contains 17-18% water, from the kneaders, throws it forcibly upon a board and spreads it. The board is fitted with two pairs of handles so that it may be lifted. When the bottom attains the required thickness, (8cm for a one-ton pot and 10cm for a two-ton pot) the board is lifted and turned over. The pot bottom is reversed and laid upon a second board and the edges of this slab of clay are covered with rough cloths to prevent too rapid drying. The usual drying time for various pots is as follows:

One-ton pot bottom .... about 70 hours
Two-ton pot bottom .... about 120 hours

The rough cloths around the edge are removed and the edge is wedged up between the hands so that a thin rim of clay, about 7cm high, rises around the bottom. Rolls of clay about 20cm long and 7cm in diameter are prepared and spread upon the outside of the rim. The building up from the bottom continues, the layers of clay being superimposed one after the other, until the wall reaches a height of 25 to 30 cm. The wall is covered with rough cloths and left to dry slowly. The side of the pot is smoothed by a flat piece of wood.

When this first section of the pot wall is sufficiently dry to support the next upper section, the latter is built up in the same way. Three or four sections, each from 20 to 25cm high, are necessary in order to raise the wall to the full height of the pot.

c. Drying and aging: During the whole of the building process, the humidity and temperature of the room are kept at about 70% R.H. and 10 to 15°C.

Type of Pot	Time needed	
	For drying	For aging
One-ton pot	12-13 days	2-3 months
Two-ton pot	15-16 days	3-4 months

The room conditions mentioned above are maintained until the pots are used.

2. Casting Method of Pot-Making (for one-ton pot only).

a. Slip for ordinary flint glass or crown glass melting:

Honyama clay .... 25% (Passed 40 mesh)
Kaolin .... 15% (Passed 40 mesh)

Pyrophyllite	10%	(Passed 40 mesh)
Chamotte	20%	(20 - 40 mesh)
Chamotte	5%	(40 - 80 mesh)
Chamotte	25%	(Passed 80 mesh)

Water: 20% of the total weight of the above dry materials.
Sodium silicate: 0.2% of the same.
Sodium carbonate: 0.1% of the same.

Lining is the same as in the hand method.

b. The mold: The core consists of one block; the shell, three blocks; and the base, one block. The base must be leveled sufficiently to prevent cracking.

c. Casting: The molds are filled by a slip distributor. The entire operation of filling requires 30 minutes. The time needed for casting varies from 16 to 24 hours, according to the room temperature and dryness of the mold. After casting, the core is removed. After 24 hours the shells are taken off, and a week later the lining is put on.

d. Drying: Two drying methods are adopted.

(1) Natural drying: Shrinking period in two months. Pots are allowed to age for three months.

(2) Humidity drying: Fourteen days after forming pots, they are put into drying boxes, where they are dried for 14 days at 80% R.H. and about 40°C. The pots remain in the drying box another 30 days at 30% R.H. and about 60°C. The pots are then ready for use and aging is not necessary.

B. METHODS OF POT MAKING AT NIPPON OPTICAL CO.

At this plant, the body was made by slipcasting and the lining was done manually.

1. Formulae of Mixtures

a. Body:

Binders -	Kibushi clay	15%
	Kaolin	5%
	Gairome	15%
Non-plastic materials -	Grogs, 15-50 mesh	40%
	under 50 mesh	20%
Water content		18.5%
Dispersing agents as Na_2O		0.16%

Note: Grogs are prepared by burning Kibushi clay at 1500°C for 6 hours.

b. Lining:

Binders -	Gairome	35%
Non-plastic materials -	Feldspar	12%
	Silica sand	12%
	Grogs, 30-50 mesh	7%
	50-80 mesh	13%
	80-120 mesh	10%

Under 120 mesh ... 11%
Water content 20%
Dispersing agents as Na_2O 0.15%

2. Procedures

a. Slip making:

(1) Soaking and swelling of binders.

(2) Slip making by addition of grogs.

(3) Keeping the finished slip for a week or longer.

b. Casting:

(1) The slip is cast between gypsum moulds within half an hour.

(2) Removal of the inner mould 12 hours after casting.

(3) Removal of the outside mould 24 hours after casting.

c. Lining and finishing:

(1) Cut-off of the upper surplus portion.

(2) Fitting the band with the above mentioned portion.

(3) Lining of the inner surface after scratching off the surface with a comb (three or four days after casting).

d. Drying:

(1) Drying at the room temperature for 40 days or longer.

(2) Drying at high temperatures (to 60°C) for ten days.

(3) Minimum time, 60 days.

III. THE FURNACE

Gas heated furnaces are used and normally they are controlled manually. (In the case of the Odawara Plant of the Fuji Optical Co., the gas is produced at the factory and is piped directly to the furnaces without the use of an intermediate storage tank; pressure is maintained only by controlling the draft in the generating plant.) Thermocouples and recording instruments are installed so that a record of temperatures in each furnace can be obtained. For higher temperatures, optical pyrometers are used.

Methods of preheating vary slightly. In some cases, the pots are preheated in separate furnaces which are also used as annealing ovens. In other cases, the pots are preheated in the melting oven before charging. In the latter cases, they are examined for cracks by means of water-cooled metal mirrors attached to long poles.

Charging of the pots is accomplished manually and requires considerable time. A small scoop is used.

The finished glass is cooled in the pots and later molded into blanks by placing the pieces in refractory containers. Small size lenses are actually pressed into rough shape in the usual manner.

Table I
LIST OF FIRST CLASS QUALITY GLASS MANUFACTURED BY THE FUJI OPTICAL CO.
CHEMICAL COMPOSITION AND OPTICAL CONSTANTS

(Figures indicate percent)

	SiO_2	H_3BO_3	ZnO	$CaCO_3$	Na_2CO_3	KNO_3	As_2O_3	$Ba(NO_3)_2$	K_2CO_3	Pb_3O_4	$NaNO_3$	Al_2O_3	n_d	Mean Dispersion C − F	V	Total Sum Produced (Kilograms)
FK5-11*	50.7	19.7							3.7		6.5	0.1	1.48820	0.00696	70.1	20
BK1-28	55.8	11.8		1.1	8.8	22.3	0.2						1.51043	0.00802	63.6	60
BK7-374	53.4	16.1			12.6	14.0	0.4	2.5				1.0	1.51592	0.00805	64.1	57,358
BBLK3-34	56.2	7.3	0.8		19.5		0.4	10.9	4.9				1.51871	0.00856	60.6	755
K3-7	54.8	5.2	2.8	5.7	13.0	18.1	0.4						1.51855	0.00876	59.2	567
BaK1-14	38.2	5.8	7.9		1.7		0.4	37.4	8.6				1.57270	0.00995	57.6	648
BaK4-106	40.7	8.8	9.4		6.4		0.4	28.3	4.1	1.9			1.56954	0.01063	56.2	17,907
SK12-13	26.3	15.2	5.8				0.8	49.0		0.7		2.2	1.60820	0.01073	56.7	17
SK4-13	25.3	14.8	2.3				0.7	55.0				1.9	1.61344	0.01043	58.8	367
SK5-57	27.3	18.3	1				1.0	49.8				3.6	1.58758	0.00964	61.0	7,878
SK7-28	25.1	17.7	1.9				0.7	54.6					1.60639	0.01020	59.5	756
SK8-17	27.9	11.4	6.7				0.5	50.2		1.5		1.8	1.60757	0.01093	55.6	59
SK9-26	28.5	11.5	5.3				0.9	48.9		3.4		1.5	1.61380	0.01112	55.2	628
SK10-28	24.0	12.1	3.8				0.7	56.7		0.6		2.1	1.62346	0.01097	56.8	1332
SK11-5	37.9	12.5	2.0		2.9		0.6	38.4	4.2			1.5	1.56217	0.00926	60.7	6
SK12-8	28.5	15.9	2.1		2.9		0.6	45.3	2.8			1.9	1.58310	0.00983	59.3	30
SK14-7	25.0	18.5	0.5	1.2			0.4	52.7				1.7	1.60195	0.00996	60.4	320
SK16-10	22.8	16.8					0.4	59.0				1.0	1.62016	0.01029	60.3	25
KF2-10	58.6		2.1		23.3	3.6	0.4			12.0			1.52702	0.01029	51.0	1463
KF3-11	59.6		2.2		20.2		0.4			6.0	11.1	0.5	1.51370	0.00955	53.8	267
SSK1-2	28.4	8.7	6.0				0.6	51.6		3.0		1.7	1.61870	0.01145	54.0	82
BaF7-6	35.5	5.8	4.5		5.0	7.7	0.4	22.8		18.3			1.60838	0.01313	46.3	32
LF4-11	47.0	1.6					0.5		10.2	30.0	10.7		1.57967	0.01392	41.6	1031
LF5-15	46.8					6.3	0.3		14.8	31.8			1.58013	0.01424	40.7	228
F1-57	42.0					3.6	0.3		8.2	43.9			1.62570	0.01755	35.7	1359
F2-69	42.0					5.6	0.3		8.2	43.9			1.62070	0.01704	36.4	6,367
F3-103	43.4				7.7	7.9	0.3			40.7			1.61244	0.01656	37.0	9,061
F5-86	44.6				8.2	7.8	0.3			39.1			1.60313	0.01582	38.1	8,492
BaSF1-12	35.5		4.3		1.4	13.4	0.6	16.6		28.2			1.62799	0.01600	39.2	774
SF2-48	38.6					7.0	0.4		5.3	48.7			1.64829	0.01913	33.9	11,117
SF5-33	35.4					11.6	0.4			52.6			1.67612	0.02104	32.1	[illegible]
KzF2-2**	41.7	27.9			6.2	3.7	0.4		1.8	0.3		2.0	1.52727	0.01016	51.9	41
LLF2-9	54.9				6.8	16.1	0.3			21.9			1.54037	0.01148	47.1	22
																130,603

*KF − 19.3 **Sb_2O_3 − 16.0

IV. OPTICAL GLASS PRODUCED

The following tables list the glass manufactured by the Fuji Optical Co. and Nippon Optical Co. and give the chemical composition of each, the optical constants and the amount of glass produced.

Table II
LIST OF ALL FIRMS TO WHICH OPTICAL GLASS WAS SOLD BY FUJI OPTICAL CO., 1941 to 1945

(Unit: kg)

Firms	1941	1942	1943	1944	1945	Total
Tokyo Daiichi Rikugun Zoheisho	3,645	17,688	17,316	26,878	20,572	86,099
Fuji Shashin Koki			6,492	8,024	9,615	24,131
Tomioka Kogaku	883	9,766	9,084	50	400	20,183
Showa Kogaku (Inoue Kogaku)	265	1,330	2,533			4,128
Okada Kogaku		2,378	84		1,677	4,139
Seiki Kogaku			32	3,424	186	3,642
Nippon Taipu			1,612	530	500	2,642
Fuji Kogaku					2,231	2,231
Konishiroku Shashin Kogyo					1,906	1,906
Asahi Kogaku				260	1,074	1,334
Takachiho Kogaku					1,684	1,684
Shimazu Seisakusho		60	651		200	911
Tokyo Tokei (Tamagawa Koki)		707	185	1,074		1,966
Chiyoda Kogaku			15	1,292	617	1,924
Yamato Kogaku			1,721			1,721
Riden Kogaku			162			162
Total	4,793	31,929	39,887	41,532	40,662	158,803

Note: Amounts include products of the second and third class sold.

TABLE III
AMOUNTS OF GLASS USED BY FUJI OPTICAL COMPANY FOR THE PRODUCTION OF LENSES

Year	1941	1942	1943	1944	1945	Total
Kgs used	0	0	342	373	710	1,423

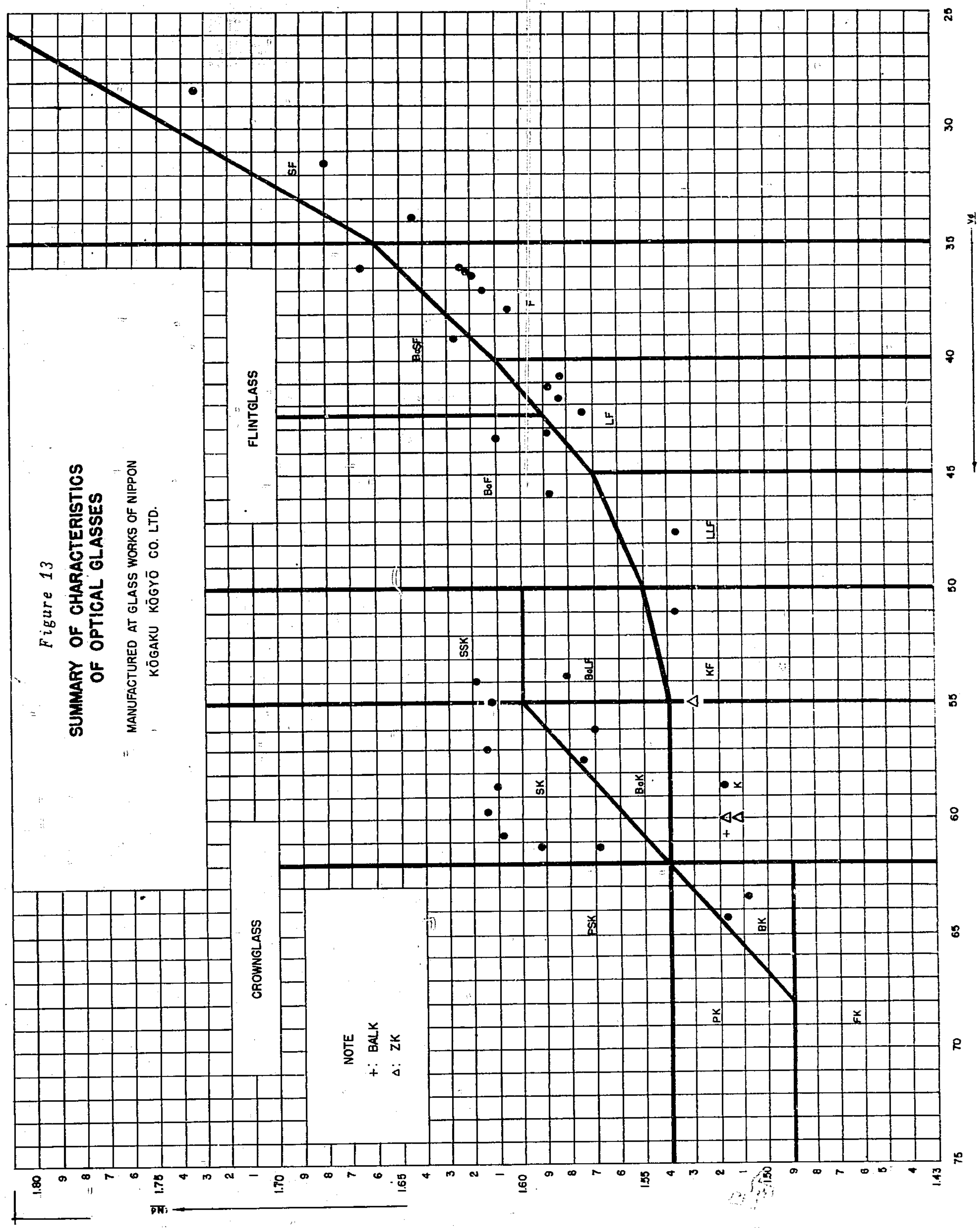


Figure 13

SUMMARY OF CHARACTERISTICS OF OPTICAL GLASSES

MANUFACTURED AT GLASS WORKS OF NIPPON KŌGAKU KŌGYŌ CO. LTD.

TABLE IV
NIPPON OPTICAL CO.
OPTICAL CONSTANTS

No.	Type	nd	$\nu = \frac{nd-1}{nF-nC}$	No.	Type	nd	$\nu = \frac{nd-1}{nF-nC}$
1	BK 1	1.5090	63.4	22	SSK 1	1.6182	54.1
2	BK 7	1.5183	64.4	23	LLF 2	1.5393	47.8
3	BaLK 3	1.5197	60.9	24	LLF 7	not determined	
4	K 3	1.5185	58.8	25	BaF 3	1.5887	45.9
5	ZK 2	1.5187	60.3	26	BaF 4	1.6095	43.6
6	ZK 3	1.5118	60.1	27	LF 1	1.5733	42.3
7	ZK 5	1.5338	54.9	28	LF 2	1.5882	41.2
8	BaK 1	1.5744	57.7	29	LF 4	1.5837	41.7
9	BaK 4	1.5700	56.0	30	LF 5	1.5822	40.7
10	SK 1	1.6133	57.0	31	LF 7	not determined	
11	SK 4	1.6106	58.8	32	F 1	1.6256	36.1
12	SK 5	1.5915	61.1	33	F 2	1.6224	36.2
13	SK 7	not determined		34	F 3	1.6150	37.0
14	SK 9	1.6134	55.0	35	F 4	1.6193	36.4
15	SK 10	not determined		36	F 5	1.6048	37.9
16	SK 11	1.5656	61.2	37	BaSF 1	1.6262	39.2
17	SK 14	1.6091	60.7	38	BaSF 2	1.6662	36.0
18	SK 16	1.6165	59.7	39	SF 2	1.6476	33.8
19	KF 2	not determined		40	SF 3	1.7436	28.1
20	KF 4	1.5373	51.0	41	SF 5	1.6792	31.6
21	BaLF 4	1.5800	53.8				

(See pages 24 and 25 for Tables V and VI.)

TABLE VII
OPTICAL GLASS MAKING RAW MATERIALS
USED BY NIPPON OPTICAL CO.

No.	Name	Maker or the Place of Production
GM. 1	Natural Flint (SiO_2)	Ouchi-Kogyosho (Natural Rock, FUKUSHIMA)
GM. 2	Calcined Flint	Calcined GM. 1
GM. 3	Silica Sand	Pulverised and Sieved GM. 2
GM. 4	Sodium Carbonate, Anhydrous (Na_2CO_3)	Mitsubishi-Kwasei Co. Ltd., FUKUOKA
GM. 5	Sodium Nitrate ($NaNO_3$)	Nippon Kwagaku Co. Ltd., TOKYO
GM. 6	Potassium Nitrate (KNO_3)	Nippon Kwagaku Co. Ltd., TOKYO
GM. 7	Potassium Carbonate (K_2CO_3)	Sumitomo Kwagaku Co. Ltd., EHIME
GM. 8	Barium Carbonate ($BaCO_3$)	Sakai Kwagaku Co. Ltd., OSAKA
GM. 9	Barium Nitrate ($Ba(NO_3)_2$)	Sakai Kwagaku Co. Ltd., OSAKA
GM. 10	Zinc Oxide (ZnO)	Sakai Kwagaku Co. Ltd., OSAKA
GM. 11	Calcium Carbonate ($CaCO_3$)	Shiraishi-Kogyo Co. Ltd., MIE
GM. 12	Magnesium Carbonate ($MgCO_3$)	Nippon Maguneshumu Co. Ltd., OSAKA
GM. 13	Lead Oxide (PbO)	Dainippon Toryo Co. Ltd., OSAKA
GM. 14	Aluminum Hydroxide ($Al(OH)_3$)	Takeda Yakuhin Co. Ltd., OSAKA
GM. 15	Borax ($Na_2B_4O_7 \cdot 10H_2O$)	Takeda Yakuhin Co. Ltd., OSAKA
GM. 16	Boric Acid (H_3BO_3)	Takeda Yakuhin Co. Ltd., OSAKA
GM. 17	Arsenous Oxide (As_2O_3)	Nippon Kogyo Co. Ltd., AKITA

TABLE V
NIPPON OPTICAL CO.
OPTICAL GLASS

CHEMICAL COMPOSITIONS (%)

No.	Type	SiO_2	B_2O_3	Na_2O	K_2O	BaO	PbO	ZnO	Al_2O_3	As_2O_3	CaO	MgO
1	BK 1	70.5	6.6	5.45	14.4					0.4	2.65	
2	BK 7	67.5	10.5	9.5	8.5	2.5			0.1	0.3		0.05
3	BaLK3	64.7	3.0	5.0	15.0	10.0		2.0		0.3		
4	K 3	68.3	2.2	14.4	7.0		2.9		0.2	0.4	4.6	
5	ZK 2	64.0	4.8	5.1	15.2			10.2	0.2	0.5		
6	ZK 3	68.1	2.1		13.6			8.1	1.0	0.3		0.5
7	ZK 5	58.2	3.1	13.8	8.0	1.5	5.4	8.7	1.0	0.3		
8	BaK 1	47.1	4.55	3.2	4.9	29.9		8.5	1.3	0.5		
9	BaK 4	51.8	6.2	4.4	4.8	17.9	3.2	11.2		0.4		
10	SK 1	38.5	6.7			42.8		9.0	2.5	0.5		
11	SK 4	33.45	10.7			48.5		1.2	5.6	0.5		
12	SK 5	38.7	13.8			42.3			4.6	0.5		
13	SK 7	34.0	13.5			47.5		0.5	5.0	0.5		
14	SK 9	38.0	6.0			41.6	2.5	7.9	3.5	0.5		
15	SK 10	33.5	9.8			50.0		5.3	3.7	0.5		
16	SK 11	48.1	10.5	2.6	3.6	30.1		2.1	2.6	0.4		
17	SK 14	34.6	15.0			45.9			5.0	0.5		
18	SK 16	30.0	15.5			50.0			4.0	0.5		
19	KF 2	60.5		13.5	7.9		13.1	2.7	1.7	0.5		
20	KF 4	60.2		12.3	7.7	5.1	11.2	2.7		0.4		
21	BaLF4	46.1	3.7	0.9	6.7	21.5	4.05	15.65	1.3	0.3		
22	SSK 1	37.9	6.15			40.5	4.3	7.75	2.9	0.5		
23	LLF 2	63.4		5.8	7.8		22.5			0.5		
24	LLF 7	57.4		7.9	7.6		26.7			0.4		
25	BaF 3	48.2		2.1	8.1	14.3	19.3	7.6		0.4		
26	BaF 4	44.8		3.9	4.0	16.1	22.2	8.4	0.2	0.4		
27	LF 1	54.5		4.5	7.5	1.5	31.5	0.2		0.3		
28	LF 2	51.1	2.0	5.3	6.6		34.65			0.35		
29	LF 4	52.0	2.0	5.25	6.65		32.15			0.3		
30	LF 5	52.5		5.4	6.9		34.8			0.4		
31	LF 7	52.4		6.4	6.8		34.0			0.4		
32	F 1	44.1		2.3	6.9		46.3			0.4		
33	F 2	45.0		3.0	6.3		45.4			0.3		
34	F 3	46.4		4.0	5.2		44.1			0.3		
35	F 4	46.0		6.7	2.3		44.7			0.3		
36	F 5	48.3		4.2	5.9		41.4			0.3		
37	BaSF1	42.4		3.6	4.4	10.8	33.1	5.0	0.2	0.5		
38	BaSF2	36.9		1.2	4.0	13.8	38.8	4.7	0.1	0.5		
39	SF 2	40.7		1.0	7.25		50.95			0.3		
40	SF 3	30.5		2.6	4.0		62.5			0.4		
41	SF 5	37.9		3.6	3.4		54.8			0.3		

Note: The 2nd column, "Type", shows the correspondence of S&G designation.

TABLE VI
NIPPON OPTICAL CO.

AMOUNTS OF GLASS
PRODUCED AND AVAILABLE (Kgs)

No.	Type	1941		1942		1943		1944		1945	
		(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)
1	BK 1	800	91	800	378		19		249		1
2	BK 7	99200	34526	85600	40904	70400	27965	40800	31893	1600	10902
3	BaLK 3	1600	640	1600	749	3200	1530	3200	2627		831
4	K 3	800	639	1600	250	10400	1957	41600	7200	1600	5321
5	ZK 2	3200	1373	800	1328		263		596		191
6	ZK 3		354						122		110
7	ZK 5		131	800	1		328		389		63
8	BaK 1	2000	556	2000	971	1000	465	2000	514		168
9	BaK 4	15000	4726	18000	8304	15000	5084	21000	7892		3972
10	SK 1	1000		1000	952	4000	5	19000	1603	3000	1718
11	SK 4	3000	359		196		6	4000	482	4000	515
12	SK 5	4000	1638	8000	3039	7000	1688	5000	2478		1072
13	SK 7									1000	
14	SK 9							1000		3000	
15	SK 10							1000		1000	1
16	SK 11			1000	408				502		
17	SK 14					1000					273
	SK*					590					
18	SK 16									1000	
	SK*			900		960					
19	KF 2									800	
20	KF 4					800			45	3200	80
21	BaLF 4	2000	959	2000	1169	4000	2105	5000	4378		970
22	SSK 1					1000	486	1000	312		47
23	LLF 2		16			2400		3200	384		413
24	LLF 7							800			
25	BaF 3						12				67
26	BaF 4								4		85
27	LF 1	2000	104	1000	946				49		110
28	LF 2		258						151		
29	LF 4			1000	426			1000	182	3000	
30	LF 5	1000	375			2000	69		299	1000	65
31	LF 7							1000			
32	F 1	4800	843	2400	1575	1200	590	1200	1218		239
33	F 2	7200	7614	26400	12990	45600	12878	36000	18304	1200	8879
34	F 3	1200	802	1200	831		113		1469		310
35	F 4								228		17
36	F 5	25200	1670	8400	2985	6000	2128	10800	2908		1416
37	BaSF 1	6000	1662	4800	1579	4000	1596	1200	1462		125
38	BaSF 2										148
39	SF 2	20499	6179	20400	7674	33600	8043	31200	10353		3288
40	SF 3					1200		2400	9		301
	SF*			400		2300		3600			
41	SF 5		24	2400	230	2400	232	4800	980	1200	441

* test melt.

Note: Column (A): Amounts of glasses melted for a year
Column (B): Amounts of glasses supplied for a year

TABLE VIII
PURITY SPECIFICATIONS FOR RAW CHEMICALS USED IN OPTICAL GLASS MANUFACTURE
JANUARY 16, 1941

1. Boric Acid

H_3BO_3	more than 99.0%
Fe_2O_3	less than 0.005%
Cl'	less than 0.01%
SO_3"	less than 0.01%

2. Borax

$Na_2B_2O_7 \cdot 10H_2O$	more than 99.0%
Fe_2O_3	less than 0.005%
Cl'	less than 0.01%
SO_3"	less than 0.01%

3. Sodium Carbonate (anhydrous)

Na_2CO_3	more than 99.0%
Water	less than 0.5%
Fe_2O_3	less than 0.002%
Cl'	less than 0.02%
SO_3"	less than 0.01%

4. Sodium Nitrate

$NaNO_3$	more than 99.0%
Water	less than 0.3%
Fe_2O_3	less than 0.002%
Cl'	less than 0.01%
SO_3"	less than 0.01%

5. Potassium Carbonate (anhydrous)

K_2CO_3	more than 99.0%
Water	less than 0.5%
Fe_2O_3	less than 0.002%
Cl'	less than 0.02%
SO_3"	less than 0.01%

6. Potassium Nitrate

KNO_3	more than 99.5%
water	less than 0.5%
Fe_2O_3	less than 0.003%
Cl'	less than 0.01%
SO_3"	less than 0.01%

7. Barium Carbonate

$BaCO_3$	more than 98.0%
water	less than 0.5%
Fe_2O_3	less than 0.01%
Cl'	less than 0.01%
SO_3"	less than 0.03%

7. Barium Carbonate (Cont'd)

sulphur	less than 0.01%
organic matters (carbon etc.)	trace

8. Barium Nitrate

$Ba(NO_3)_2$	more than 99.0%
water	less than 0.5%
Fe_2O_3	less than 0.002%
Cl'	less than 0.01%
SO_3"	less than 0.01%

9. Minium

Pb_3O_4	more than 95.0%
all oxides of lead	more than 99.5%
Fe_2O_3	less than 0.005%
Cu	less than 0.003%
Pb	trace

10. Litharge

PbO	more than 99.5%
Fe_2O_3	less than 0.005%
Cu	less than 0.003%
Pb	less than 0.3%

11. Zinc Oxide

ZnO	more than 99.5%
Fe_2O_3	less than 0.01%
Cl'	less than 0.01%
SO_3"	less than 0.01%

12. Antimony Oxide .... undetermined

13. Aluminum Hydroxide

Fe_2O_3	less than 0.01%
Cl'	less than 0.01%
SO_3"	less than 0.01%
Alkalies	undetermined

14. Arsenic Acid

As_2O_3	more than 99.5%
Fe_2O_3	less than 0.01%
Cl'	less than 0.01%
SO_3"	less than 0.01%

15. Fluoride Salts .... undetermined

Note: Undetermined data which was to have been added after the researches were completed, could not be obtained.

Purchase specifications of silica rocks (flint) are as follows:

SiO_2 .... more than 99.8%
Fe_2O_3 .... less than 0.005%
Al_2O_3 .... less than 0.01%
Oxides of Alkali Earths .... less than 0.01%

The above specifications of purity set to minimize the variation of optical constants from melt to melt and to help in the general standardization of products, were drawn up by the following committee:

M. NAGAOKA .... Director of Nippon Optical Co.
G. TAKAMATSU .... Director of Osaka Industry Laboratory
K. FUWA .... Tokyo Shibaura
K. TABATA .... Professor at Tokyo University of Technology
S. NAGAI .... Professor at Tokyo Imperial University
I. SAWAI .... Professor at Kyoto University

V. LENS SYSTEM

A. GENERAL

No startling or new optical developments or lens systems were found. The Japanese contented themselves with copying the constants of the optical systems from Germany and the instruments from the United States. Their main problem was to vary the curvatures and separations and, in other cases, to increase the number of elements in any particular type of lens system so as to make it perform almost as well as the original when Japanese-made glass was substituted for Shott glasses.

An independent development departing from the known Schmidt type camera was found in one case. The designer, whose problem was to compute a fast (f ratio less than 1) camera for twilight aerial photography, abandoned the use of the standard Schmidt correcting plate. Instead of the fourth order curved surfaces, he adapted concentric spherical surfaced glass correcting plates in order to parabolize the spherical mirror. This system has excessive distortion and vignetting and the camera was not completed as originally designed. A model of this camera, constructed by the First Air Technical Arsenal, was used as a film testing instrument.

B. PHOTOGRAPHIC LENSES, FUJI OPTICAL CO.

1. Lens, Both for Ordinary Use and for Aerial Photography

Aperture .... 1 : 4.5
Equivalent focal length 200mm
Designer .... T. ASANO

The following table gives the constants for the construction of the lens, illustrated in Figure 14. The successive radii of curvature are denoted by "r_1", "r_2", etc., as counted from the front surface, the minus sign denoting that the curve is concave toward the incident light, and no sign, that it is convex toward the same. The axial thickness and separations of the components are denoted by "d_2", "d_3", etc. The suffix of "d" is the number of the surface through which the light passes soon after passing through the corresponding thickness or separation. The measurements of "r" and "d" are all in millimeters. The material is defined in terms of the refractive index, "N" for the D-line, followed by Abbe number, "v", as conventionally employed. The suffix of "N" or "v" indicates the correspondingly marked element in the drawing. The last column of the table shows the nearest types in the optical glass catalogue.

Surface	Radius of Curvature	Component	Axial Thickness	Refractive Index	Abbe No.	Type
r_1	56.30			N_a: 1.60658	v_a: 59.7	SK 7
r_2	infinity	d_2	8.20			
r_3	-126.0	d_3	8.90	N_b: 1.57890	v_b: 41.7	LF 4
r_4	52.60	d_4	3.70			
r_5	-449.0	d_5	12.26	N_c: 1.52637	v_c: 51.0	KF 2
r_6	56.30	d_6	3.10	N_d: 1.62346	v_d: 56.8	SK 10
r_7	-80.71	d_7	10.70			

2. Lens Especially Suitable for Infra-Red Photography (See Figure 14)

Aperture .... 1 : 5.0
Equivalent focal length 500mm
Designers .... B. OKAZAKI and Y. DOI

Surface	Radius of Curvature	Component	Axial Thickness	Refractive Index	Abbe No.	Type
r_1	133.45			N_a: 1.58858	v_a: 61.1	SK 5
r_2	-1886	d_2	15.00			
r_3	-238.75	d_3	36.80	N_b: 1.61028	v_b: 36.9	F 3
r_4	119.37	d_4	7.00			
r_5	-1014	d_5	50.70	N_c: 1.52637	v_c: 51.0	KF 2
r_6	139.86	d_6	7.00	N_d: 1.62346	v_d: 56.8	SK10
r_7	-172.75	d_7	19.00			

3. Telephoto Lens Especially Suitable for Infra-Red Purposes (See Figure 14)

Aperture .... 1 : 8.0
Equivalent focal length 1000mm
Designer .... B. OKAZAKI

Surface	Radius of Curvature	Component	Axial Thickness	Refractive Index	Abbe No.	Type
r_1	228.20			N_a: 1.62550	v_a: 35.7	F 1
r_2	122.50	d_2	12.00			
r_3	122.50	d_3	0.02	N_b: 1.58876	v_b: 61.2	SK 5
r_4	885.6	d_4	21.00			
r_5	-342.50	d_5	207.48	N_c: 1.57890	v_c: 41.7	LF 4
r_6	194.90	d_6	9.00			

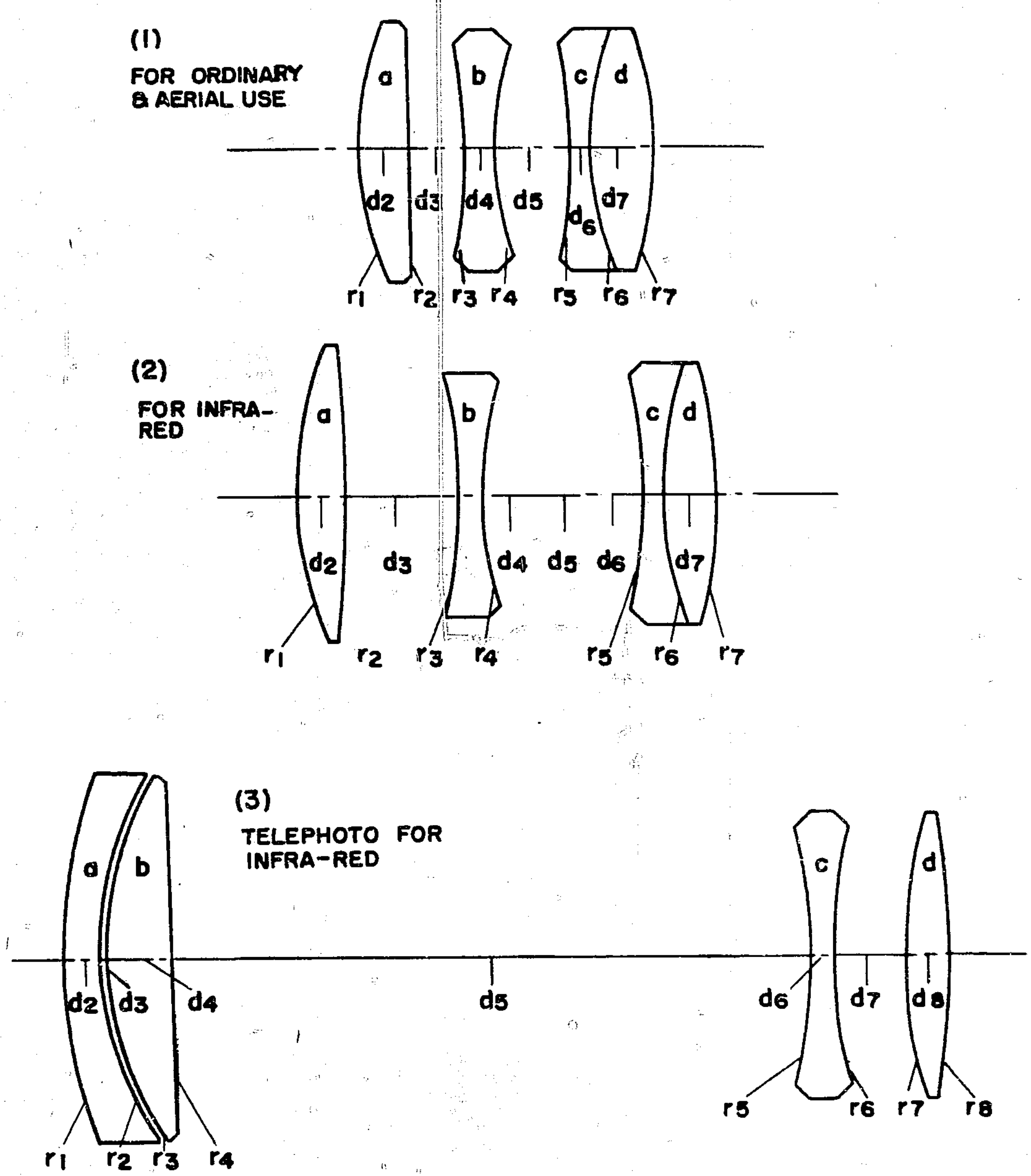


Figure 14
PHOTOGRAPHIC LENSES

Surface	Radius of Curvature	Component	Axial Thickness	Refractive Index	Abbe No.	Type
r_7	295.90	d_7	25.00	N_d: 1.62690	v_d: 35.7	F 1
r_8	625.6	d_8	13.00			

VI. GRINDING AND POLISHING

Standard methods of grinding and polishing were observed. Lenses are finished on "heads" and prisms on "fences".

An experimental method was used in the case of the standard Schmidt correcting plate. This method of finishing consists of a series of approximations and does not have much advantage over hand finishing except that it can be successfully used by less experienced lens grinders. It involves four steps:

1. The rough grinding, which is accomplished by guiding a diamond impregnated wheel against the face of the correcting plate (**Figure 15**) by means of a template. The time required is about 9 hours.

2. The second rough grinding is carried out on the same machine but the diamond impregnated wheel is replaced by a plastic (acryl resin) wheel impregnated with 100-mesh carborundum powder. Time required is about 28 hours.

3. The third grinding is carried out on an ordinary polishing machine, the tool being a metal disk backed with sponge rubber in which thin lead strips are imbedded. The polishing material is 600-mesh alundum powder. See Figure 16. The time required is about 15 hours.

4. Final polishing is accomplished on the ordinary polishing machine, but the tool is a brass spiral faced with pitch. The polishing powder is rouge used in standard lens work. See Figures 17 and 18. Time required is 18 hours.

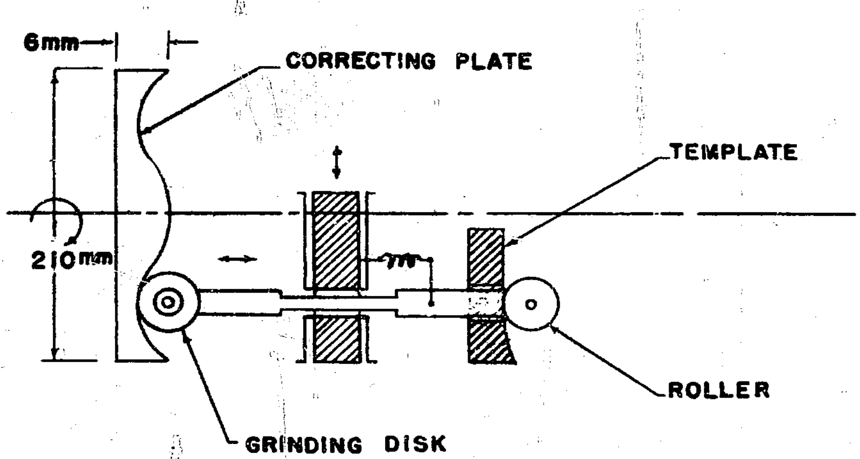


Figure 15
ROUGH GRINDING

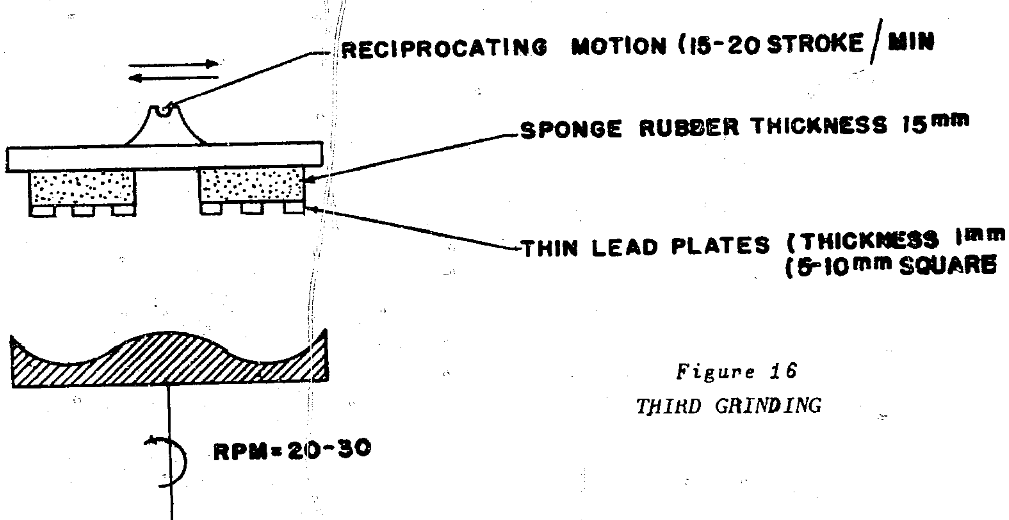


Figure 16
THIRD GRINDING

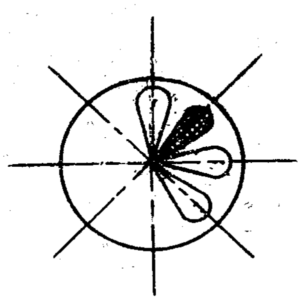


Figure 17
SCHMIDT CURVE FOR THIRD GRINDING

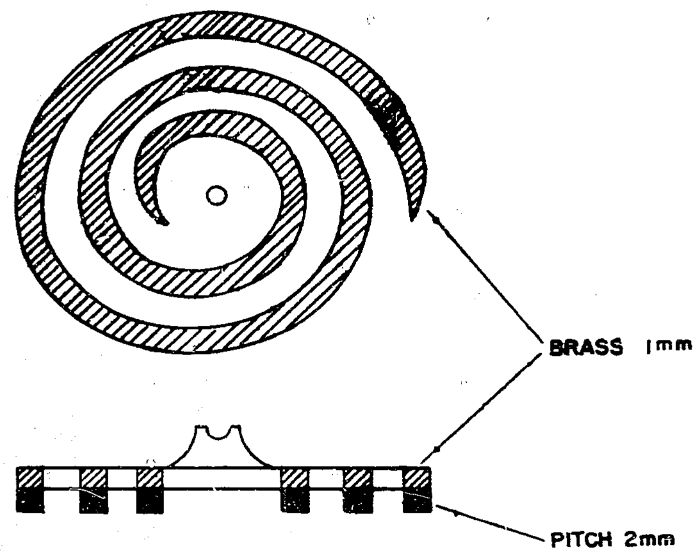


Figure 18
FINAL POLISHING

VII. "COATING" FOR THE PURPOSE OF INCREASING THE TRANSPARENCY OF GLASS SURFACES

Only two methods were found for "coating" glass surfaces:

1. The chemical method, in which the glass is treated with nitric acid.

2. The evaporation method, in which cryolite is evaporated and deposited upon the glass surface, in vacuum. After treatment, the glass is baked at 150°C for one hour for durability.

The film thicknesses and refractive index are adjusted for wave length 5500 Å Units.

ENCLOSURE (A)

EQUIPMENT SHIPPED TO ORDNANCE INVESTIGATION LABORATORY, INDIANA HEAD, MARYLAND

NavTechJap Equipment No.	Item	No. Shipped
JE10-3101	Oiji Type machine gun sight	1
-3102	Type 95 gun bombsight	1
-3103	Type 2 Model 1 bombsight	1
-3105	Bubble sextant	2
-3106	Small drift meter	2
-3108	Type 97 drift meter mount	2
-3110	Bombsight bubble levels	1
-3112	Celestial navigation slide rule	4
-3113	Navigational plotting boards	2
-3114	Type IV gun bombsight	1
-3115	Type III gun bombsight	5
-3116	Celestial navigation calculator	2
-3118	12cm A.A. binocular tripods	4
-3119	Type 90 Model 5 bombsight	1
-3120	Drift meter for night use	1
-3121	Type 97 MK1 Model 4 drift meter	2
-3123	Canada balsam	2 Bottles
-3124	18cm binoculars	2
-3126	8cm binoculars	1
-3127	12cm binocular for Type 97 director	2
-3128	Spherical star maps	2 BX
JE10-4978(1-4)	Sextants	4
JE21-3114	Periscopes for suicide torpedoes	10 BX
-3105(1-3)	Stereoscope viewers	3
-3107(1-3)	Sextants	3
-3109-1	12cm spotting binoculars (tripod, mount)	1
-3101-1,2	12cm spotting binoculars	2
-3110	12cm A.A. binoculars	1
JE50-5035 & 5037	Sextants	2

JE21-3032(1,2)
-3130(1-5) Samples of following:

Samples of Pot Materials from the Fuji Optical Co.

1. Materials	Where Obtained
Honyama Clay Honyama Clay 40 mesh Honyama Clay elutriated	Seto Saikutsusho, AICHI Pref.
Pyropyllite Pyropyllite 30 mesh	Mitsuishi Kozan, OKAYAMA Pref.
Diaspore Diaspore calcined Diaspore 40 mesh	Mitsuishi Kozan, OKAYAMA Pref.
Feldspar	Tohoku Keichoseki Co., Ltd., FUKUSHIMA Pref.
Kaolin Kaolin 40 mesh	Kyoritsu Genryo Co., NAGOYA

ENCLOSURE (A), continued

2. <u>Samples of Pots (A Piece of Finished Pot)</u>:

   a. For flint glass or ordinary crown glass (Hand method)
   b. For barium crown glass (Hand method)
   c. For dense barium crown glass (Hand method)
   d. For flint glass or ordinary crown glass (Casting method)

3. <u>Samples of Pots (A Piece After Making Glass)</u>:

   a. After melting flint glass (Hand method)
   b. After melting crown glass (Hand method)
   c. After melting dense barium crown glass (Hand method)
   d. After melting crown glass (Casting method)

<u>Samples of Raw Materials for Pot Making Obtained from Nippon Optical Co.</u>

Sample	Name	Source	Note
Plastic Materials			
1.	Korean Kaoline	Kato-Gun, KEISHO-NAN-DO, Korea	Residual clay Low plastic
2.	Taishu Kaoline (raw)	Tsushima Island, Nagasaki Pref.	Residual, felspathic clay Low plastic
3.	Taishu Kaoline (raw)	Tsushima Island, Nagasaki Pref.	Residual, felspathic clay Low plastic
4.	Tokiguchi Gairome clay	TOKITSU, Gifu Pref.	Transported clay Plastic and good for casting
5.	Hara Gairome clay	Ena-Gun HARA-Machi, Gifu Pref.	Transported clay High plastic and good for casting
6.	Seikirei Gairome clay	SEIKIREI, Kankyohoku-Do, Korea	Transported clay High plastic but not good for casting
7.	Motoyama Kibushi clay (raw)	SETO, Aichi Pref.	Transported clay Very plastic and good for casting Much organic substance
8.	Motoyama Kibushi clay (raw)	SETO, Aichi Pref.	Transported clay Very plastic and good for casting Much organic substance
9.	Sansei Kibushi clay (raw)	NISHI-SHIDARE, Nishikamo-Gun, Aichi Pref.	Transported clay Very plastic Much organic substance

Note: - With the exception of 2, 7 and 9, all samples above are elutriated.

Sample	Name	Source	Note
Non-plastic Materials			
10.	Roseki	NITSU-ISHI, Okayama Pref.	Resembling pyrophyllite
11.	Felspar	KAWAMATA, Fukushima Pref.	

ENCLOSURE (A), continued

12. Grog — Burned Motoyama Kibushi clay

The chemical compositions of the raw materials listed above are as follows:

No. Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Alk.	Ig.Loss
1.	45.0	38.1	0.5	1.7			13.2
3.	56.2	29.7	0.5	0.2	0.6	5.3	7.9
4.	45.3	38.3	0.5	1.0	0.2		14.4
5.	48.5	36.6	0.6	0.8	0.1		13.1
6.	46.2	38.8	0.3	0.9			13.6
8.	48.1	34.9	0.9	0.5	0.4		14.3
9.	45.1	33.2	1.6	0.5	0.4		17.3
10.	60.4	27.9	0.1	0.6	0.9		6.2
11.	62.3	21.6	0.2	0.2		14.8	0.3
12.	Similar to No. 8.						

The above data show the elutriated clay compositions.

<u>Samples of Fire Bricks Obtained From Nippon Optical Co.</u>

B 1 : Commercial name, G-1
Refractoriness, SK. 40
Maker, Toyo-Taika Co. Ltd.

B 2 : Used G-1 (B1)
Position used, arch of furnace
Length of time used, 1 year
Temperature used, ordinary 1450°C
maximum 1500°C

B 3 : Refractoriness, SK. 36
Maker, TOYO-TAKA Co. Ltd.

B 4 : Used B3
Position used, screen of furnace
Length of time used, 1 year
Temperature used, ordinary, 1450°C
maximum 1500°C

<u>Samples of Pots From the Nippon Optical Co.</u>

P. 1 Finished Pot (Drying State)
Upper part of pot

P. 2 Used Pot (Optical glass, KF 2, melted)
Flux line of pot

P. 3 Same Pot, (P. 2)
Wall of pot

ENCLOSURE (A), continued

Samples of Glass Manufacture by the Fuji Optical Co.

1	Fluor Crown	F K 5
2	Borosilicate Crown	B K 1
3	Borosilicate Crown	B K 7
4	Light Barium Crown	BaLK3
5	Ordinary Crown	K 3
6	Barium Crown	BaK 1
7	Barium Crown	BaK 4
8	Dense Barium Crown	S K 2
9	Dense Barium Crown	S K 4
10	Dense Barium Crown	S K 5
11	Dense Barium Crown	S K 7
12	Dense Barium Crown	S K 8
13	Dense Barium Crown	S K 9
14	Dense Barium Crown	S K10
15	Dense Barium Crown	S K11
16	Dense Barium Crown	S K12
17	Dense Barium Crown	S K14
18	Dense Barium Crown	S K16
19	High Dispersion Crown	S F 2
20	Crown Flint	K F 3
21	Highest Dense Barium Crown	SSK 1
22	Barium Flint	BaF 7
23	Light Flint	L F 4
24	Light Flint	L F 5
25	Ordinary Flint	F 1
26	Ordinary Flint	F 2
27	Ordinary Flint	F 3
28	Ordinary Flint	F 5
29	Dense Barium Flint	BaSF1

ENCLOSURE (A), continued

30	Dense Flint	S F 2
31	Dense Flint	S F 5
32	Kurz Flint	KzF 2
33	Highest Light Flint	LLF 2

Samples of Glass Materials

No.	Name	Where Obtained
1	Alumina	Showa Denko
2	Antimony Oxide	Kokusan Kagaku
3	Arsenious Oxide	Yasubei Konishi; Chugai Boeki
4	Barium Carbonate	Nihon Kagaku
5	Barium Nitrate	Sakai Kagaku
6	Boric Acid	Shionogi
7	Calcium Carbonate	Chugai Boeki
8	Lead Oxide (Red Lead, Minium)	Dainippon Toryo
9	Potassium Carbonate	Sumitomo Kagaku
10	Potassium Nitrate	Showa Denko
11	Sodium Carbonate	Mitubishi Kasai
12	Sodium Nitrate	Showa Yakuhin
13	Silica (Raw and 120 mesh)	Tohoku Keichoseki
14	Zinc Oxide	Nihon Peinto; Sakai Kagaku; Kansai Peinto

Samples of Glasses from Nippon Optical Co.

Sample No.	Type	Sample No.	Type
1	BK 1	21	BaLF4
2	BK 7	22	SSK 1
3	BaLK3	23	LLF 2
4	K 3	24	LLF 7
5	ZK 2	25	BaF 3
6	ZK 3	26	BaF 4
7	ZK 5	27	LF 1

ENCLOSURE (A), continued

8	BaK 1	28	LF 2
9	BaK 4	29	LF 4
10	SK 1	30	LF 5
11	SK 4	31	LF 7
12	SK 5	32	F 1
13	SK 7	33	F 2
14	SK 9	34	F 3
15	SK 10	35	F 4
16	SK 11	36	F 5
17	SK 14	37	BaSF1
18	SK 16	38	BaSF2
19	KF 2	39	SF 2
20	KF 4	40	SF 3
		41	SF 5

Samples of Grinding and Polishing Materials
Fuji Optical Co.

1. **Grinding Materials:**

Sample No. 1	Carborundum	60 mesh	Showa Denko Co., KANAGAWA Pref.
Sample No. 2	Carborundum	150 mesh	Showa Denko Co., KANAGAWA Pref.
Sample No. 3	Emery	80 mesh	Yoshioka Co., TOKYO
Sample No. 4	Emery	100 mesh	Yoshioka Co., TOKYO
Sample No. 5	Emery	150 mesh	Yoshioka Co., TOKYO
Sample No. 6	Emery	200 mesh	Yoshioka Co., TOKYO
Sample No. 7	Emery	Mixture of smaller mesh (For use, separated into 5 grades of grain size by elutriation. These samples are No. 8 - No. 12.)	Yoshioka Co., TOKYO
Sample No. 13	"Rasite"	1000 mesh (Alundum)	Tio Kogyo Co., TOKYO
Sample No. 14	"Rasite"	1500 mesh (Alundum)	Tio Kogyo Co., TOKYO

Note: No. 13 and No. 14 are used only for lens grinding.

2. **Polishing Materilas:**

Sample No. 15	Pitch hard	Morishita Bengara Kogyo Co., TOKYO
Sample No. 16	Pitch soft	Morishita Bengara Kogyo Co., TOKYO
Sample No. 17	Rouge	Morishita Bengara Kogyo Co., TOKYO

ENCLOSURE (A), continued

Samples of Abrasive Materials, Nippon Optical Co.

No.	Name	Makers
A. 1	Garnet No. 1	
A. 2	Garnet No. 2	
A. 3	Garnet No. 3	
A. 4	Garnet No. 4	
A. 5	Garnet No. 5	
A. 6	Garnet No. 6	
A. 7	Rasite No. 40	Toa-Koko Co. Ltd., OSAKA
A. 8	Rasite No. 60	Toa-Koko Co. Ltd., OSAKA
A. 9	Rasite No. 280	Toa-Koko Co. Ltd., OSAKA
A. 10	Rasite No. 900	Toa-Koko Co. Ltd., OSAKA
A. 11	Rasite No. 1200	Toa-Koko Co. Ltd., OSAKA
A. 12	Iron Vitriol, 1st. Class, (from iron oxalate)	Kibi-Kogyo Co. Ltd., OKAYAMA Pref.
A. 13	Iron Vitriol, (from iron oxalate)	Nippon Kogaku Co. Ltd., TOKYO
A. 14	Iron Vitriol, 2nd. Class, (from iron sulfate)	Kibi Kogyo Co. Ltd., OKAYAMA Pref.
A. 15	Iron Vitriol, 3rd. Class, (from iron sulfate)	Kibi Kogyo Co. Ltd., OKAYAMA Pref.

Miscellaneous

1.	Gas Pitch	Nippon-Sekiyu Co. Ltd., KANAGAWA Pref.
2.	Asphalt (hard)	
3.	Asphalt (soft)	
4.	Balsam,	Takeda-Kwagaku Co. Ltd., OSAKA

Samples of Lenses Obtained from the Fuji Optical Co.

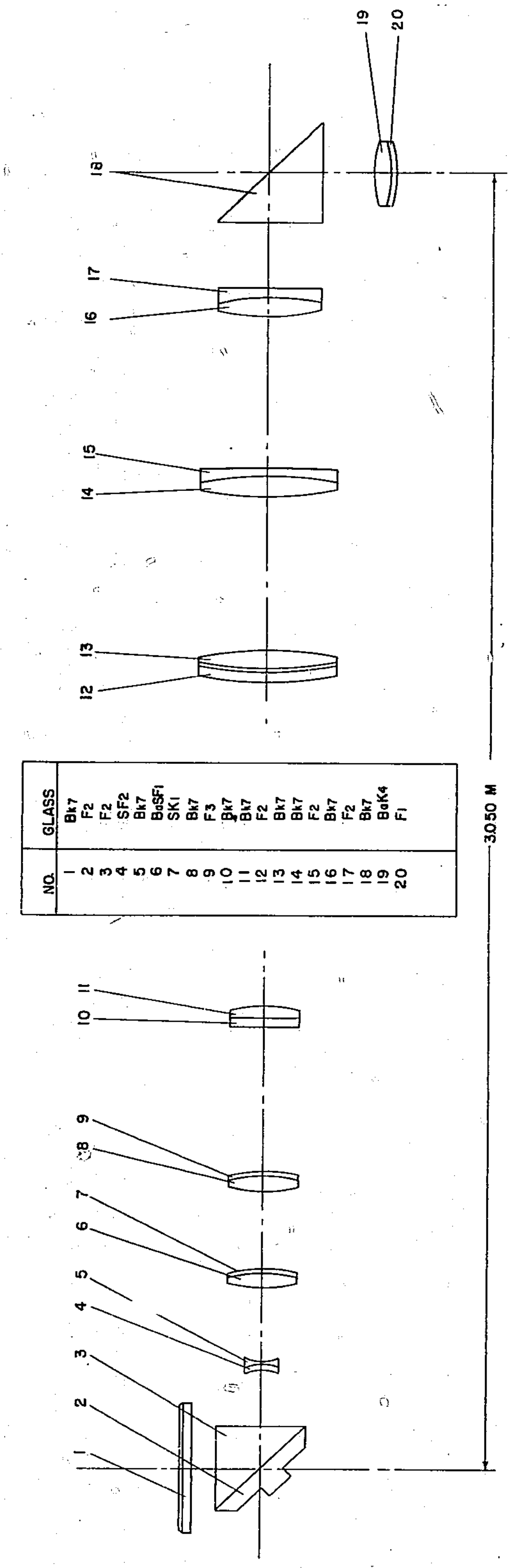
3 lenses	f = 200mm F : 4.5 (for aerial photography)	
3 lenses	f = 500mm F : 5.0	
3 lenses	f = 1000mm F : 8.0	

ENCLOSURE (A), continued

Samples of Surface Treating Agent and the Resulting Glasses from the Nippon Optical Co.

M. 1	Artificial cryolite
M. 2	Glass No. 1 --- F 2, cryolite-treated on both surfaces
M. 3	Glass No. 2 --- F 2, acid-treated on both surfaces
M. 4	Glass No. 3 --- BK 7, cryolite-treated on both surfaces
M. 5	Glass No. 4 --- BK 7, cryolite-treated on one surface

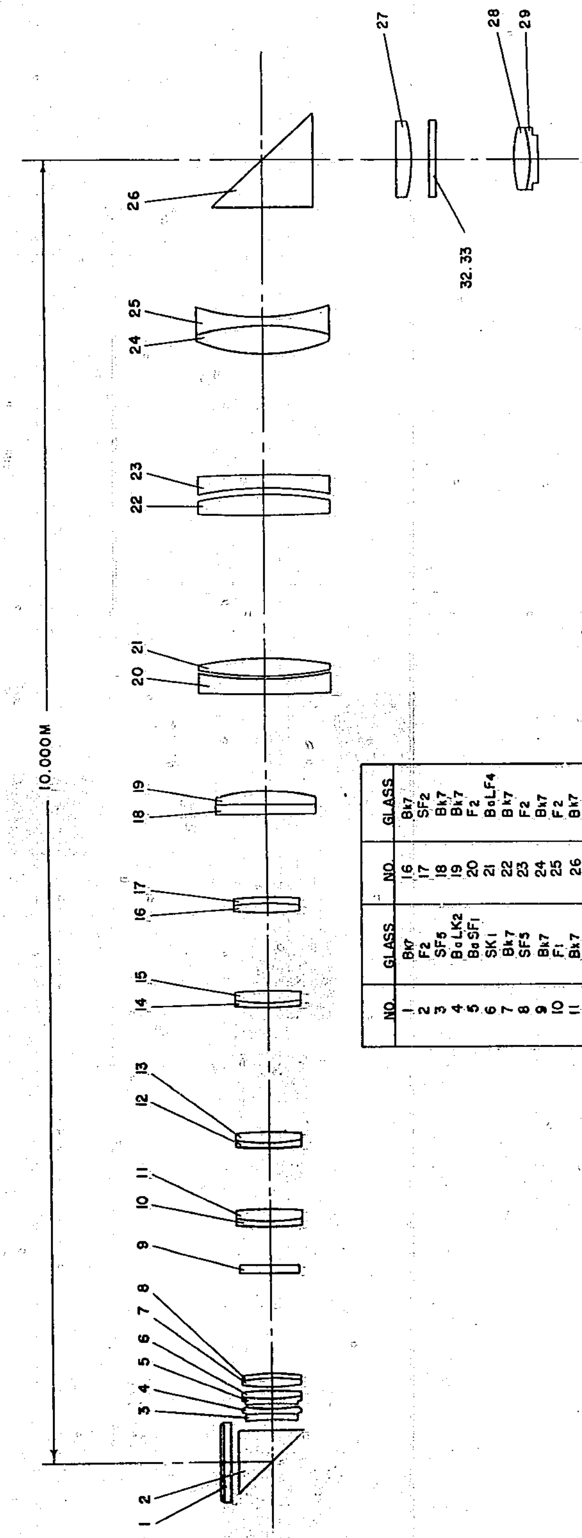
ENCLOSURE (B)



NO.	GLASS
1	Bk7
2	F2
3	F2
4	SF2
5	Bk7
6	BaSF1
7	SK1
8	Bk7
9	F3
10	Bk7
11	Bk7
12	F2
13	Bk7
14	Bk7
15	F2
16	Bk7
17	F2
18	Bk7
19	BaK4
20	F1

OPTICAL DIAGRAM OF 3.05M ONE-MAN SUBMARINE PERISCOPE

ENCLOSURE (C)



NO.	GLASS	NO.	GLASS
1	Bk7	16	Bk7
2	F2	17	SF2
3	SF5	18	Bk7
4	BaLK2	19	Bk7
5	BaSF1	20	F2
6	SK1	21	BaLF4
7	Bk7	22	Bk7
8	SF5	23	F2
9	Bk7	24	Bk7
10	F1	25	F2
11	Bk7	26	Bk7
12	F1	27	Bk7
13	Bk7	28	Sk5
14	F1	29	SF5
15	Bk7		
		32	ORANGE
		33	GRAY

OPTICAL DIAGRAM FOR 10M TYPE 3 PERISCOPE

ENCLOSURE (D)

DATA ON ODAWARA PLANT
OF FUJI PHOTO-FILM CO., LTD.

November, 1945

1. Name of Plant: Fuji Photo-Film Co., Ltd., Odawara Factory.

2. Location:

   a. Fuji Photo-Film Co., Ltd.: No. 210, NAKANUMA, Minamiashigara-Machi, Ashigarakami-Gun, Kanagawa-Ken.

   b. Odawara Factory: No. 220, ISAIDA, Odawara-Shi, Kanagawa-Ken.

3. General Description:

   a. Factory ground: 93,500 square meters.

   b. Building areas: 26,000 square meters. (Total damaged by air raid 825 square meters; half damaged, 1485 square meters.)

4. Owners:

   a. Share capital: ¥ 25,000,000 (divided into 500,000 ordinary shares of ¥ 50 each).

   b. List of share-holders owning 10% and more:

      (1) Name: Dai Nippon Celluoid Company, Ltd.
      (2) Address: No. 217, Hichido-Nishi-Machi, SAKAI-SHI.

5. Company Officials:

S. HARUKI	President
S. MORITA	Managing director
S. KOBAYASHI	Managing director
K. TAKUCHI	Director
S. FUJIZAWA	Director
K. KITAJIMA	Director

6. When Organized:

   a. Fuji Photo-Film Co., Ltd.: January 20th, 1934.

   b. Odawara Factory: January 5th, 1939.

7. Operation before the War:

   a. Photographic chemicals: Silver nitrate - 3000 kg per month.

   b. Optical glass: 300 kg per month.

Our main factory, the Ashigara factory of Fuji Photo-Film Co., Ltd., was established for the production of all kinds of films (motion picture films, roll films, professional films, X-ray films and process films) and of dry plates and sensitive papers; the Odawara factory, as a branch, began to produce the vital raw material silver nitrate for photographic materials. Subsequently, we began to produce the optical glass for making binocular and camera lenses.

ENCLOSURE (D), continued

8. Number Employed Before War:

Office clerks	23
Engineers	37
Women employees	82
Men employees	272
Total	414

9. Operation during the War:

a. Photographic chemicals:

(1) Silver nitrate - 2800 kg per month.
(2) "Elon" (photographic developing agents) - 100 kg per month.
(3) Hydroquinone (photographic developing agents) - 700 kg per month.

b. Optical glass: 3000 kg per month.

c. Photographic lens (210mm F 4.5 & 500mm F 5): 100 pieces per month.

10. Number Employed during War:

Office clerks	30
Engineers	70
Women employees	218
Men employees	435
Total	753

11. Operation Now Proposed:

a. Photographic chemicals:

(1) Silver nitrate - 1000-1500 kg per month.
(2) "Elon" (photographic developing agents) - 250-500 kg per month.
(3) Hydroquinone (photographic developing agents) - 700-1000 kg per month.

b. Optical glass: 500-1500 kg per month.

c. Spectacle glass and ampoule glass: 500-1000 kg per month.

d. Photographic lens (210mm F 4.5, 180mm F 3.5, 75mm F 3.5 & 50mm F 3.5): 200 pieces per month.

e. Electric heater made of earthen ware: 3000 pieces per month.

12. Number to be Employed:

Office clerks	18
Engineers	47
Women employees	50
Men employees	123
Total	238

13. Inventory of Machinery and Equipment on Hand:

a. Plant for manufacturing optical glass (Producing capacity 2000-3000 kg per month):

ENCLOSURE (D), continued

Fret mill 7
Glass melting furnace 16
Gas producer .... 4 (one damaged)
Stirring machine 4
Electric furnace 33
Glass polishing machine 14
Rough grinding machine 8
Glass cut-off saw 15
Muffle furnace 9
Glass press molding machine 12

b. Machinery for manufacturing photographic lens (200 lenses per month) (Including Repair and Electric Department):

Lathe & bench lathe 24
Turret lathe 2
Milling machine 4
Drilling machine 9
Lens grinding machine 12
Lens polishing machine 26
Lens centering machine 15
Planing machine 1
Shaper 2
Switch board 16
Transformer 6
Lancashire boiler (steam volume produced - 35 tons daily)....... 1
Babcock boiler Ct type (steam volume produced - 49 tons daily).. 1
Cornish boiler (steam volume produced - 21 tons daily) 1

c. Photographic chemicals producing department (Silver nitrate, 3 tons and 1500 kg photographic developing agents per month):

Porcelain pan for dissolving silver 10
Centrifugal separater 8
Gas scrabber 1
Distillator 2
Steam bath 8
Evaporating pan 100
Porcelain washer 12
Porcelain filter 6
Iron storage tank 2
Stamp mill 1
Disintegrator 1
Paddle type agitater with tank 2
Autoclave 2
Pan for discompotion and adding 2

14. Raw Materials on Hand:

a. For photographic chemicals:

Nitric acid .... 6400 kg
Caustic soda .... 1900 kg
Silver ingot .... 5200 kg
Aniline .... 64,000 kg
Manganese dioxide .... 40,000 kg
Sulphuric acid .... 31,000 kg
Formalin .... 1000 kg
Ammonium chloride .... 1450 kg

ENCLOSURE (D), continued

b. For optical and special glass and lens:

Silica	298,000 kg
Boric acid (distributed by government)	40,800 kg
Sodium carbonate	7280 kg
Red lead	18,100 kg
Barium nitrate	6220 kg
Potassium carbonate	20,580 kg
Potassium nitrate	40,000 kg
Mounting for lens (brass)	150 kg
Coal	200 tons
Nichrome wire (diameter 0.6mm)	1000 m

15. Monthly Estimate of Raw Materials or Products Required for Next Six Months:

a. For photographic chemicals:

	Monthly	For next 6 months
Nitric acid	1500 kg	9000 kg
Caustic soda	240 kg	1440 kg
Silver ingot	970 kg	5820 kg
Aniline	2215 kg	13,290 kg
Manganese dioxide	8700 kg	52,200 kg
Sulphuric acid	13,150 kg	78,900 kg
Formalin	1875 kg	11,250 kg
Ammonium chloride	550 kg	3300 kg

b. For optical and special glass and lens:

	Monthly	For next 6 months
Silica	8100 kg	48,600 kg
Boric acid	1140 kg	6840 kg
Sodium carbonate	1280 kg	7680 kg
Red lead	1200 kg	7200 kg
Zinc white	460 kg	2760 kg
Barium nitrate	2000 kg	12,000 kg
Potassium carbonate	600 kg	3600 kg
Potassium nitrate	1940 kg	11,640 kg
Mounting for lens	200 kg	1200 kg
Coal	200 tons	1200 tons

c. For electric heater made of earthen ware:

	Monthly	For next 6 months
Nichrome wire (diameter 0.6mm)	20,000 m	120,000 m
Lead wire	7000 m	42,000 m
Attaching plug	3500 pieces	21,000 pieces
Attaching cap	3500 pieces	21,000 pieces

16. Semi-Finished Goods on Hand:

Silver nitrate	12,215 kg
"Elon"	69 kg
Hydroquinone	76 kg
Optical glass (block)	15,191 kg

ENCLOSURE (D). continued

Optical glass (pressed) .... 12,733 pieces
Camera lens - 1m F 8 .... 50 pieces
50cm F 5 .... 225 pieces
20cm F 4.5 .... 280 pieces

17. Profit and Loss Statement (in ¥):

a. 1943:

	April	October
Income from goods sold	13,110	15,230
Other income	225	245
Carried forward amts. of semi-finished and finished goods to the next term	3328	4461
Total	16,663	19,936

	April	October
Cost of goods	6333	8001
Expenditure	5236	6154
Carried forward amts. of semi-finished and finished goods from the previous term	3888	3328
Current-term profit	1206	2453
Total	16,663	19,936

b. 1944:

	April	October
Income from goods sold	16,932	16,985
Other income	263	456
Carried forward amts. of semi-finished and finished goods to the next term	5542	6219
Total	22,737	23,660

	April	October
Cost of goods	8894	9100
Expenditure	6847	6399
Carried forward amts. of semi-finished and finished goods from the previous term	4461	5542
Current-term profit	2535	2619
Total	22,737	23,660

c. 1945:

	April
Income from goods sold	11,670
Other income	466
Carried forward amts. of semi-finished and finished goods to the next term	8485
Total	20,621

	April
Cost of goods	9587
Expenditure	2944
Carried forward amts. of semi-finished and finished goods from the previous term	6219
Current-term profit	1871
Total	20,621

18. Balance Sheet:

a. 1943:

	April	October
Land	665	689
Building	4174	4337
Fixture	538	562
Machinery Installation	8993	8888
Car & carriers	82	87
Instruments & furniture	529	554
Construction a/c	173	1971
Securities	1121	1153
Trust deposits	1157	1201
Inventory assets	8921	10,171
Sales credit	2852	4210

	April	October
Capital	10,000	10,000
Legal reserve fund	505	570
Special reserve fund	2100	2300
Divident reserve fund	800	900
General retiring allowance reserve fund	948	1061
Legal retiring allowance reserve	220	215
Bills payable	3496	657
Long-term debt	5500	5500
Short-term debt		8014

ENCLOSURE (D), continued

	April	October
Bills receivable	48	43
Cash & deposits	1730	6818
Credit receivable	14	33
Temporary payment	1171	1424
Securities for payment) Money deposited)	432	678
Total	32,541	42,819

	April	October
Money unpaid in advance	5669	3531
Temporary receipts	76	5499
Money deposited	1520	1556
Carried forward profit	501	563
Current-term profit	1206	2453
Total	32,541	42,819

b. 1944:

Debt	April	October
Capital unpaid	11,250	5250
Land	704	755
Building	4351	4595
Fixture	619	621
Machinery installation	8684	8413
Car & carriers	124	116
Instrument & furniture	548	537
Construction a/c	5081	7083
Securities	5545	8913
Trust deposits	1451	1587
Inventory assets	11,876	14,894
Sales credit	5132	5791
Bills receivable	75	1090
Cash & deposits	909	1864
Credit receivable	49	842
Temporary payment	2238	2047
Reserve deposit for tax	300	700
Securities for payment) Money deposited)	608	726
Total	59,344	65,824

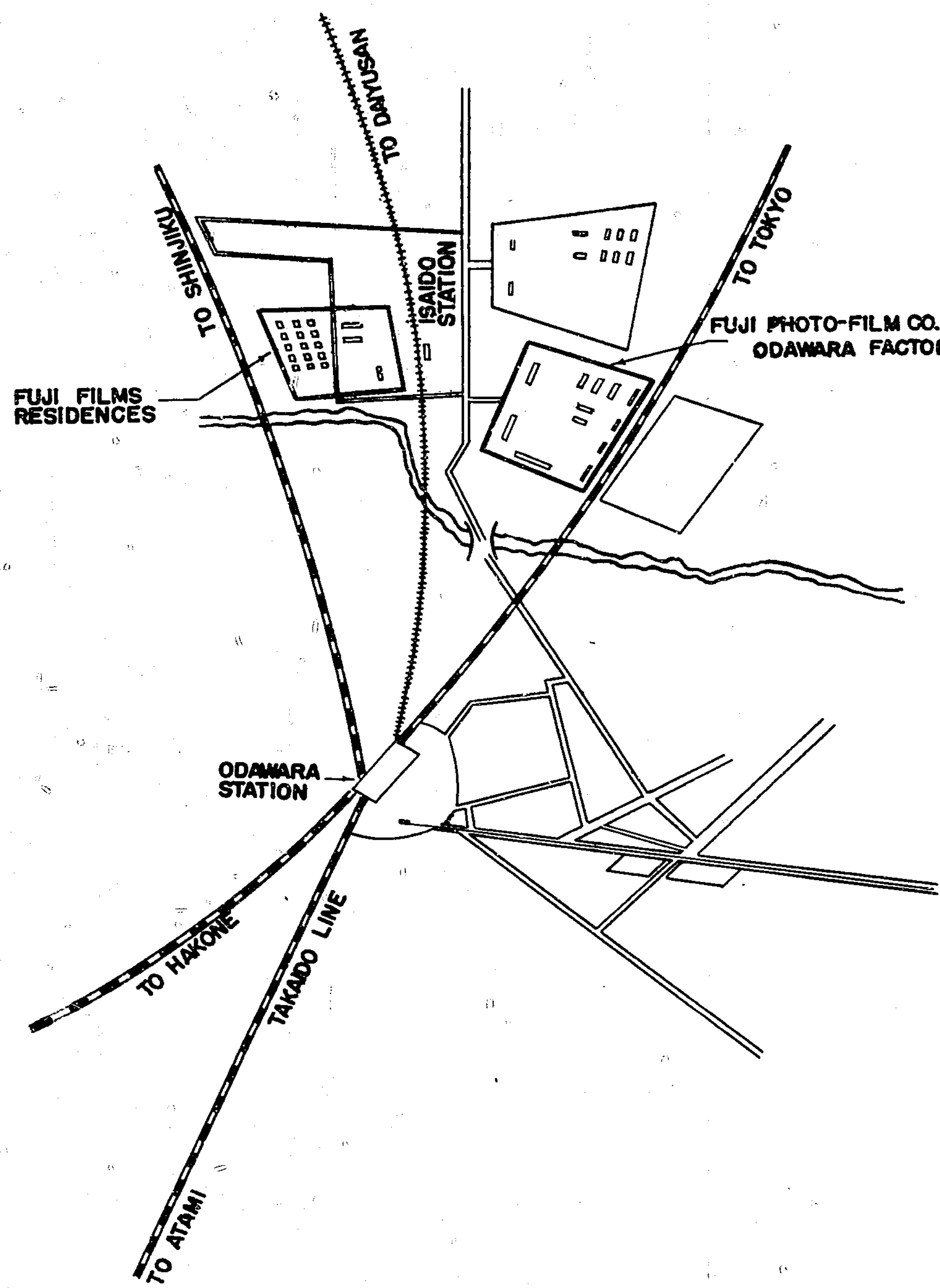
Credit	April	October
Capital	25,000	25,000
Legal reserve fund	1535	1600
Reserve for tax	1200	1750
Special reserve fund	2500	2700
Dividend reserve fund	900	900
Reserve fund for study	100	100
General retiring allowance reserve fund	1187	1305
Legal retiring allowance reserve	285	283
Bills payable	336	708
Long-term debt	5500	5500
Short-term debt	9634	14,421
Money unpaid in advance	4972	3624
Temporary receipts	885	2171
Money deposited	2105	2442
Carried forward profit	670	701
Current-term profit	2535	2619
Total	59,344	65,824

c. 1945:

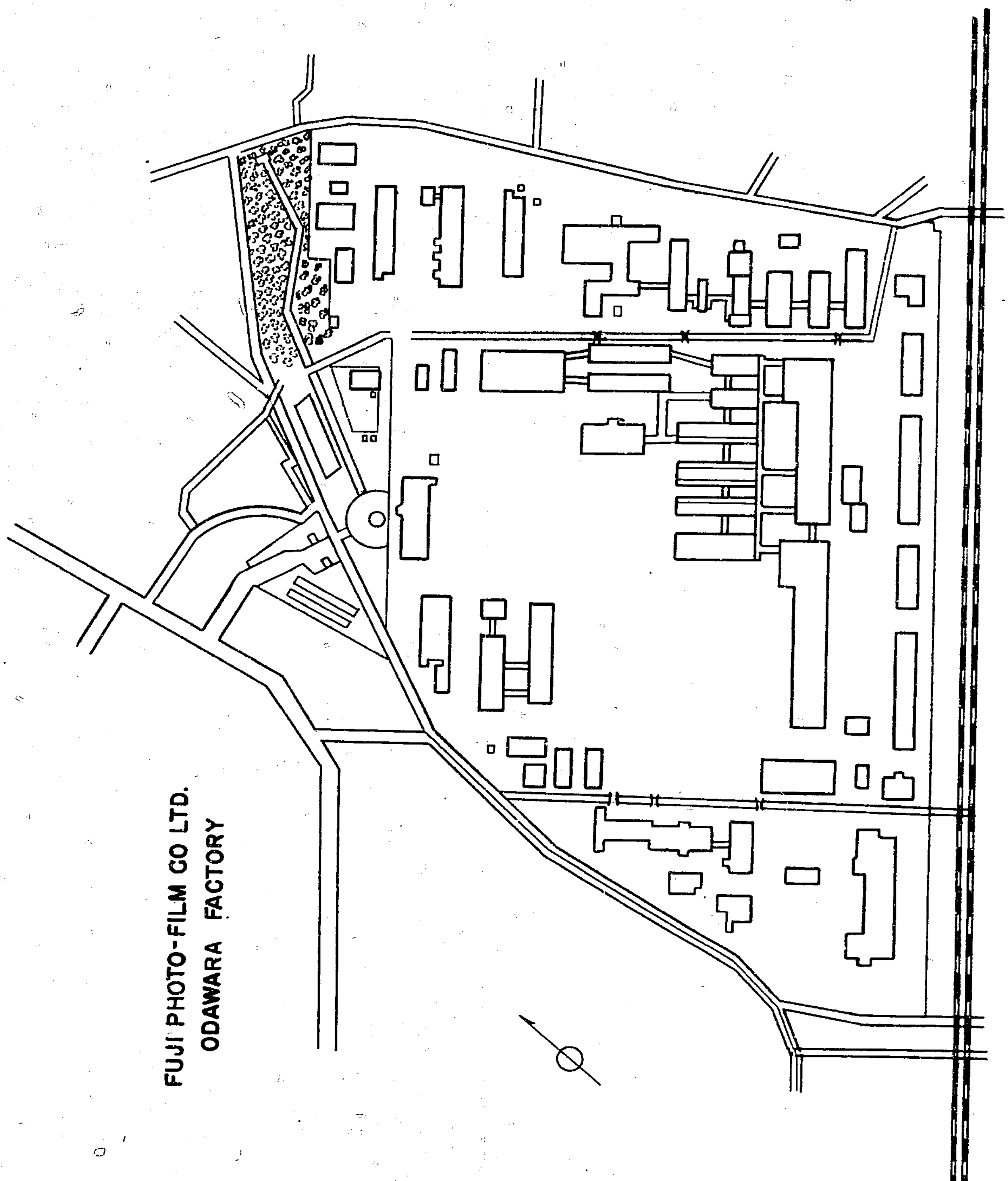
Debt	April
Capital unpaid	5250
Land	755
Building	4531
Fixture	622
Machinery installation	8108
Car & carriers	200
Instrument & furniture	552
Construction a/c	8797
Securities	9103
Trust deposits	1691
Inventory assets	16,152
Sales receivable	6460
Cash & deposits	1414
Credit receivable	799
Temporary payment	2153
Reserve deposit for tax	910
Securities for payment) Money deposited)	803
Total	68,300

Credit	April
Capital	25,000
Regal reserve fund	1665
Reserve for tax	2070
Special reserve fund	2800
Dividend reserve fund	900
General retiring allowance reserve fund	1424
Reserve fund for study	100
Legal retiring allowance reserve	320
Long-term debt	5500
Short-term debt	17,872
Money unpaid in advance	2473
Temporary receipts	2329
Money deposited	3234
Carried forward profit	742
Current-term profit	1871
Total	68,300

ENCLOSURE (D), continued



ENCLOSURE (D), continued



ENCLOSURE (E)

DATA ON ASHIGARA PLANT
OF FUJI PHOTO-FILM CO., LTD.

1. Name of Plant: Fuji Photo Film Co., Ashigara Factory.

2. Location: No. 210 Nakanuma, MINAMIASHIGARA-Cho, Ashigarakami-Gun, Kanagawa-Ken.

3. General Description:

a. Land: 2,890,193 square feet.

b. Buildings: 607,295 square feet.

c. Main machinery and plant:

(1) Raw-film preparing machines - 15 sets.
(2) Photographic-film preparing machines - 1 set.
(3) Photographic-paper preparing machines - 2 sets.
(4) Dry plate preparing machines - 2 sets.
(5) Other accessory machines.

d. Capital:

Ashigara Factory	¥ 15,000,000
Odawara Factory	¥ 7,700,000
Imaizumi Factory	¥ 2,000,000
Kawakami Factory	¥ 300,000
Total	¥ 25,000,000

4. Owners:

a. Share capital: ¥ 25,000,000 (500,000 shares, 2214 share holders).

b. List of share-holders owning 10% and more:

(1) Dai-Nippon Celluloid Co., Ltd. (125,000 shares).
(2) Shichido, Sakaishi, OSAKA.

5. Company Officials:

S. HARUKI	President
S. MORITA	Managing Director
S. KOBAYASHI	Managing Director

6. When Organized: 20 January 1934.

7. Operation before the War (monthly production):

35mm cinema films	11,684,000 feet
Roll films	236,000 rolls ("Brownie" size)
X-Ray films	15,000 doz. 10" x 12"
Photographic papers	616,700 doz. 4 3/4" x 6½"
Dry-plates	160,000 doz. 4 3/4" x 6 7/8"

Prior to the incorporation of this firm in January, 1934, this factory was constructed and equipped by the Dai-Nippon Celluloid Company, Ltd. and named Ashigara Factory of Dai-Nippon Celluloid Company, Ltd.

ENCLOSURE (E), continued

In September, 1937, the factory was enlarged to increase the production of celluloid film base and photographic film.

In October, 1940, the factory was enlarged to increase the production of X-Ray film.

In July 1943, construction of a new plant was started in order to increase the production of inter-layer materials for safety glass. This plant was not completed.

8. Number of Employees before the War:

Men	850
Women	620
Total	1470

9. Operation during the War (monthly production):

35mm cinema films	8,680,000 feet
Roll films	162,000 rolls ("Brownie" size)
X-Ray films	12,000 doz. 10" x 12"
Aero-films	14,600 square meters
Inter-layers for safety glass	5890 kg
Electric insulating thin foil	500 kg
Photographic papers	836,000 doz. 4 3/4" x 6½"
Dry-plates	123,000 doz. 4 3/4" x 6½"

10. Number of Employees during the War:

Men	740
Women	620
Total	1360

11. Operation now Proposed:

35mm cinema films	7,000,000 feet
Roll films	200,000 rolls ("Brownie" size)
X-Ray films	15,000 doz. 10" x 12"
16mm films	1,000,000 feet
Cut films	100,000 doz. 4 3/4" x 6½"
Photographic papers	670,000 doz. 4 3/4" x 6½"
Dry-plates	50,000 doz. 4 3/4" x 6½"

12. Number to be Employed:

Men	700
Women	500
Total	1200

13. Inventory of Machinery and Equipment:

a. Land: 2,890,193 square feet.

b. Buildings: 607,295 square feet.

c. Dry-plate manufacturing equipment (monthly production capacity - 200,000 doz. 4 3/4" x 6½"):

ENCLOSURE (E), continued

Combined glass washing, substrating, and drying machines .... 2 sets
Emulsion preparing plants .... 2 sets
Emulsion coating and drying plants .... 2 sets
Glass-cutting machines 4
Conveyers .... 2 sets

d. Photographic paper manufacturing equipments (monthly production capacity - 1,000,000 doz. 4 3/4" x 6½"):

Emulsion preparing plants .... 2 sets
Emulsion coating and drying plants .... 2 sets
Slitting and cutting machines 8
Conveyers .... 1 set

e. Photographic film manufacturing equipment (monthly production capacity - 120,000 meters of 1 meter width):

Emulsion preparing plants .... 2 sets
Film substrating machines .... 4 sets
Paper-slitting machines 3
Collodion coating machines .... 2 sets
Emulsion coating and drying plant .... 1 set
Perforators for cinema film 30
Film slitting and cutting machines 42

f. Celluloid film base manufacturing equipments (monthly production capacity - about 45 tons):

Collodion mixers .... 15 sets
Film coating machines .... 15 sets
Solvent recovering plants .... 4 sets
Solvent distillation plants .... 3 sets

g. Miscellaneous plants:

Air blowers 23
Air washers 50
Pumps 54
Refrigerators 21
Various kinds of electric motors 534
Transformers 27
Steam boilers .... 4 sets
Various kinds of repairing machines 61

14. Raw Materials on Hand:

Nitrocellulose .... 73,003 kg (4080 kg)
Acetylcellulose .... 37,172 kg (17,800 kg)
Camphor .... 10,440 kg
Ether .... 15,002 kg (246 kg)
Alcohol .... 2815 kg (450 kg)
Acetone .... 34,393 kg (11,500 kg)
Gelatine .... 54,000 kg
Potassium bromide .... 27,502 kg (1850 kg)
Silver nitrate .... 2500 kg
Benzol .... 4367 kg
Baryta paper .... 120,000 square meters
Glass for dry-plates .... 74 cases
Coal .... 800 tons

Note: Parentheses indicate military use materials

ENCLOSURE (E), continued

15. Monthly Estimate of Raw Materials or Products Required for Next Six Months:

Nitrocellulose	35,000 kg
Acetylcellulose	6000 kg
Camphor	2000 kg
Ether	2000 kg
Alcohol	25,000 kg
Acetone	8000 kg
Gelatine	15,000 kg
Potassium bromide	7000 kg
Silver nitrate	1500 kg
Benzol	3000 kg
Methanol	2500 kg
Baryta paper	3000 kg
	160,000 square meters
Glass for dry plates	1500 cases
Black paper	2500 kg
Cardboard	20,000 kg

16. Profit and Loss Statement (in ¥):

a. 1943:

	April	October
Income from goods sold	13,110	15,230
Other income	225	245
Carried forward amts. of semi-finished and finished goods to the next term	3328	4461
Total	16,663	19,936

	April	October
Cost of goods	6333	8001
Expenditure	5236	6154
Carried forward amts. of semi-finished and finished goods from the previous term	3888	3328
Current-term profit	1206	2453
Total	16,663	19,936

b. 1944:

	April	October
Income from goods sold	16,932	16,985
Other income	263	456
Carried forward amts. of semi-finished and finished goods to the next term	5542	6219
Total	22,737	23,660

	April	October
Cost of goods	8894	9100
Expenditure	6847	6399
Carried forward amts. of semi-finished and finished goods from the previous term	4461	5542
Current-term profit	2535	2619
Total	22,737	23,660

c. 1945:

	April
Income from goods sold	11,670
Other income	466
Carried forward amts. of semi-finished and finished goods to the next term	8485
Total	20,621

	April
Cost of goods	9587
Expenditure	2944
Carried forward amts. of semi-finished and finished goods from the previous term	6219
Current-term profit	1871
Total	20,621

ENCLOSURE (E), continued

17. Balance Sheet (in ¥):

a. 1943:

Debt	April	October	Credit	April	October
Land	665	689	Capital	10,000	10,000
Building	4174	4337	Legal reserve fund	505	570
Fixture	538	562	Special reserve fund	2100	2300
Machinery installation	8933	8888	Dividend reserve fund	300	900
Cars and carriers	82	87	General retiring allowance reserve fund	948	1061
Instruments and furniture	529	554	Legal retiring allowance reserve	220	215
Construction a/c	173	1971	Bills payable	3496	657
Securities	1121	1153	Long-term debt	5500	5500
Trust deposit	1157	1201	Short-term debt		8014
Inventory assets	8921	10,191	Money unpaid in advance	5669	3531
Sales credit	2853	4210	Temporary receipts	76	5499
Bills receivable	48	43	Money deposited	1520	1556
Cash & deposits	1730	4210	Carried forward profit	501	563
Credit receivable	14	33	Current-term profit	1206	2453
Temporary payment	1171	1424			
Securities for payment) Money deposited)	432	678			
Total	32,541	42,819	Total	32,541	42,819

b. 1944:

Debt	April	October	Credit	April	October
Capital unpaid	11,250	5230	Capital	25,000	25,000
Land	704	755	Legal reserve fund	1535	1600
Building	4351	4595	Reserve for tax	1200	1750
Fixture	619	621	Special reserve fund	2500	2700
Machinery installation	8684	8414	Dividend reserve fund	900	900
Cars and carriers	124	116	Reserve fund for study	100	100
Instruments and furniture	548	537	General retiring allowance reserve fund	1187	1305
Construction a/c	5081	7083	Legal retiring allowance reserve	285	283
Securities	5545	8913	Bills payable	336	708
Trust deposits	1451	1587	Long-term debt	5500	5500
Inventory assets	11,676	14,894	Short-term debt	9634	14,421
Sales credit	5132	5791	Money unpaid in advance	4972	3624
Bills receivable	75	1090	Temporary receipts	885	2171
Cash and deposits	1451	1864	Money deposited	2105	2442
Credit receivable	49	842	Carried forward profit	670	701
Temporary payment	2238	2047	Current-term profit	2535	2519
Reserve deposit for tax	300	700			
Securities for payment) Money deposited)	608	726			
Total	59,344	65,824	Total	59,344	65,824

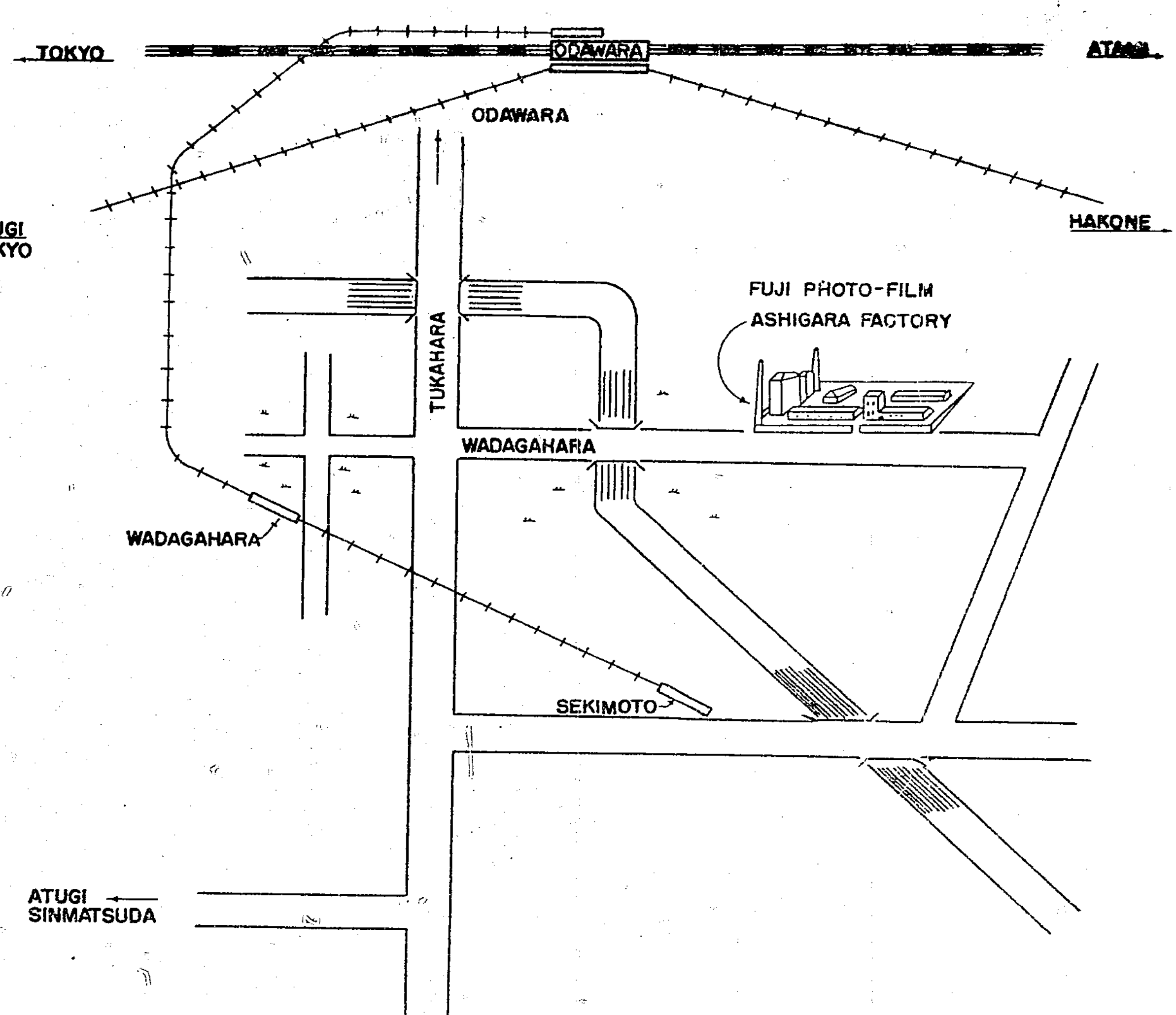
c. 1945:

Debt	April	Credit	April
Capital unpaid	5250	Capital	25,000
Land	755	Legal reserve fund	1665
Building	4531	Reserve for tax	2070
Fixture	622	Special reserve fund	2800
Machinery installation	8108	Dividend reserve fund	900
Cars and carriers	200	Reserve fund for study	100

ENCLOSURE (E), continued

Debt	April
Instruments and furniture	552
Securities	9103
Trust deposits	1691
Inventory assets	16,152
Sales credit	6460
Cash and deposits	1414
Credit receivable	1799
Temporary payment	2153
Reserve deposit for tax	910
Securities for payment) Money deposited)	803
Total	68,300

Credit	April
General retiring allowance reserve fund	1424
Legal retiring allowance reserve	320
Long-term debt	5500
Short-term debt	17,872
Money unpaid in advance	2473
Temporary receipts	2329
Money deposited	3234
Carried forward profit	742
Current-term profit	1871
Total	68,300



ENCLOSURE (F)

DATA OF SPECIAL PHOTOGRAPHIC OBJECTIVES
COMPILED AT THE OPTICAL RESEARCH LABORATORY
AT KANAZAWA FIRST AIR TECHNICAL ARSENAL

SONAR-TYPE
(F - 1:1.5, f_d-100., Field 43°.)

		Glass No.	N_c	N_d	N_f
r_1 - 68.50 r_2 - 433.84	d_1 - 9.33 d_2 - 0.38	OB681(BaSF6) Air	1.66409 1.0	1.66868 1.0	1.68002 1.0
r_3 - 35.86 r_4 - 85.78 r_5 -1750.00 r_6 - 23.80	d_3 -11.81 d_4 - 7.05 d_5 - 1.90 d_6 -15.24	OB681(BaSF6) OB489(BK10) OB702(SF11) Air	1.66409 1.48657 1.77526 1.0	1.66868 1.48882 1.78363 1.0	1.68002 1.49397 1.80527 1.0
r_7 -2000.00 r_8 - 43.00 r_9 - 23.38 r_{10}- 35.50 r_{11}- 98.70	d_7 - 2.48 d_8 -19.80 d_9 - 3.00 d_{10}- 3.00	OB725(LLF6) OB681(BaSF6) OB609(BaLF4) OB611(LF5)	1.52876 1.66409 1.57698 1.57619	1.53185 1.66868 1.58015 1.58027	1.53950 1.68002 1.58780 1.59038

Zdp' - 46.227

ORTHOMETER-TYPE (FOR INFRA-RED)
(F - 1:4.5, f_c-100.088, Field 63°)

		Glass No.	N_a'	N_c	N_d
r_1 -25.50 r_2 -95.00	d_1 -5.1 d_2 -0.1	OB556(SK4) Air	1.60112 1.0	1.60472 1.0	1.60782 1.0
r_3 -93.90 r_4 -18.20	d_3 -2.3 d_4 -0.7	OB595(LLF7) Air	1.54191 1.0	1.54594 1.0	1.54942 1.0
r_5 -22.83 r_6 -34.00	d_5 -3.0 d_6 -7.0	OB872(BaK1) Air	1.56543 1.0	1.56884 1.0	1.57179 1.0
r_7 -32.50 r_8 -21.25	d_7 -3.3 d_8 -1.6	OB872(BaK1) Air	1.56543 1.0	1.56884 1.0	1.57179 1.0
r_9 -17.30 r_{10}-80.00 r_{11}-24.70	d_9 -1.9 d_{10}-6.8	OB595(LLF7) OB556(SK4)	1.54191 1.60112	1.54594 1.60472	1.54942 1.60782

Zcp' - 87.0038

ENCLOSURE (F), continued

TESSAR-TYPE (FOR INFRA-RED)
(F - 1:5.0 f_c-500,160, Field 45°.)

		Glass No.	$N_{a'}$	N_c	N_d
r1- 125.0 r2- 530.0 r3- 00.0	d1-16.0 d2- 7.0 d3-22.0	OB556(SK4) OB1422(F3) Air	1.60112 1.60134 1.0	1.60472 1.60666 1.0	1.60782 1.61135 1.0
r4- 310.0 r5- 113.0	d4- 7.0 d5-32.0	OB611(LF5) Air	1.57157 1.0	1.57619 1.0	1.58027 1.0
r6-1500.0 r7- 113.0 r8- 199.5	d6- 5.0 d7-24.0	OB350(ZK1) OB556(SK4)	1.52752 1.60112	1.53069 1.60472	1.53339 1.60782

Zcp - 424.314

TELEPHOTO-LENS (ZEISS TELIKON-TYPE)
(F - 1:6.3 f-750. Field 35°)

		Glass No.	N_c	N_d	N_e
r1 - 158.80 r2 - 675.00 r3 - 300.00	d1- 15.0 d2- 16.5 d3- 0.9	SK4 F5 Air	1.60954 1.59874 1.0	1.61263 1.60328 1.0	1.61521 1.60718 1.0
r4 - 300.00 r5 - 548.90	d4- 9.3 d5-224.5	SF3 Air	1.73238 1.0	1.73976 1.0	1.74618 1.0
r6 - 97.83 r7 - 160.00 r8 - 370.40	d6- 7.5 d7- 6.0 d8- 0.1	SK4 F5 Air	1.60954 1.59874 1.0	1.61263 1.60328 1.0	1.61521 1.60718 1.0
r9 -2300.00 r10- 363.80	d9- 19.0	SF3	1.73238	1.73976	1.74618

Zdp' - 299.121