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U. S. NAVAL TECHNICAL MISSION TO JAPAN
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From: Chief, Naval Technical Mission to Japan.
To : Chief of Naval Operations.

Subject: Target Report - Japanese Explosives.

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

1. Subject report, dealing with Target O-25 of Fascicle O-1 of reference (a), is submitted herewith.

2. The investigation of the target and the preparation of the report were accomplished by Lt. Comdr. R.A. Cooley, USNR, assisted by Lieut. H.L. Blackwell, USNR, and Ensign H.L. Horton, USNR.



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Captain, USN

RESTRICTED

O-25

JAPANESE EXPLOSIVES

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

FASCICLE O-1, TARGET O-25

DECEMBER 1945

U.S. NAVAL TECHNICAL MISSION TO JAPAN

SUMMARY

ORDNANCE TARGETS

JAPANESE EXPLOSIVES

A Japanese has written "ammunition is an organic creature which, however we make it, insists always upon his own independence, betraying sometimes our selfish expectations." Although this kind of superstition is not generally indicative of the state of knowledge of Japanese technicians, yet there appears to be little that is new in the composition or manufacture of Japanese explosives.

Some American experts have characterized the present Japanese methods of manufacture as those used in the United States between 1910 and 1930.

The Japanese used a great deal of trinitroanisol and hexanitrodiphenylamine, both of which are generally considered to be too deleterious to the workers' health for manufacture in the United States. The Japanese had not developed new methods to protect their workers but continued to manufacture trinitroanisol and hexanitrodiphenylamine.

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- (A) Investigation of Third Naval Powder Plant, Maizuru Naval Depot.
- (B) Investigation of Nisson Chemical Industrial Co., Ltd., Taketoyo Plant.
- (C) Plan of Washing Tank for TNT-Nisson Chemical Industrial Co.
(NavTechJap Document No. ND50-3205.1).
- (D) Plan of Crystallizing Tank for TNT-Nisson Chemical Industrial Co.
(NavTechJap Document No. ND50-3205.2).
- (E) Plan of Nitrator for Toluol-Nisson Chemical Industrial Co.
(NavTechJap Document No. ND50-3205.3).
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REFERENCES

Japanese Personnel Interrogated:

Captain M. MITSUI - Head of Ammunition Department and Ordnance Experiment Station Kure Navy Yard, Former Head of Explosives Section, Naval Technical Department.

Captain MIMII - Ammunition Section of Naval Technical Department.

INTRODUCTION

Although nothing of great interest in Japanese explosives or their methods of manufacture was found, the following report, dealing with the chemical composition, properties and testing of explosives, is submitted.

THE REPORT

A. MOST RECENT AND MOST EFFECTIVE EXPLOSIVES

The introduction of aluminum into explosives had been under investigation for some time, and such compositions as Type A with 60% TNT, or sometimes TNA, 24% FNDA and 16% aluminum had been proposed for use in torpedo warheads but had not yet been accepted. Type 2 explosive with 30% aluminum and 70% TNA had been used as an incendiary explosive in submarine gun shells.

Also of relatively recent interest had been the K type explosives with inorganic salts (see Table I for compositions).

The most powerful underwater explosive as indicated by underwater tests on compartment bulkheads was said to be explosive Type 94 (60% TNA and 40% TMTNA). In air, the most powerful explosive was said to be 50% TNT and 50% Pentalite, $C(CH_2ND_3)_4$, although it was not markedly different from Type 94.

For torpedo warheads, Type 94 was abandoned because of its sensitivity and susceptibility to sympathetic detonation.

B. CHEMICAL COMPOSITION AND PROPERTIES OF JAPANESE EXPLOSIVES

Table I shows the use, chemical composition, sensitivity and power of a number of explosives. Table II gives essentially the same information on ammonium explosives.

C. METHODS OF MANUFACTURE OF EXPLOSIVES

Enclosures (A) and (B) give detailed information on manufacturing procedures and equipment. A brief outline of the synthesis methods used for explosives is as follows:

1. Trinitroanisol

Dinitrochlorbenzene is methylated in the presence of methyl alcohol and 37% caustic soda. The resulting dinitroanisol is then nitrated to trinitroanisol. The dinitrochlorbenzene is obtained from benzene which is first chlorinated and then nitrated twice.

2. Picric Acid

Phenol is sulfonated with 98% H_2SO_4 and then nitrated with 62% nitric acid.

3. Hexanitrodiphenylamine

Dinitrodiphenylamine is nitrated with 98% nitric acid. The starting material, dinitrodiphenylamine, is obtained from the reaction of aniline, dinitrochlorbenzene, and soda ash.

4. Trinitrotrinitramine

Hexamethylenetetramine is treated with 98% nitric acid and potassium permanganate to yield trinitrotrinitramine.

Table I
EXPLOSIVES USED BY JAPANESE NAVY

Name	Composition	Color	Employment	Sensitivity (drop hammer)	Friction Test	Explosion Point (°C)	Explosion Point (Inst.)	Mortar	Speed of Expl. (Relative)	Velocity of Explosion (m/s)	Loading Density	Melting Point (°C)
Type 91, TNA Trinitroanisole	$O_2N \begin{array}{c} \text{OCH}_3 \\ \text{NO}_2 \end{array}$	Yellow	Armor-piercing Projectile	19	60	279	490-508	108	92	6800	1.60	64
Type 92, TNT Trinitrotoluene	$O_2N \begin{array}{c} \text{CH}_3 \\ \text{NO}_2 \end{array}$	Light Yellowish Brown	General Machine gun Projectile	17	60	321	480-490	96	96	6900	1.59 (melting)	82
Tetryl (Tet) Tetra-nitromethy- lamine	$CH_3-N \begin{array}{c} \text{NO}_2 \\ \text{NO}_2 \end{array}$	Bluish Yellow	25mm machine gun Priming charge Projectile	11	40-50	190	350	115	101	6900	1.50 (press)	130
Hexogen TMNTA Trimethylentrini- tramine	$O_2N \begin{array}{c} \text{N} \\ \text{H}_2 \text{C} \end{array} \begin{array}{c} \text{NO}_2 \\ \text{NO}_2 \end{array}$	True White	For Type 94 Explosives	13		240			114	8380	1.60 (press)	200
Hexyl HNDA Hexanitrodipheny- lamine	$O_2N \begin{array}{c} \text{N} \\ \text{H} \end{array} \begin{array}{c} \text{NO}_2 \\ \text{NO}_2 \end{array}$	Yellow	For Type 97 & 98 Explosives	17		250			90	7100	1.64 (press)	250
Pentrit TNPE Tetra-nitropentaery- thrite	$C(CH_2NO_2)_4$	White	20mm machine gun	13	60	205		108	128	8400	1.60 (press)	140
Type 94 M	TNA 60 TMNTA 40	Yellow	Hollow charge grenade	13	40-50	216	430-440	112	107	7700	1.64 (melting)	178
Type 97 H	TNT 60 HNDA 40	Light Yellowish Brown	Torpedo (abandoned) Torpedo & Depth Charge	14	60	302	480	92	96	7100	1.65 (melting)	
Type 98 H ₂	TNA 60 HNDA 40	Yellow	Bombs torpedo & Depth Charge	14	60	264	490	96	100	7100	1.65 (melting)	
Type 2, Incendiary explosives B4	TNA 60 Al powder 40	Grayish White	Projectiles	17	60	300	500-505	64	82		1.90 (melting mixture)	
E	TNA 60 NH ₄ NO ₃ 40	Light Yellow	Bombs (not yet used)	19	60			108			1.60 (melting mixture)	
Simose explosives PA, Picric acid	$O_2N \begin{array}{c} \text{NO}_2 \\ \text{OH} \end{array}$	Yellow	Priming charge Common projectiles	12	60	303		100	100	7800	1.68 (melting)	122.5
A (ko)	TNT 60 HNDA 24 Al powder 16	Dark Green	Torpedo (not yet accepted)									
Pentryl	TNT 50 TNPE 50	Light Yellow	Aero G.M.C. Hollow charge									

1. Percussion Test: Weight of hammer 5 kg. Does not explode within height indicated. 2. Friction Test: Explosive will withstand the indicated value. 3. Mortar Test: Indicated value compared with picric acid.

Table II
AMMONIUM EXPLOSIVES USED BY THE JAPANESE NAVY

Name	Composition	(%)	Color	Sensitivity Percussion Test (drop hammer) (cm)	Friction Test (kg)	Explosion Point	Mortar Test (relative)	Power of Expl. Spec. Brisance	Velocity of Explosion	Apparent Gravi- metric Density
Type 88 K ₀	Ammonium Perchlorate Ferrosilicate Wood Pulp Heavy Oil	75 16 6 3	Gray	17	30-40	430	100	100	3800m/s	1.05
Type 4, Mk 1 K ₁	Ammonium Perchlorate Ferrosilicate Talc Chlornaphthalene	80 8 10 2	Grayish White	18	60	455	84	89	3600	1.24
Type 4, Mk 2 K ₂	Ammonium Nitrate Wood Pulp Coal Tar	89 65 6	Grayish Black	34	60	470	82	70	3900	1.00
Type 4, Mk 3 K ₃	Ammonium Perchlorate Ammonium Sulfate Ferrosilicate Chlornaphthalene	47 32 20 1	Grayish White	20	60	470	81	83	2900	1.20
Type 4, Mk 4 K ₄	Sodium Chlorate (or potash chlorate) Petroleum	88 12	White	14	60	580	59	77		1.6-1.8 1.05
Type 4, Mk 5 K ₅	Ammonium Perchlorate Ammonium Nitrate Ferrosilicate Wood Pulp Heavy Oil	55 29 10 5 1	Gray	28	60	450	81	92		1.05
Type 4, Mk 6 K ₆	Sodium Chlorate Petroleum Wood Pulp	84 10 6	Yellowish Brown	17	60		67	78		1.3-1.4
Type 4, Mk 7 K ₇	Sodium Chlorate Wood Pulp Coal Tar Wood Charcoal	84 5 3 8	Grayish Black	25	30	385	63	82		1.2
Type 1, Mk 1 P ₁	Ammonium Picrate Aluminum Powder Wood Pulp Heavy Oil	81 16 2 1	Dark Green (Powder)	17	60	490	81	100	4280	1.16
Type 1, Mk 5 P ₅	Ammonium Picrate Ferrosilicate Wood Pulp Heavy Oil	81 16 2 1	Dark Green	15	60	450	72	99	4100	1.16
Type 1, Mk 6 P ₆	Ammonium Picrate Ferrosilicate Wood Pulp Heavy Oil	86 11 2 1	Dark Green	13	60	450	74	95	4620	1.13

(Note: All above explosives were used in mines and depth charges.)

D. TESTING OF JAPANESE EXPLOSIVES1. Sensitivity

The sensitivity of an explosive is measured by the five following tests, the last two of which are considered highly practical.

- a. Drop hammer test for shock.
- b. Friction test with a known pressure between the two rubbing surfaces.
- c. Detonation test by a standard amount of picric acid at various distances from the explosive under investigation.
- d. Bullet test consisting of firing into a closed pipe containing explosive.
- e. Firing in a gun at increasing accelerations.

2. Detonation

The following brisance test is carried out. The explosive in question is placed on a lead plate resting on a copper cylinder supported on an iron base. After the explosive has detonated, the change in dimensions of the copper cylinder is measured. Detonation velocity is measured by the Dautsch method or by a "rotating camera".

3. Blast

The blast created by an explosive charge is measured by a "blast meter" which is a lead plate mounted on supports. The deformation of the supported lead plate is measured after the blast.

ENCLOSURE (A)

INVESTIGATION OF THIRD NAVAL POWDER PLANT, MAIZURU NAVAL DEPOT

1. Purpose: To evaluate development and productive capacity of Japanese Naval explosive industry. Specifically, to study methods of manufacture and equipment.
2. Explosives manufactured: Trinitroanisol, picric acid, pentyrethatal tetranitrate, hexoyle, purification of TNT.
3. Organization: The Maizuru Naval Depot is an arsenal that contains a naval academy, docks and repair facilities, munitions and naval supplies, explosive manufacture and loading, etc. The explosive manufacturing division is but a small part of the arsenal, and its production is largely controlled by the demands of the loading division. Small amounts of explosives were shipped to her loading plants, but the capacity of the manufacturing plant was not large enough to warrant large scale shipments.
4. Sources of information: Lt. Commander SATO, Chief of Explosive Division, worked at the arsenal for seven years as sub chief, appointed as chief in February 1945; traveled in England, France and Germany in 1925, and studied colloid chemistry; was educated at Tokyo Imperial University; member of Explosives Department at Second Naval Arsenal; worked chiefly in measuring viscosities.

Lt. Comdr. MITSUHASHI (Technical) worked 12 years at the arsenal; attended Hamamatsu Technical School and studied applied chemistry; has worked with TNA, HND, PETN, picric acid and, the purification of TNT.

5. Manufacture of Pentaerythritoltetranitre (PETN):

- a. Equipment: Stainless steel jacketed nitrator, stainless steel wash tank, centrifuge, steel purifying tank, acetone recovery.
- b. Process: Into 825 kg of 98% HNO_3 , which has been cooled to 10-15°C, 150 kg PE is slowly added by hand. Agitation, with small paddles, is kept at 140 RPM, and temperature is kept under 15°C. Charging requires approximately 2 1/2 hours. The batch is settled for 30 minutes and then dropped into wash tank into which has been placed 2000 kg. of H_2O . Acid recovery is not undertaken, and the batch is washed five times. NaOH is then added to make a 0.5% alkaline solution. The batch is then washed four times. The water is syphoned off each time. Slurry is then pumped by centrifugal pump to the centrifuge, and excess water is extracted. The product is then taken to the next building for purification.

Into 150 kg of acetone at 50-55°C is dropped 60 kg of PETN which is agitated for one hour for complete dissolving. The solution is then filtered through cotton cloth to remove insolubles and dropped into 150 kg of H_2O where PETN is precipitated. The batch is then centrifuged and taken to the drying house, placed on trays, dried for 22 hours at 55°C. PETN is then ready for shipment, loading, or blending.

6. Manufacture of Trinitroanisol (TNA):

- a. Equipment: Converters (4), separators (4), centrifuge (4), nitrators (4), blowcase, acid mixer, separator (4), centrifuge (4), nitrator (3), wash tank (3), filter (3), pelletor (3).
- b. Process: Into a converter, in which 800 kg of methyl alcohol is placed, caustic soda is added (196 kg) with alternate 1/10 increments of dinitrochlorbenzol. Temperature is kept at 40-45°C during charging and

ENCLOSURE (A). continued

requires seven hours. Temperature is brought up to 50°C by steam on the jacket and held for 30 minutes. The batch is then cooled to 35°C, requiring three hours, and is discharged to the separator. Mother liquor is filtered off, and the batch is washed four times with water. On final washing, the slurry is run to a centrifuge and excess water is taken off. The crude DNA is then placed in boxes and taken to the next building for nitration.

The nitrator construction is the same as the converters, utilizes jacket for cooling and heating, and has no internal coils.

Into the nitrator, 3200 kg of mixed acid of the following composition is placed:

HNO ₃	17%
H ₂ SO ₄	77%
H ₂ O	6%

Dinitroanisol is added to the nitrator by hand, and the temperature is allowed to rise slowly to 50°C and is held at 50-55°C until the batch is completely charged (requires 6 hours). The batch is steamed up to 60-68°C, held for 30 minutes and cooled to 35°C (requires 4 hours) and is discharged to the separator where acid is filtered off. Recovered acid is then fortified with 98% HNO₃ and is reused for succeeding nitrations. The batch is washed five times and sent to the centrifuge.

Two methods of purification have been used. First, dissolving in CH₃OH and recrystallizing in water, and second, melting in hot water, drawing off melt water and then adding cold water to pellet the TNA. The water method has superseded methyl alcohol purification with a resulting simplification of operation and at no appreciable detriment to the quality of the product.

7. Manufacture of Hexanitrodiphenylamine (Hexyl):

a. Equipment: Stainless steel nitrator with jacket and coils, stainless steel separator, wash tank, centrifuge, drying house.

b. Process: Into the nitrator is placed 2100 kg of 80% HNO₃, and dinitrodiphenylamine is slowly added by hand. Charging requires from three to four hours, and the temperature is kept between 45-55°C. The batch is then steamed to 90-95°C, requiring 1 1/2 hours and is held for an additional 1 1/2 hours. It is then cooled to 45°C (4-5 hours), and the charge is dropped to the separator where the waste acid is drawn off and sent to the fortifier to be rebled with 98% HNO₃ for further nitrations. The batch is then dumped to the wash tank and washed with hot and cold water washes (1, 5 cold; 2, 3, 4 hot). The batch is then sent to the centrifuge and then to driers.

8. Manufacture of Picric Acid: This plant was dismantled and in the process of being moved to a new explosive area. Inspection of the dismantled equipment indicated that the process would be much the same as other Japanese picric acid plants.

9. Purification of Trinitrotoluene (TNT): This process consisted entirely of taking 80.0°C SP TNT and purifying it with sodium sulphite. The crude TNT was dumped into mixers, the sulphite solution added and then washed, dried and repacked. Final SP was claimed to be 80.5°C.

10. Acid Plant: Fuming sulfuric and 98% HNO₃ were brought into the plant by tank car. However, waste mixed acid was denitrated, and both HNO₃ and sulfuric were concentrated.

ENCLOSURE (A), continued

The sulfuric acid concentrator, built in February 1945, was the Pouling system of 15 tons per day. Of four furnaces built, only two were in operation, and the best production obtained was only 10 tons per day.

The nitric acid concentrator consisted of two hisilicon towers of 11 sections, each being 60cm ID. Absorption towers were ceramic and used S.S. centrifugal pumps to circulate the acid. Capacity was rated at 10 tons per day of 98% HNO_3 .

The denitration operation utilized the HNO_3 concentrator equipment, and piping was so arranged that the change could be easily made.

11. Production: The plant was rated by the central government for specific production, and all methods and procedures were controlled by a central board.

	Production per day	Cost per kg
Picric Acid	2 tons	3y10
TNA	8 tons	3y15
HND	6 tons	3y73
PETN	800 kg	6y78

	Annual Production (Ton)					
	1940	1941	1942	1943	1944	1945*
TNA	650	2000	2100	2100	1638	427
HND	435	1200	1350	596	541	100
Picric	670	-	203	600	834	53

*Until August

12. General: The plant was fairly well maintained, and designed well for the processes and operations used. However, basically the equipment and methods of operation were obsolete and very inefficient. The plant served as a yardstick for privately owned plants and provided a training ground for methods of manufacture during the years of peace.

ENCLOSURE (A), continued



Figure 1(A)
BUILDING FOR THE MANUFACTURE OF TRINITROANISOL

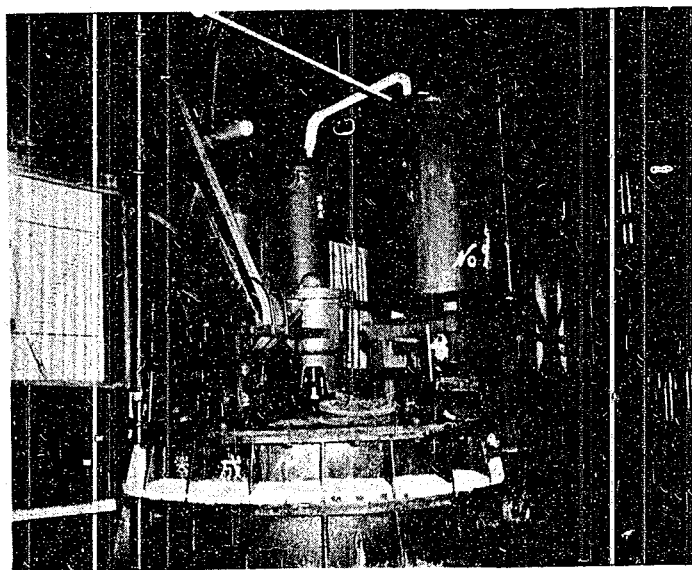


Figure 2(A)
TRINITROANISOL NITRATOR

ENCLOSURE (A), continued

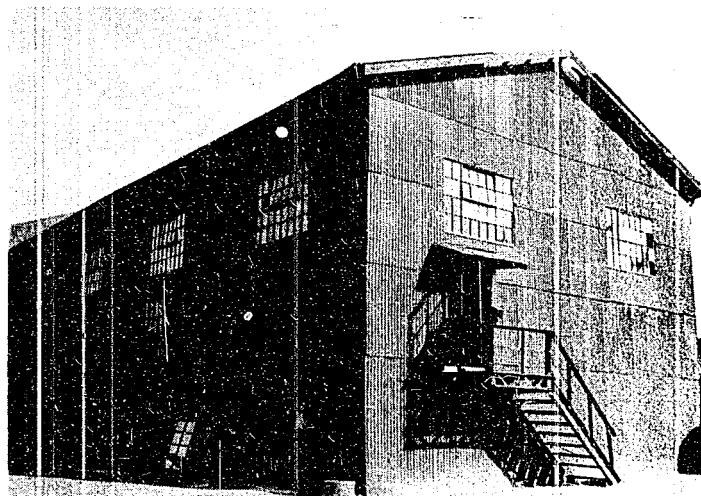


Figure 3(A)
BUILDING FOR THE MANUFACTURE OF HEXANITRODIPHENYLAMINE

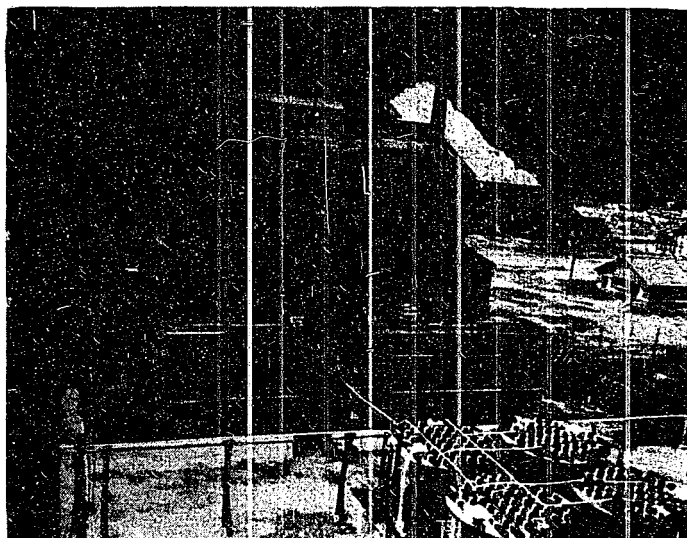


Figure 4(A)
SULPHURIC ACID CONCENTRATOR BUILDING

ENCLOSURE (A), continued

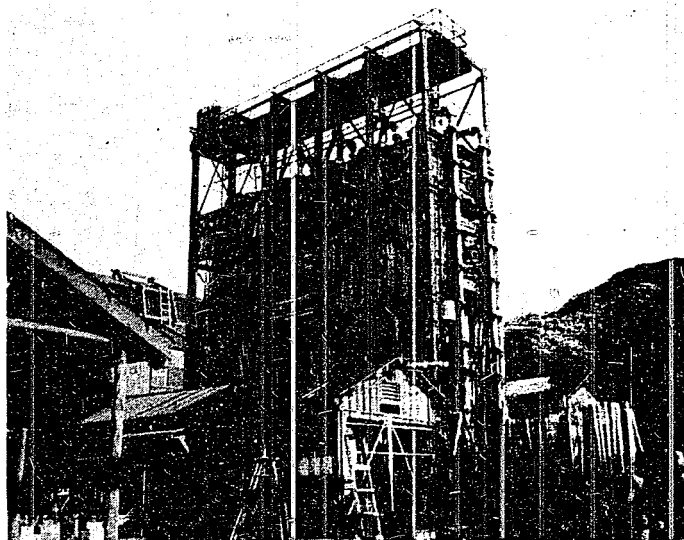


Figure 5(A)

NITRIC ACID ABSORPTION TOWERS AT ACID RECOVERY PLANT

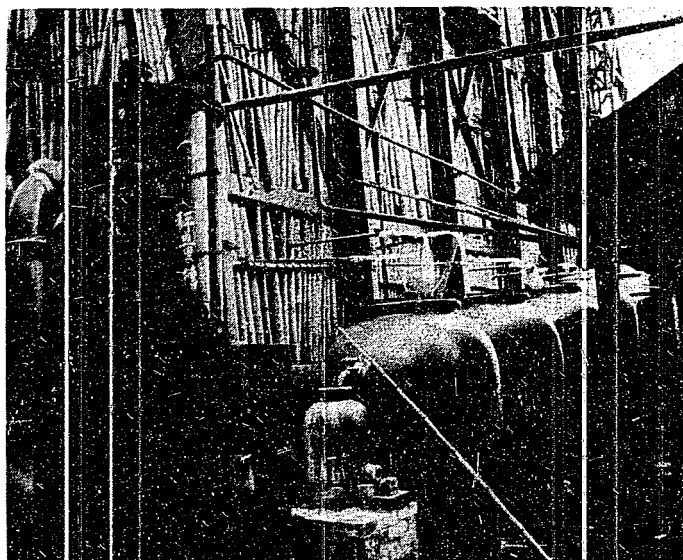


Figure 6(A)

EQUALIZING POTS FOR NITRIC ACID ABSORPTION TOWERS

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ENCLOSURE (A), continued

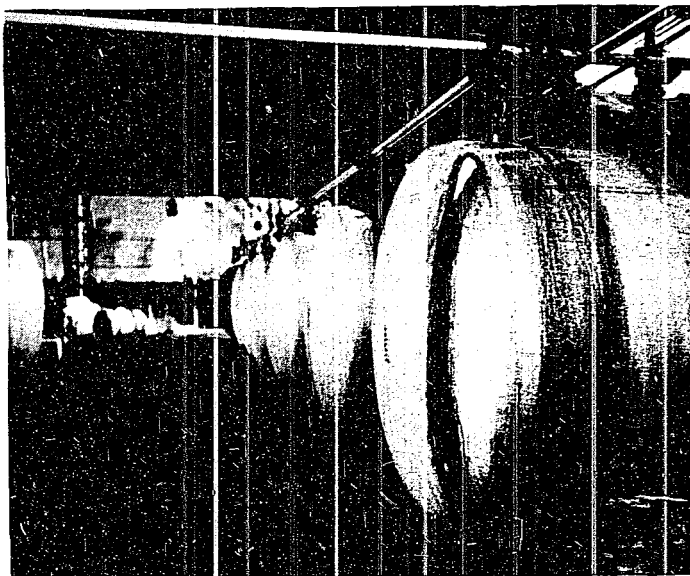


Figure 7(A)
ALUMINUM STORAGE TANKS FOR NITRIC ACID

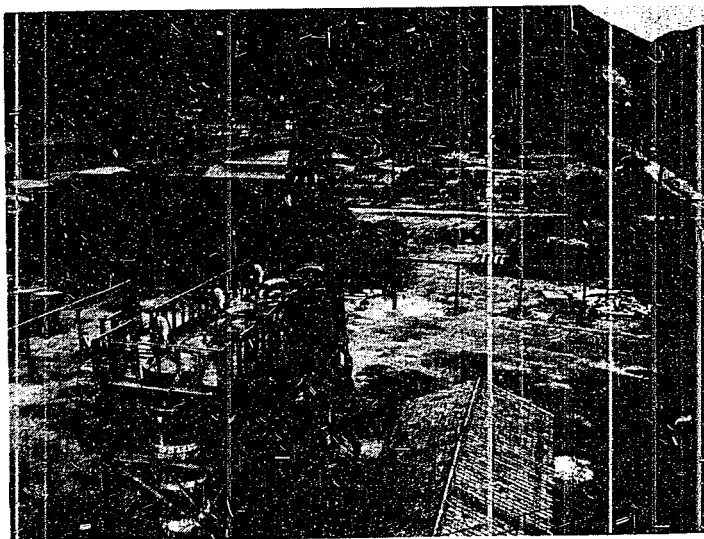


Figure 8(A)
LOOKING SE FROM THE NITRIC ACID CONCENTRATOR BUILDING
TNA Building in the background

ENCLOSURE (B)

INVESTIGATION OF NISSON CHEMICAL INDUSTRIAL CO., LTD., TAKETOYO PLANT

1. Purpose: To evaluate development and production capacity of Japanese explosives industries which supply explosives for naval use. Specifically, to study methods of manufacture and equipment.
2. Explosives Manufactured: TNT, TETN, Pentolite, ammonia nitrate explosives, (military) sodium nitrate explosives, dynamite, cannon powder, machine gun powder, rocket gun powder, sporting powder.
3. Organization: The Nisson Chemical Industrial Co., Ltd., is a privately owned stock corporation established in 1919 and capitalized at 67,250,000 yen. There are several chemical plants in the Japanese homeland which are controlled by this company, but it is believed that the Taketoyo plant is the only one which manufactures high explosives. The plant supplied naval cannon powder, naval machine gun powder, and naval rocket gun powder to the Second Naval Powder Plant (HIRATSUKA), high explosives to the Third Naval Powder Plant (MAIZURU), and dynamite and sporting powder to the Nihon Explosive Control Co., Ltd. The maximum number of employees at the plant reached 2310 in February 1945, and production was maintained at the highest possible level at all times.
4. Sources of Information: Chief of Smokeless Powder Division, Mr. SUKUNACHI. Attended Tokyo Imperial University for 3 years, and was enrolled in department of explosives. Was stationed with Japanese Army in Manchuria for two years (1936-38). Has been employed at plant since 1941.
- Chief of the High Explosives Division, Mr. KASAMA. Attended Kanazawa Technical School for three years and studied applied chemistry. Has worked at plant for 16 years, with TNT seven years, and PETN five years.

5. Production: (tons per month)

Military propellants 210
 Military high explosives 160
 Dynamite 810
 Sporting Powder 5

	Annual Production (Ton)					
	1940	1941	1942	1943	1944	1945*
Cannon Powder	420	576	1017	1026	935	379
M.G. Powder				48	180	42
Rocket Powder						13
High Explosive Powder		382	517	948	856	344
Dynamite	6014	6142	6497	6132	5386	1627

*Until August

6. Cannon and Machine Gun Powder: Manufacturing processes and equipment are the same as that of the Second Naval Powder Plant at HIRATSUKA, and are covered in the report on that plant.

7. Rocket Powder:

- a. Equipment: Same as other smokeless powder.
- b. Composition: Nitro cotton 60%, nitroglycerine 27%, centralite 3%, mono nitronaphthalein 7%, potassium sulfate 3%, less than 3.5% water.

ENCLOSURE (B), continued

- c. Dimensions: Length 500mm. External diameter 108-111mm. Thickness 4915mm.
- d. Process: A 1:1 mixture of gun cotton and collodion cotton is placed in a copper vat in which water at 18-20°C is present. The mononitronaphalein is added, then the nitroglycerine, and then centralite. Paste is kneaded in hot rolls (75-85°C) and this process is repeated 13 times. After the third kneading the potassium sulfate is added. Mixture is then pressed with a pressure not to exceed 80 kg/cm². Resultant powder contains less than 4% H₂O.
8. Manufacture of Pentolite (50/50 TNT and PETN): TNT and PETN are dissolved in acetone and are coprecipitated by the addition of water. Batch is filtered, dried, and packed.
9. Manufacture of Pentaerythritaltetranitrate (PETN): Equipment and process is essentially the same as that of the Third Naval Powder Plant at MAIZURU and is covered in Enclosure (A).
10. Manufacture of Trinitrotoluene (TNT):
- a. Equipment: Nitrators, acid tanks, prewashing tank, crystallizing vat, dry house.
- b. Process: The nitrations are carried on in two stages, with plans for incorporating a third. Graining is carried on in wood grainers (natural cooling), and purification is done with sodium sulphate to obtain a TNT of freezing point 80.0°C.
- (1) Nitration: 3000 kg of tri waste acid is taken into the nitrator, and 900 kg of 98% HNO₃ is added to it. Temperature is at 40°C at start of toluene addition, and it rises to 65°C after all of the 500 kg have been added. This addition requires 3-4 hours. The charge is then steamed up to 95°C (one hour), is held for three hours, and cooled to 80°C. It is then settled for 30 minutes. Waste acid from previous batch is run into the nitrator by gravity, and the displaced DNT runs through an overflow pipe into the tri nitrator into which had been previously added 1950 kg of 100% H₂SO₄. This required one hour. The charge is then heated to 85°C by steam, and 1450 kg of mixed acid is added. This requires two hours. Charge is then steamed up to 120°C (one hour) and is held for three hours. The batch is then cooled to 85°C (30 minutes) and settled 45 minutes; and TNT is run off to prewashing tank (45 minutes) by again being displaced with a previous waste acid.
- (2) Washing: After one wash in the prewashing tank, the charge is run to the wash tank and washed 10 times with 1000 kg of hot water per each wash. The molten TNT is then run to crystallizer and is crystallized by natural cooling in 3-4 hours. 100 kg of sodium sulphate in a 15% aqueous solution is then added and is agitated for 45 minutes. Batch is then water washed for two hours, and wash water runs to settling basins. The TNT is then placed in centrifuge, and excess water is extracted. The batch is then taken in boxes to the drying houses, placed in trays and dried by hot circulated air.
- (3) Production:
- 3 nitrations per 25 hours.
2 lines in operation.
Yield: 1.96 TNT/kg of toluene.
1.5 kg HNO₃ per kg of TNT.
1.6 kg H₂SO₄ per kg of TNT.

ENCLOSURE (B), continued

(4) Acid Composition:

	Primary M.A.	Primary W.A.	Tri M.A.	Tri Waste Acid
H ₂ SO ₄	63-67%	74-80%	53-56%	72-74%
HNO ₃	70-22%	0-4%	42-44%	8-10%
H ₂ O	13-15%	20-22%	2-3%	16-18%

Note: Nitro bodies were not analyzed.

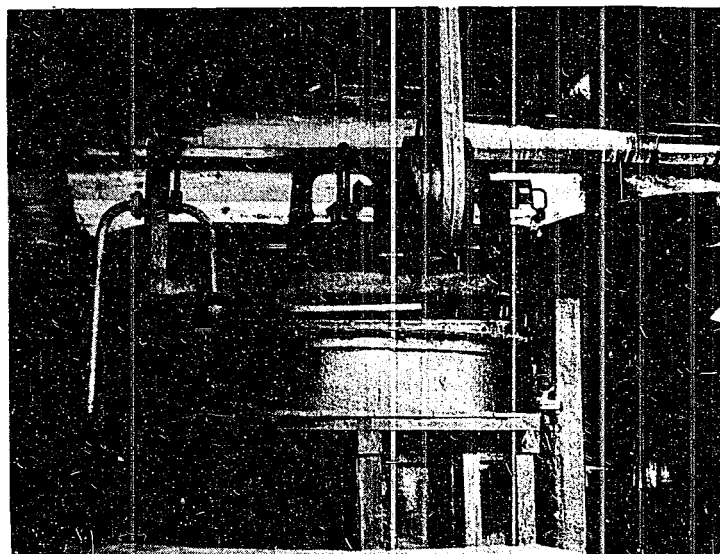


Figure 1(B)
PETN NITRATOR

ENCLOSURE (B), continued

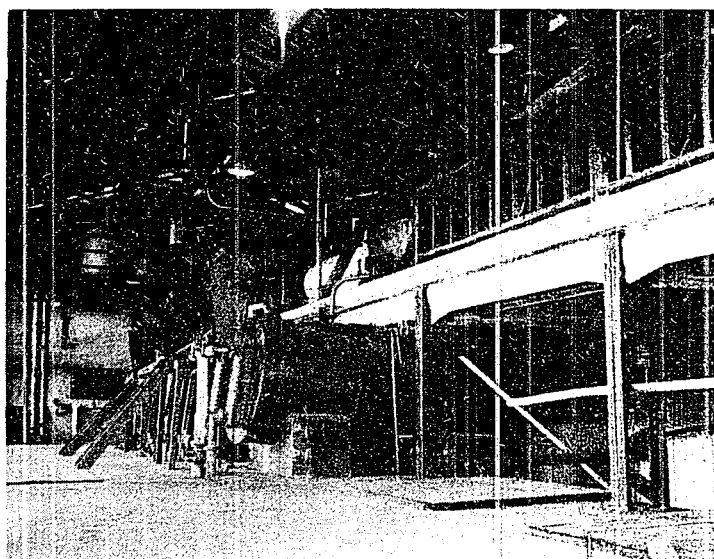


Figure 2(B)
TNT NITRATOR LINE

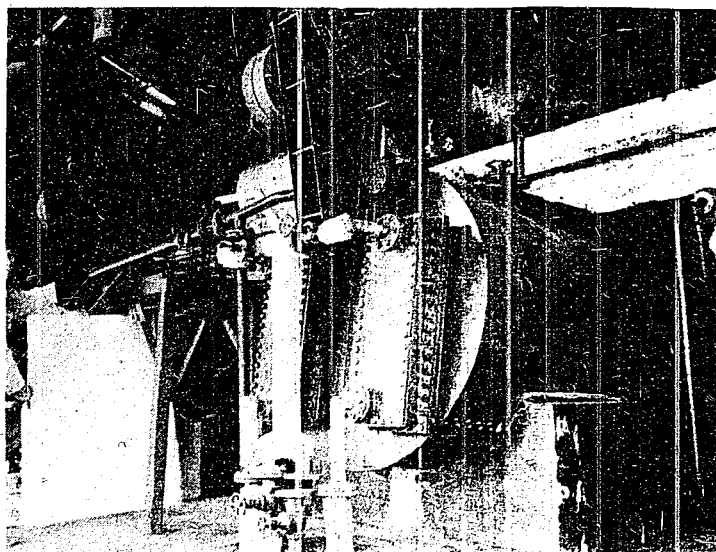


Figure 3(B)
TNT NITRATOR

ENCLOSURE (B), continued



Figure 4(B)
TNT PURIFICATION HOUSE

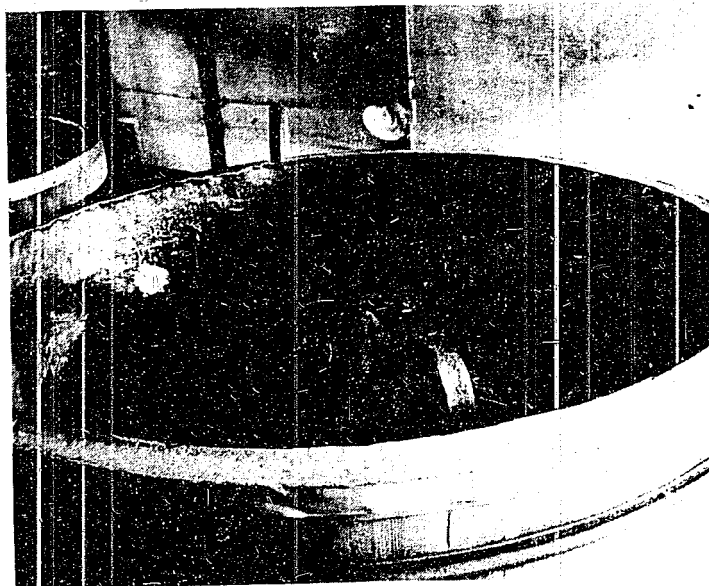


Figure 5(B)
TNT NATURAL COOLING GRAINERS

RESTRICTED

O-25

ENCLOSURE (B), continued

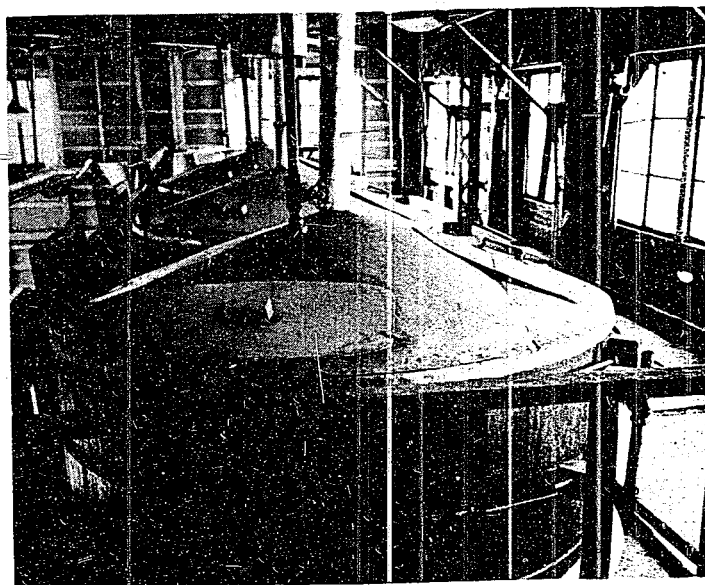
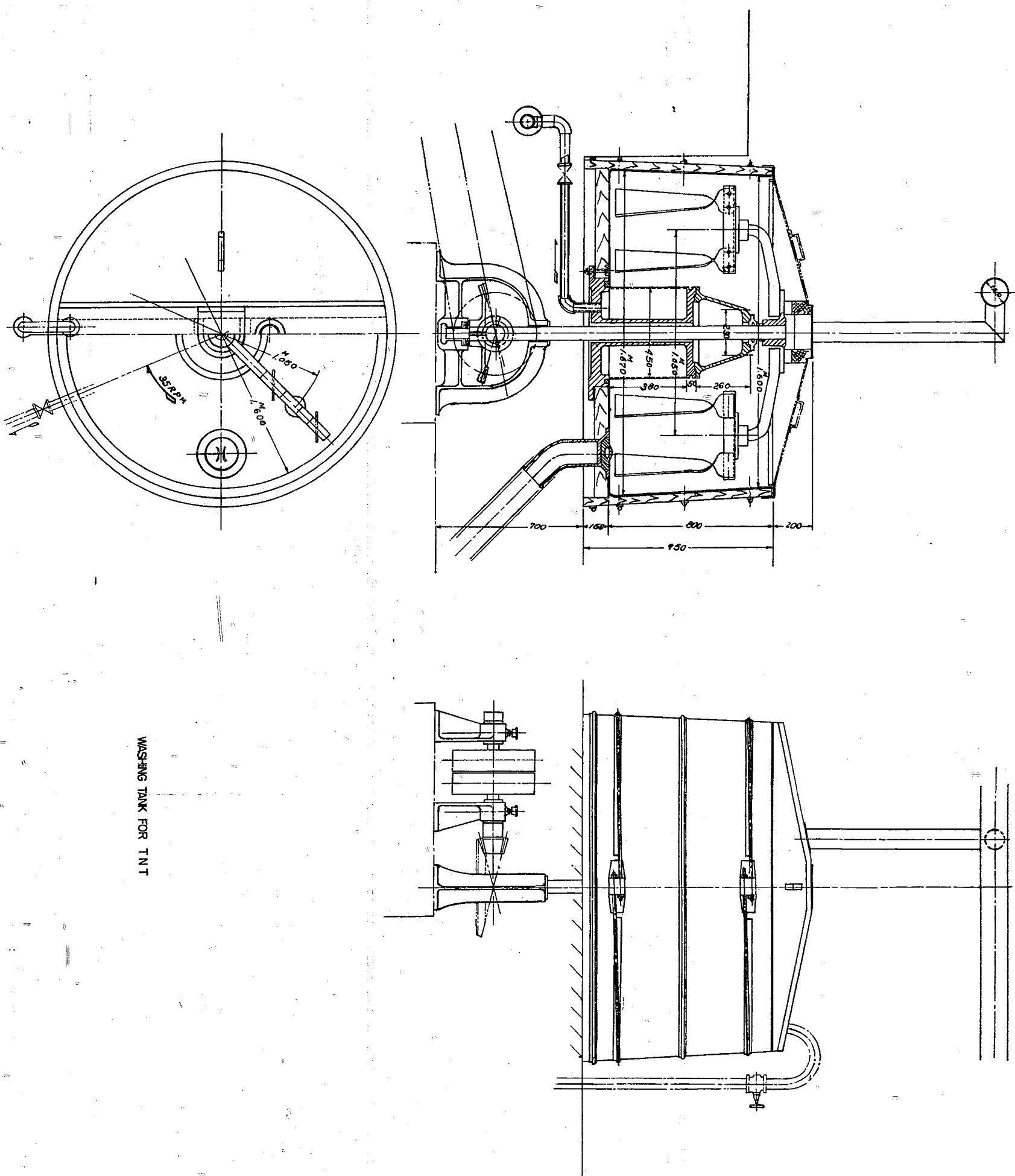


Figure 6(B)
TNT GRAINERS



WASHING TANK FOR TNT

