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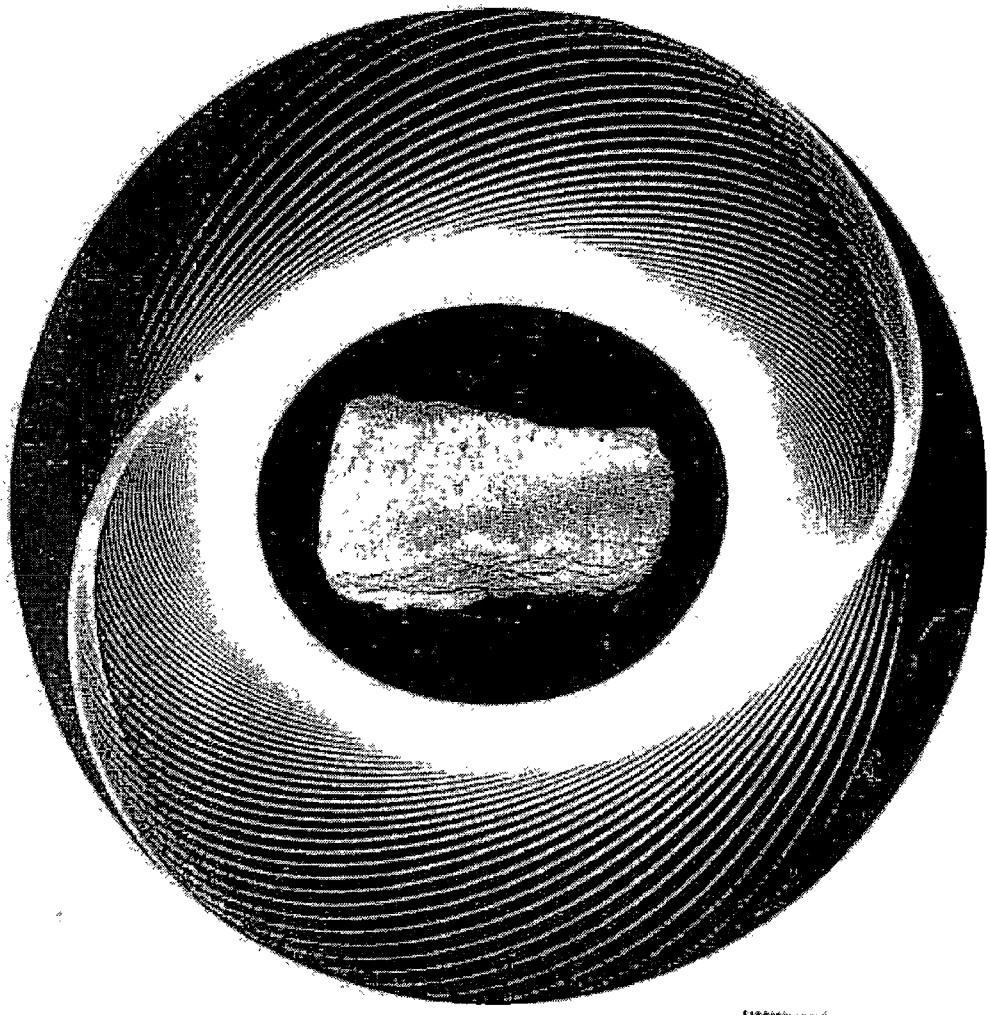
NYTAL



RTV 1966

FOREWORD

With talc now being recognized as a major component of ceramic whiteware bodies and paint formulations and finding increased use in other industries, we have decided, during this our 50th anniversary year, to put in book form our accumulated knowledge of this valuable and versatile raw material.

Although some of the information in this book emphasizes Vanderbilt materials, there is much that is of general interest to those who are concerned with the use of New York State talcs.

R. T. VANDERBILT COMPANY, INC.

June 1, 1966

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I INTRODUCTION

It is the purpose of this booklet to cover the talcs of the Gouverneur district of New York State. Talc is the common term used for this product but it must not be confused with the pure mineral talc.

NYTAL® is the trade name of the talc as produced by the Gouverneur Talc Company, Inc., subsidiary of the R. T. Vanderbilt Company, Inc., New York, N. Y.

II HISTORY

The State of New York ranks first in the United States in the production of talc and as far as is known, St. Lawrence County, or more specifically the Gouverneur area, is the largest producer of commercial talc in the world.

Talc mining in New York dates back to the last century. The first discovery of today's producing talc deposits is believed to have been made by a Colonel Henry Palmer, a participant in the California Gold Rush of 1849. Colonel Palmer[1] tells of his finding a white rock which he found suitable for paper making. In 1878 he and associates opened up the first commercial talc mine in New York State on the Nelson Freeman farm near Talcville.

From this humble beginning grew what is now considered to be the most productive talc area in the world. In the fall of 1948, Gouverneur Talc Company, Inc., began producing talc from a new, completely modern plant at Balmat, New York. With only two producers of talc in the State, government figures do not reveal the actual tonnage produced. However, it is reliably estimated that several hundred thousand tons of talc are shipped annually from this area, approximately half of this amount going to the ceramic industry and half to the paint industry. A small amount goes into the rubber, paper and miscellaneous industries.

Figure No. 1 shows the location of this Gouverneur district.

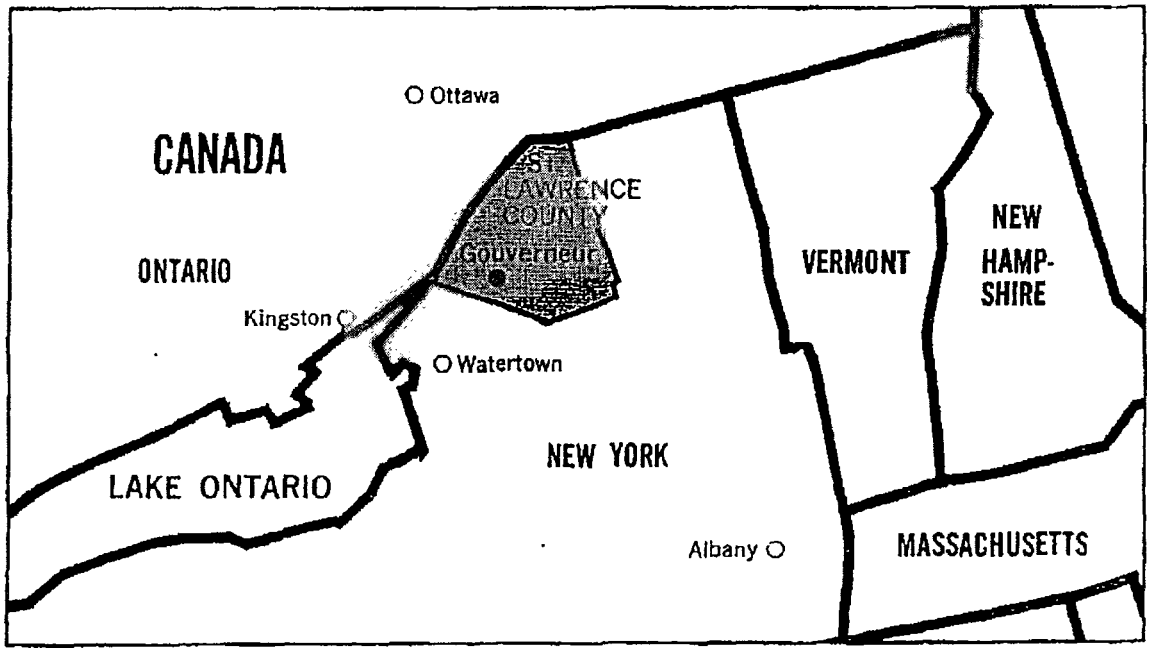


Figure 1—New York Talc Area

III GEOLOGY & MINERALOGY

Talc is usually thought of as a soft material, and pure talc is the starting point on Mohs' scale where it is indicated as having the hardness of one. However, New York tremolitic talcs — meaning talcs containing appreciable amounts of combined lime — are quite hard, running as high as six on the Mohs' scale.

Ries, Tarr and Lindgren[2] have pointed out that these talc deposits occur in schistose layers of enstatite and tremolite gradually merging into the surrounding crystalline limestone. The most abundant country rocks of this area are pre-Cambrian gneisses, the greater portion of which are impure. The limestones have been replaced locally by enstatite and tremolite which later were altered to talc, this change being represented by the following equations:

Enstatite → Talc

$$4MgO \cdot SiO_2 + H_2O + CO_2 \longrightarrow 3MgO\ 4SiO_2\ H_2O + MgCO_3$$

Tremolite → Talc

$$CaO\ 3MgO\ 4SiO_2 + H_2O + CO_2 \longrightarrow 3MgO\ 4SiO_2\ H_2O + CaCO_3$$

Petrographic and X-ray examinations of ores of these deposits have shown them to contain three principal minerals:

Talc	$3MgO\ 4SiO_2\ H_2O$	SiO_2	63.5%
		MgO	31.7
		H_2O	4.8
Tremolite	$CaO\ 3MgO\ 4SiO_2$	SiO_2	57.7%
		MgO	28.9
		CaO	13.4
Antigorite (Serpentine)	$3MgO\ 2SiO_2\ 2H_2O$	SiO_2	43.5%
		MgO	43.5
		H_2O	13.0

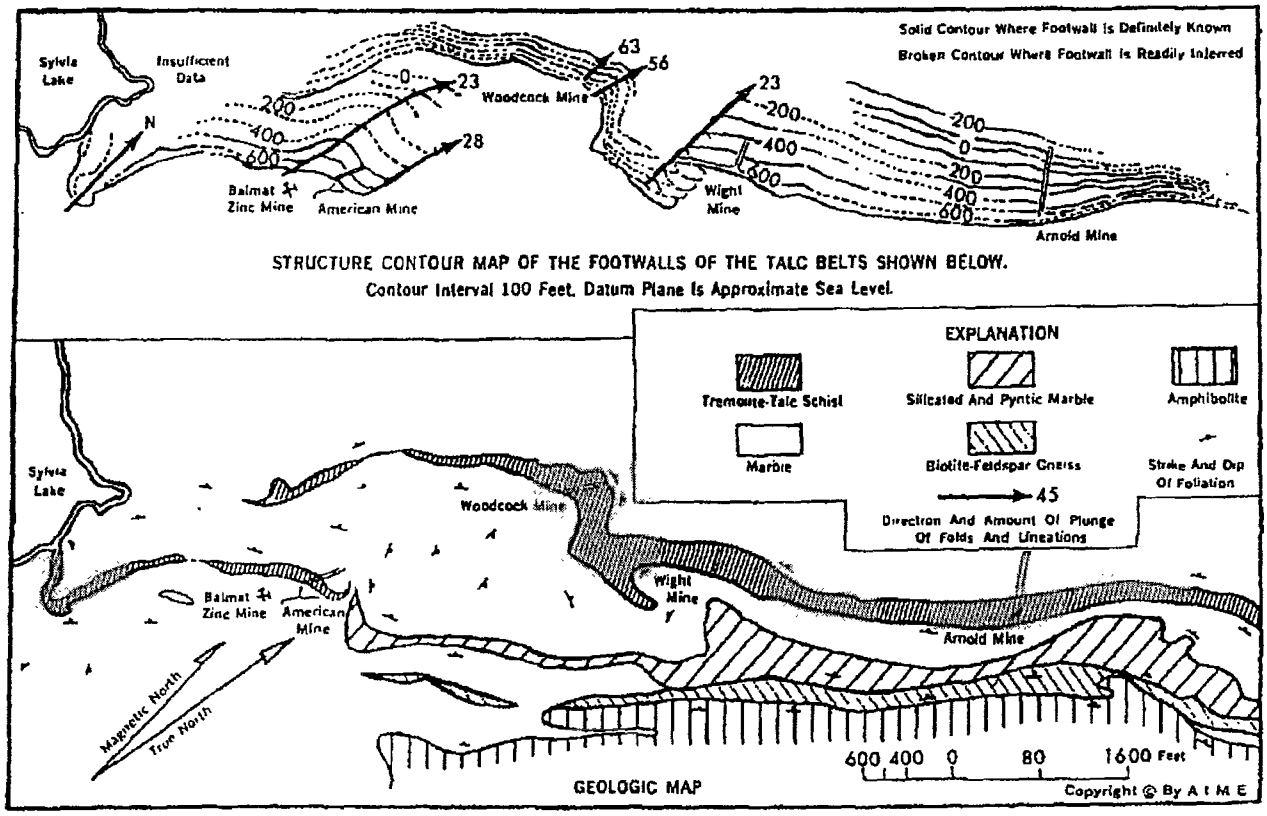


Fig. 2—Geological Features Of The Area North Of Balmat, New York

In addition to the above, many calcium and magnesium bearing minerals may be present in small amounts such as calcite, dolomite, magnesite, brucite, apatite, gypsum, phlogopite, periclase, and hexagonite. Therefore, it is quite evident that these talc deposits may easily contain two or more minerals in greatly varying amounts, depending upon the extent to which the above reactions have taken place. Extreme care in blending is, therefore, essential in producing a satisfactory commercial product.

Mineral Composition of NYTAL 100

Early in the development of the "NYTAL" ore body, samples were submitted to the Department of Geology, Columbia University and they reported the following mineral composition:

Talc	— On the order of one-third
Tremolite	— On the order of one-third
Antigorite	— Less than one-third
Magnesite	— About 5 per cent
Apatite	— Minor constituent
Periclase	— Minor constituent
Brucite	— Minor constituent
Phlogopite	— Minor constituent

At a later date Dolomite, Calcite, Hexagonite, Rhodonite and Gypsum were also found to be present in minor amounts.

Engel[2] states that the zones of commercial talc pinch and swell, and curve in sinuous to complexly folded patterns, as shown in Figure No. 2, but are rudely conformable with adjoining marble layers. The talc zones have a composite strike length of more than five miles, a probable extent down dip in excess of 2,000 feet, and widths of as much as 400 feet. Dips along the talc belts are quite variable, ranging from the horizontal through the vertical, but averaging about 45 degrees to the northwest.

Variations in thickness of the talc belts or of any included zone may be either abrupt or gradual. The belt near Talcville, which contains one producing mine, varies up to 300 feet or more in thickness, averaging perhaps 135 feet thick in the mines. Much of this thickness is commercial talc. A talc belt north of Balmat and southeast and east of Fowler, along which are 2 active mines, varies up to at least 425 feet in thickness, and averages possibly 125 feet, figure 2. In this belt, however, one of several zones of commercial talc 6 to 25 feet thick, or rarely as much as 75 feet thick, are interlayered with impure or discolored non-commercial zones within the belt. Within these two belts are talc reserves sufficient to last several generations at the present rate of production, under resourceful mining methods.

IV PROPERTIES

Composition

Talc has the theoretical formula of

$3MgO$	$4SiO_2$	H_2O
31.7%	63.5%	4.8%

1. Chemical Analyses

NYTAL, being a tremolitic talc, has the average chemical analyses as follows:

PER CENT	NYTAL 99	NYTAL 100	NYTAL 100HR	NYTAL 200	NYTAL 300	NYTAL 400
SiO_2	57.3	56.6	56.6	57.5	56.5	57.5
MgO	28.4	29.4	29.2	28.3	29.0	28.4
CaO	8.0	7.6	8.0	7.2	7.8	6.8
Fe_2O_3	0.3	0.3	0.3	1.5	.2	1.6
Al_2O_3	0.6	0.5	0.5		.7	
MnO	0.3	0.3	0.3	0.3	0.2	0.2
Na_2O	0.3	0.2	—	0.2	—	0.2
Ignition Loss	4.8	5.1	5.1	5.0	5.6	5.3
	100.0	100.0	100.0	100.0	100.0	100.0

General Appearance

1. Raw Ore

As previously stated there are many types of ore blended to produce the usable commercial talc. The two most distinctive types are a hard, grey, massive type mined for the ceramic industry (Figure No. 3) and the soft, shiny, foliated type mined for the paint industry (Figure No. 4).

There is a great difference in the chemical composition of the three major minerals. There is also a vast difference in their physical and pyro-physical properties. Rogers and Kerr[1] give the following description of these three minerals when viewed under the microscope.

> "*TALC* occurs in coarse to fine platy or fibrous aggregates. Talc greatly resembles muscovite (mica) and pyrophyllite. It may be necessary to make a chemical test in order to prove the identity of talc."
>
> "*Tremolite* occurs in long prismatic crystals and columnar to fibrous aggregates. Asbesti-

RAW ORES

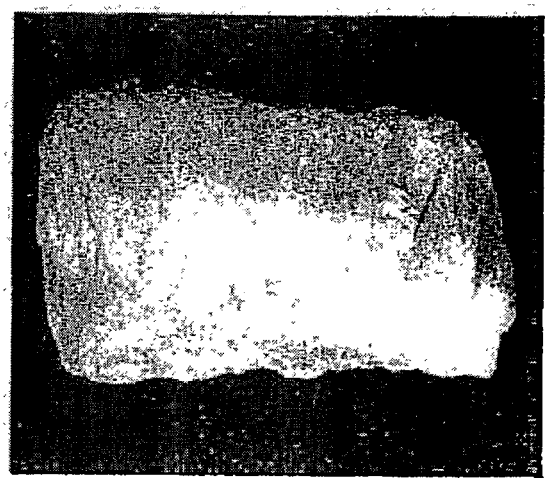


Figure 3—Hard Ore

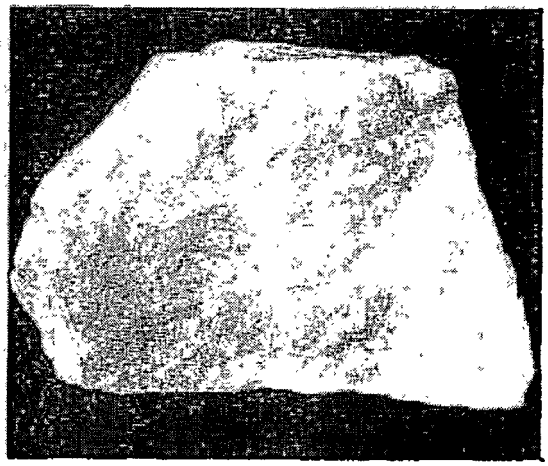


Figure 4—Soft Ore

form varieties are common. Tremolite has the same general appearance as wollastonite."

Antigorite occurs in anhedral crystals or aggregates of fibrolamellar structure. It often occurs as pseudomorphs after pyroxene, olivine, etc."

A wide variation in the unctuousness of these minerals has proven to be the physical property hardest to control and one of the most important as it greatly affects both pressing and casting properties of ceramic bodies.

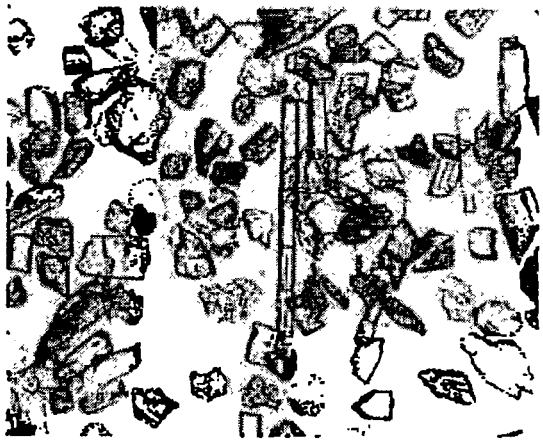


Figure 5—Nytal 99.

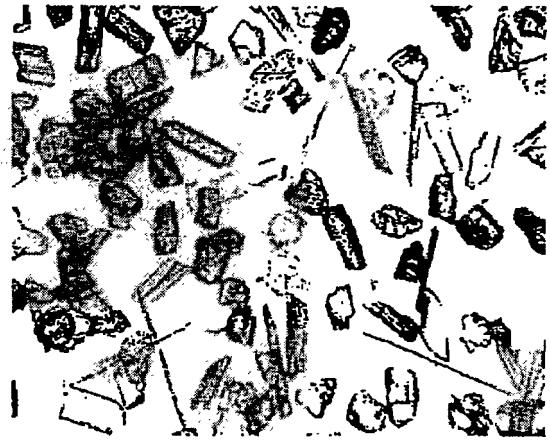


Figure 6—Nytal 100

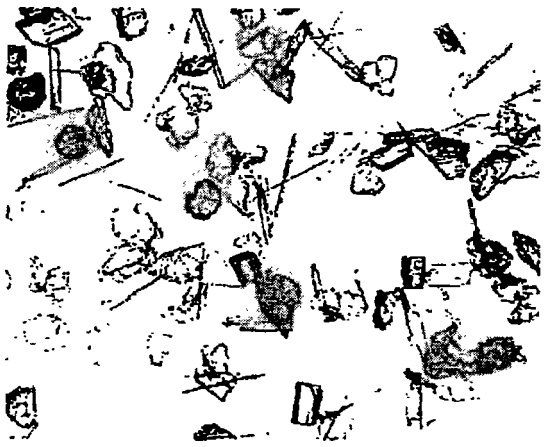


Figure 7—Nytal 300

2. Ground Talc

Figures No. 5, 6 and 7 show photomicrographs of 325 mesh residues of NYTAL 99, 100 and 300 respectively. Print magnification = 90X.

In their study of Gouverneur talcs, Stemple & Brindley[4] state:

> "Electron Micrographs have shown that talc particles exhibit a variety of platy forms and fibrous forms also exist. Single crystal electron diffraction patterns have proven that the fibrous particles consist of a close association of talc and tremolite with a simple orientational relation between the components. It is shown that this relation can be interpreted in terms of a simple structural transformation from tremolite to talc."

Grades Of Nytal Talc

NYTAL 99	Coarse Fraction of NYTAL 100
NYTAL 100	Present Standard for ceramic tile
NYTAL 100 HR	Special for Casting Slips
NYTAL 200	Coarse ground Paint grade
NYTAL 300	Fluid-energy ground Paint grade
NYTAL 400	Super-fine Paint grade

Physical Properties

1. Hardness — 1 to 6 on Mohs' scale
2. pH — 9.2 to 9.8

3 & 4. The Specific Gravity And Bulking Data on Grades of Nytal Talc

GRADES	SPECIFIC GRAVITY	BULK LBS. PER CU. FT.	
		LOOSE	COMPACTED
NYTAL 99	2.89	65.	79.
NYTAL 100	2.84	50.	71.
NYTAL 100HR	2.86	51.	73.
NYTAL 200	2.85	28.	53.
NYTAL 300	2.85	22.	50.
NYTAL 400	2.85	12.	36.

5. Screen Analyses

% RESIDUE	NYTAL 99	NYTAL 100	NYTAL 100HR	NYTAL 200	NYTAL 300	NYTAL 400
On 200 Mesh	2.0- 3.7	2.1- 2.8	1.7- 3.0	0.2 Max	0.00 Max	0.00 Max
On 325 Mesh	19.0-26.0	15.0-25.0	15.0-26.0	2.0	0.06	0.01

6. Particle Size by Sedimentation

	NYTAL 99	NYTAL 100
Finer Than 49 Microns, %	67	81
Finer Than 28 Microns, %	46	63
Finer Than 22 Microns, %	39	52
Finer Than 15 Microns, %	24	43
Finer Than 11 Microns, %	19	35
Finer Than 7.7 Microns, %	16	31
Finer Than 6.3 Microns, %	15	26
Finer Than 5.1 Microns, %	13	23
Finer Than 4.4 Microns, %	13	21
Finer Than 3.6 Microns, %	13	20
Finer Than 3.1 Microns, %	13	18
Finer Than 2.8 Microns, %	—	18
Finer Than 2.6 Microns, %	—	18
Finer Than 2.2 Microns, %	—	13
Finer Than 1.3 Microns, %	—	12

	NYTAL 200	NYTAL 300	NYTAL 400
Finer Than 20 Microns, %	86	95	....
Finer Than 10 Microns, %	62	73	93
Finer Than 7 Microns, %	49	58	81
Finer Than 5 Microns, %	39	46	66
Finer Than 3 Microns, %	29	32	46
Finer Than 2 Microns, %	25	25	35
Finer Than 1 Micron, %	....	....	24

Figure No. 8 shows particle size distribution of all NYTAL grades.

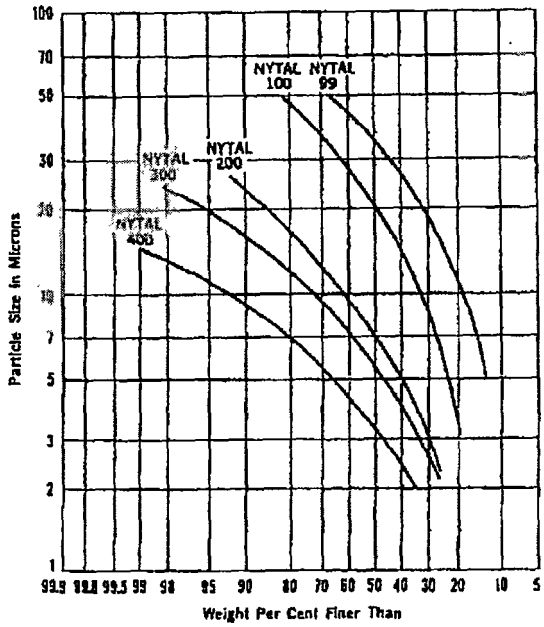


Figure 8—Particle Size Distribution. Determined by Hydrometer Sedimentation.

7. Optical Properties[1]

PURE TALC

$Mg_3(OH)_2(Si_2O_5)_2$ — Monoclinic, $\angle\beta$ = (?)

n_α = 1.538 to 1.545

n_β = 1.575 to 1.590

n_γ = 1.575 to 1.590

2V = 6 to 30°: Opt. (—)

a = β or Y, b = γ or Z, c = α or X

Color—Colorless in thin sections.

Form—Talc occurs in coarse to fine platy or fibrous aggregates that often have a more or less parallel arrangement. Shreds and plates are often bent. Euhedral crystals of talc are unknown.

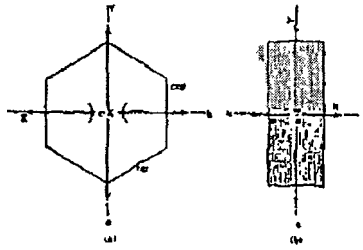


Figure 9—Orientation Diagrams of Talc. Sections Parallel to (a) (001) and (b) (010)

Cleavage perfect in one direction {001}.

Relief fair, n > balsam.

Birefringence very strong, $n_\gamma - n_\alpha$ = 0.030 to 0.050; the maximum interference colors are upper third order. Sections parallel to the cleavage give very low first-order gray colors since $n_\gamma - n_\alpha$ is almost nil (0.000x).

Extinction—The extinction is parallel to the cleavage traces in most sections; in a few sections the extinction is 2 or 3°; hence talc is probably monoclinic.

Orientation—Cleavage traces and shreds are length-slow as in muscovite.

Interference Figure—Cleavage flakes give a biaxial negative figure with a small axial angle. Dispersion, $r > v$ distinct.

Distinguishing Features—Talc greatly resembles muscovite and pyrophyllite, but may often be distinguished by the smaller axial angle provided an interference figure can be obtained.

It may be necessary to make a chemical or microchemical test in order to prove the identity of talc. The association with other magnesium minerals indicates the presence of talc rather than muscovite or sericite.

Occurrence—Talc is the principal constituent of talc schists and soapstones. It is often a hydrothermal mineral formed at the expense of antigorite and tremolite in shear zones of serpentines. Dolomite and magnesite are frequent associates.

TREMOLITE-ACTINOLITE

$Ca_2(Mg,Fe)_5(OH)_2(Si_4O_{11})_2$ — Monoclinic, $\angle\beta$ = 74°48'

n_α = 1.600 to 1.626

n_β = 1.613 to 1.644

n_γ = 1.625 to 1.655

2V = 79 to 55°; Opt. (—)

b = β or Y, c = γ, or Z = —10 to —20°

Color—Colorless to pale green in thin sections. The green varieties show faint pleochroism. Green ferriferous tremolite is known as *actinolite*.

Form—Tremolite-actinolite occurs in long prismatic crystals and columnar to fibrous aggregates. Asbestiform varieties are common. The typical cross section is rhombic with (110 ∧ 1$\bar{1}$0) = 56°.

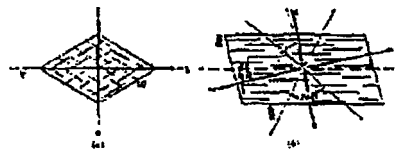


Figure 10—Orientation Diagrams of Tremolite-Actinolite. Sections (a) Normal to the c-Axis and (b) Parallel to (010)

Cleavage {110} in two directions at angles of about 56 and 124°. Longitudinal sections show cleavage traces parallel to the length. There may be parting parallel to {100}.

Relief fairly high, n > balsam.

Birefringence moderate to rather strong, $n_\gamma - n_\alpha$ = 0.022 to 0.027; so the interference colors range up to low or middle second order. Narrow longitudinal sections show the highest colors. Cross sections have white to yellow interference colors.

Extinction—The maximum extinction in longitudinal sections varies from 10 to 20°. A few longitudinal sections have parallel or nearly parallel extinction. Cross sections have symmetrical extinction.

Orientation—Elongated crystals are length-slow. In cross sections the long diagonal is the slower ray.

Twinning—Twins with {100} as twin-plane are frequent. Fine polysynthetic twinning with {001} as twin plane is occasionally encountered.

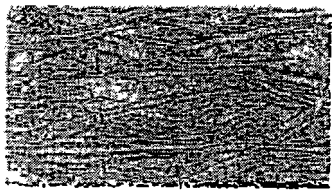


Figure 11—(X17) Tremolite

Interference Figure—Tremolite-actinolite gives a biaxial negative figure with very large axial angle. The axial plane is {010}. Dispersion, $r < v$ weak. Broad elongate sections with low interference colors give the best figure.

Distinguishing Features—The extinction angle and amphibole cross sections are characteristic. Wollastonite has the same general appearance as tremolite, but the trace of the optic axial plane is normal to the cleavage instead of parallel to it as in tremolite.

Related Minerals—A colorless amphibole, edenite, greatly resembles tremolite but has larger extinction angles.

Alteration—Tremolite-actinolite is sometimes found altered to talc.

Occurrence—Tremolite-actinolite occurs in contact-metamorphic deposits, in schists and gneisses, and in metamorphic limestones. It is also found as a replacement of pyroxene in igneous rocks.

ANTIGORITE

(Serpentine in part)

$H_4Mg_3Si_2O_9$ — Orthorhombic

n_α = 1.555 to 1.564

n_β = 1.562 to 1.573

n_γ = 1.562 to 1.573

2V = 20 to 90°; Opt. (—)

a = β or Y, b = α or X, c = γ or Z

Color—Colorless to pale green in thin sections.

Form—Antigorite occurs in anhedral crystals or aggregates of fibrolamellar structure. It often occurs as pseudomorphs after pyroxene (bastite).

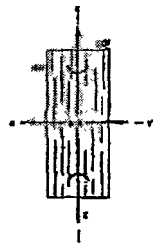


Figure 12—Orientation Diagram of Antigorite. Section Parallel to (010)

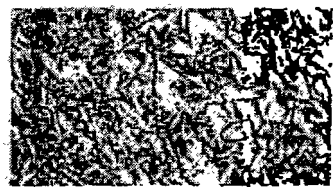


Figure 13—(X20) Antigorite in Serpentine (X Nicols)

olivine, etc.

Relief rather low, n > balsam.

Birefringence weak, $n_\gamma - n_\alpha$ = 0.007 to 0.009; the maximum interference color is first-order yellow. This yellow is slightly anomalous since it has a greenish tinge.

Extinction parallel.

Orientation—The crystals are length-slow.

Interference Figure—The figure is biaxial negative with variable axial angle. The axial plane is [100]. Dispersion, $r > v$ weak.

Distinguishing features—Chrysotile is distinguished from its dimorph antigorite by the fine fibrous structure. Antigorite usually shows aggregate structure and is in practically all cases an alteration product of some other silicate mineral. Serpophite has lower birefringence than antigorite and shows little or no form or structure.

Occurrence—Antigorite is the main constituent of serpentine, a metamorphic rock. It has been formed from olivine, enstatite, augite, etc., by hydrothermal alteration. Common associates are chrysotile, talc, magnetite, chromite, and picotite.

SERPOPHITE

(Serpentine in part)

$H_4Mg_3Si_2O_9$ — Amorphous (Mineraloid)

n = 1.50-1.57

Color—Colorless to very pale green in thin sections.

Form—Massive, almost structureless, often occurring in cores surrounded by antigorite.

Cleavage absent.

Relief very low, n > balsam, n < antigorite.

Birefringence nil to very weak, not over 0.003. Interference colors: either none or very low first-order gray.

Extinction—The extinction of serpophite is more

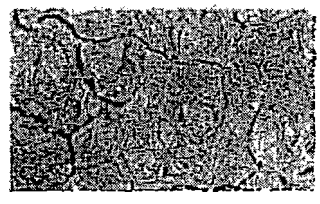


Figure 14—(X25) Serpophite (Clear Smooth Areas) and Antigorite (Rough Gray) With Secondary Magnetite in Serpentine

[1]"From OPTICAL MINERALOGY by Paul F. Kerr. 3rd Ed., Copyright © 1959, McGraw-Hill Book Company. Used by Permission."

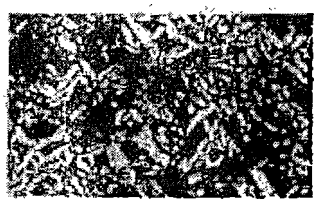


Figure 15 — Serpophite (Black or Dark Gray) With Lenticular Antigorite in Serpentine. (The Same Spot as Figure 14.) (X Nicols)

or less wavy and usually rather indefinite.

Distinguishing Features—Serpophite is distinguished from the other serpentine minerals by its very weak birefringence and its lack of structure.

Occurrence—Serpophite is one of the constituents of serpentine (used here as a rock name). It is usually intimately associated with antigorite.

◇◇◇◇◇

CHRYSOTILE

$H_4Mg_3Si_2O_9$ Orthorhombic

n_α = 1.493 to 1.546

n_d = 1.504 to 1.550

n_γ = 1.517 to 1.557

$2V_\gamma$ = 0 to 50°; Opt. (−)

Color—Colorless in thin sections.

Form—Chrysotile occurs in cross-fiber veinlets.

Relief low, n slightly greater than balsam.

Birefringence moderate, $n_\gamma - n_\alpha$ = 0.011 to 0.014; the maximum interference color is bright yellow of the first order.

Extinction parallel.

Orientation—The fibers are length-slow.

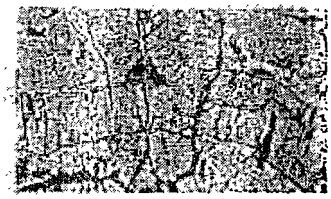


Figure 16 — (X30) Chrysotile Veinlets in Serpentine With Secondary Magnetite

Distinguishing Features—The other forms of asbestos (tremolite, anthophyllite, and crocidolite) all have higher indices of refraction than chrysotile. Tremolite has oblique extinction.

Occurrence—Chrysotile usually occurs in veinlets in serpentine that consists largely of the mineral antigorite.

"From OPTICAL MINERALOGY by Paul F. Kerr, 3rd Ed., Copyright © 1959, McGraw-Hill Book Company. Used by Permission."

Studying New York talc from Fullerville, Wright[14] disagrees with published optical data on talc. He also states where talc and tremolite occur there is no transition zone. Rather sharp boundaries of each are apparent.

8. X-Ray Diffraction

Dr. Ralph J. Holmes[5] furnished the NYTAL 99 and NYTAL 100 curves shown in Figure 17 along with standards.

NYTAL 99 is lower in Antigorite and higher in Tremolite than NYTAL 100. This is confirmed by their chemical analyses shown previously.

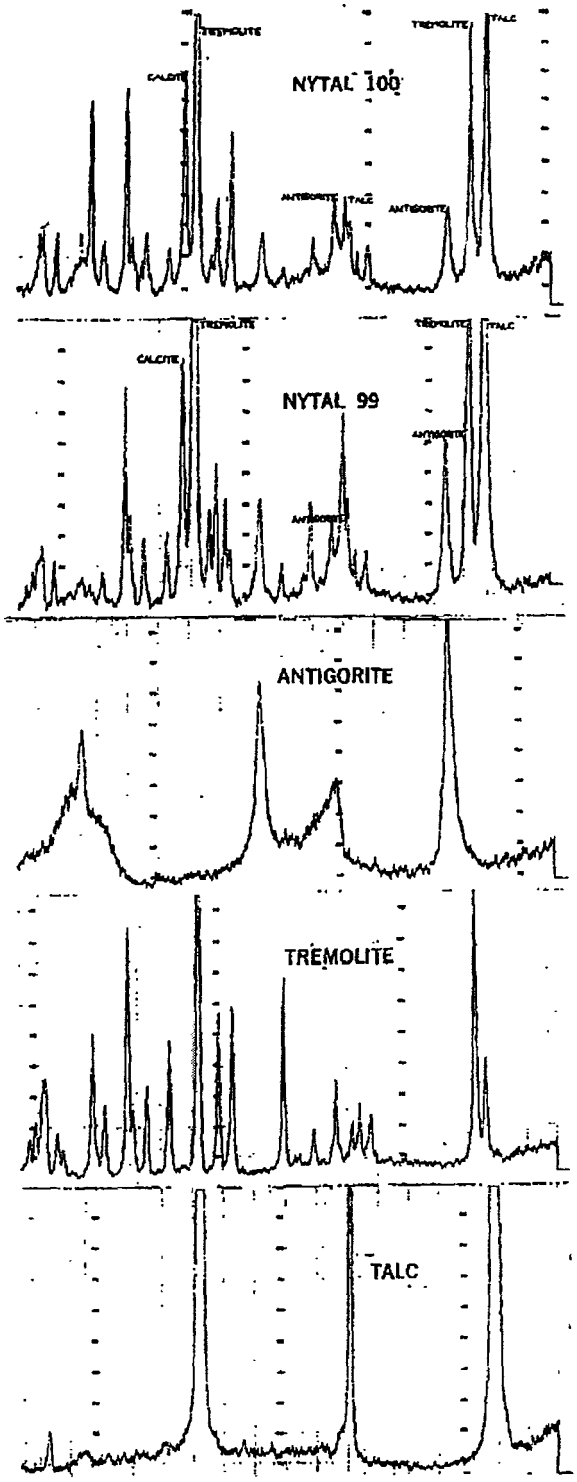


Figure 17—X-Ray Diffraction

V CERAMIC SECTION

INTRODUCTION

Talc is one of the most versatile raw materials used in ceramics today. By proper compounding very low or very high thermal expansion bodies can result, depending on one's need. By other compounding excellent electrical insulators result. During the past forty years talc has changed from a minor constituent to one of the most widely used materials in the whiteware field.

Pyro-Physical Properties

1. P. C. E. of NYTAL 100 — Cone 16
2. Loss on Ignition—Figure No. 18 shows relatively low ignition loss of N. Y. talc compared to that of Texas talcs.
3. Thermal Expansion

New York talc, due to its mode of formation contains little or no free silica. This condition results in a thermal expansion far more uniform than that of other ceramic materials such as clays, feldspars and pyrophyllites which contain varying amounts of free silica.

See Figure No. 19.

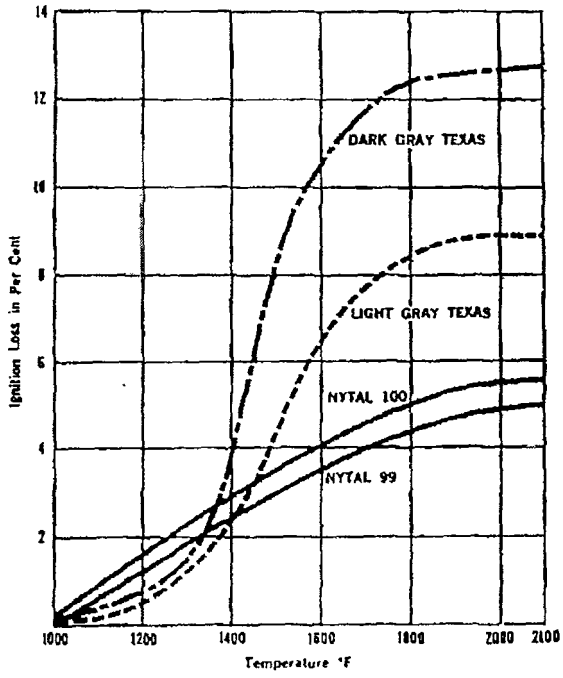


Figure 18—Ignition Loss on Texas Talcs and Nytal Talcs

4. Eutectic with Feldspar and Nepheline Syenite[4]

Figure No. 20 shows the effect of NYTAL 100 on the fusibility of North Carolina feldspar and Canadian nepheline syenite. Four parts of feldspar or syenite to one part of talc form the eutectic point.

5. Effect of Particle Size on Absorption of Electrical Porcelain Body.

Flint	22%
C-6 Conn. Feldspar	30
OM #4 Ball Clay	15
Bell's Dark Ball Clay	10
PEERLESS S. C. Kaolin	10
Lunday N. C. Kaolin	10
NYTAL Talc	3

Emrich & Hannon[6] show that the finer the grind of talc the more vitreous the body becomes. This effect is shown in Figure No. 21.

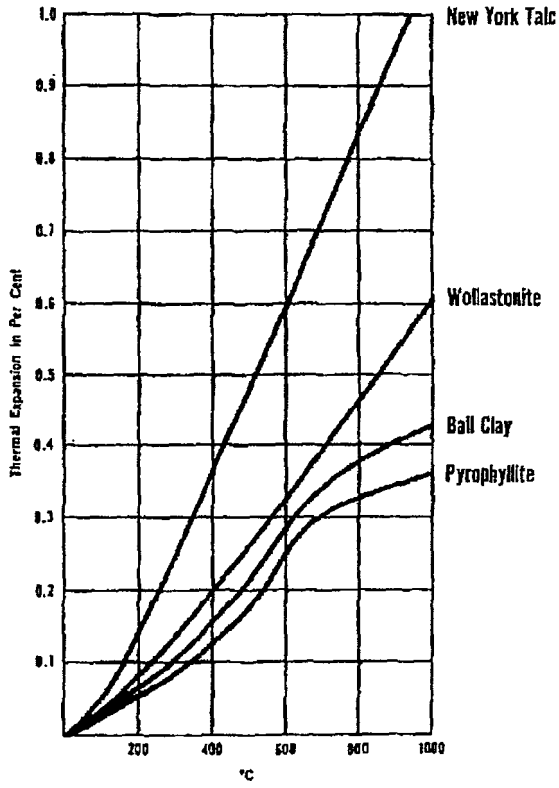


Figure 19—Thermal Expansion of Raw Materials

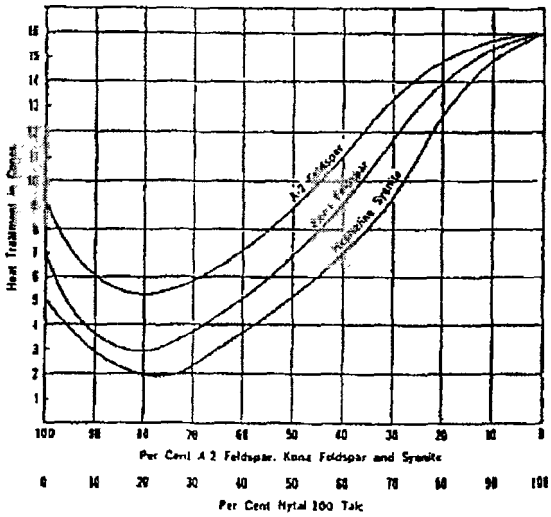


Figure 20—Fusion Behavior of Nytal 100 with A-2 Feldspar, Kona Feldspar, and Syenite

6. Differential Thermal Analysis—NYTAL 99 and NYTAL 100.

Dr. Robert L. Stone[5] reports:

"The legend on the thermogram (Figure No. 22) will serve to give the mineralogical compositions. The main difference in the two samples is that NYTAL 100 contains considerably more anthophyllite than NYTAL 99 plus, possibly, additional species of amphiboles.

The amphibole-serpentine suites that are possible in a talc rock are almost endless, and this renders interpretation very difficult. For example, anthophyllite and tremolite which are constituents of the talc, are both amphiboles; and I think there is another amphibole in these two samples. The reasoning is this: (1) anthophyllite has the exotherm at about 300° plus a doublet endotherm at about 1000° but none at 650°; (2) tremolite has a weak reaction (endo) at 700° plus a strong endo at 1100°; (3) some amphiboles show a moderate endo at 650° plus the endo at 1100°; (4) serpentines, particularly chrysotile, show the 650 endo plus a strong exo at 830°C, the intensity of which varies with crystallite size; (5) the 650-700 endo in the present samples is larger than would be accounted for by the small amount of calcite plus the chrysotile; and (6) the endo at 1100 is a doublet. I might add that the unlabelled endo at 750° may be attributed to either an amphibole or to a serpentine—it doesn't coincide with a peak of any mineral in my collection which would occur in talc ore."

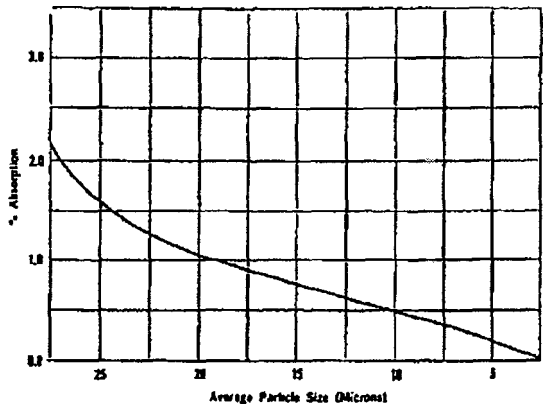


Figure 21—Effect of Particle Size of New York Talc on Absorption of Electrical Porcelain Body Fired to Cone 6

Pask and Warner[7] state that DTA is the most informative method for determining the composition of talcs because of the sensitivity of the samples to thermal effects and lack of complete dependence on regularity of structure.

7. Thermal Decomposition of Pure Talc

Ewell, Bunting & Geller[10] summarized their investigation as follows:

"A sample of a nearly pure talc was investigated both unheated and after heating at 18 temperatures from 340° to 1,435° C. The studies included the determination of heat effects, weight losses, and changes in true specific gravity occurring on heating talc. X-ray and microscopical examinations were made of the heated samples.

Water in excess of 1 molecule was mostly driven off between 380 and 500°C. This water loss was accompanied by a small endothermic heat effect, but not by any change in crystal structure or optical properties.

The molecule of combined water was driven off between 800° and 840°C. This water loss was accompanied by a large endothermic heat effect and an increase in true specific gravity from 2.83 to 2.91, and by breakdown of the talc into enstatite and amorphous silica.

Inversion of the enstatite to clinoenstatite took place gradually, both phases being observed in material heated at 1,200°C, and only clinoenstatite in material heated at 1,300°C. The material heated at 1,300°C also showed conversion of the amorphous silica to cristobalite. Thus, the final products of the thermal decomposition of talc are clinoensta-

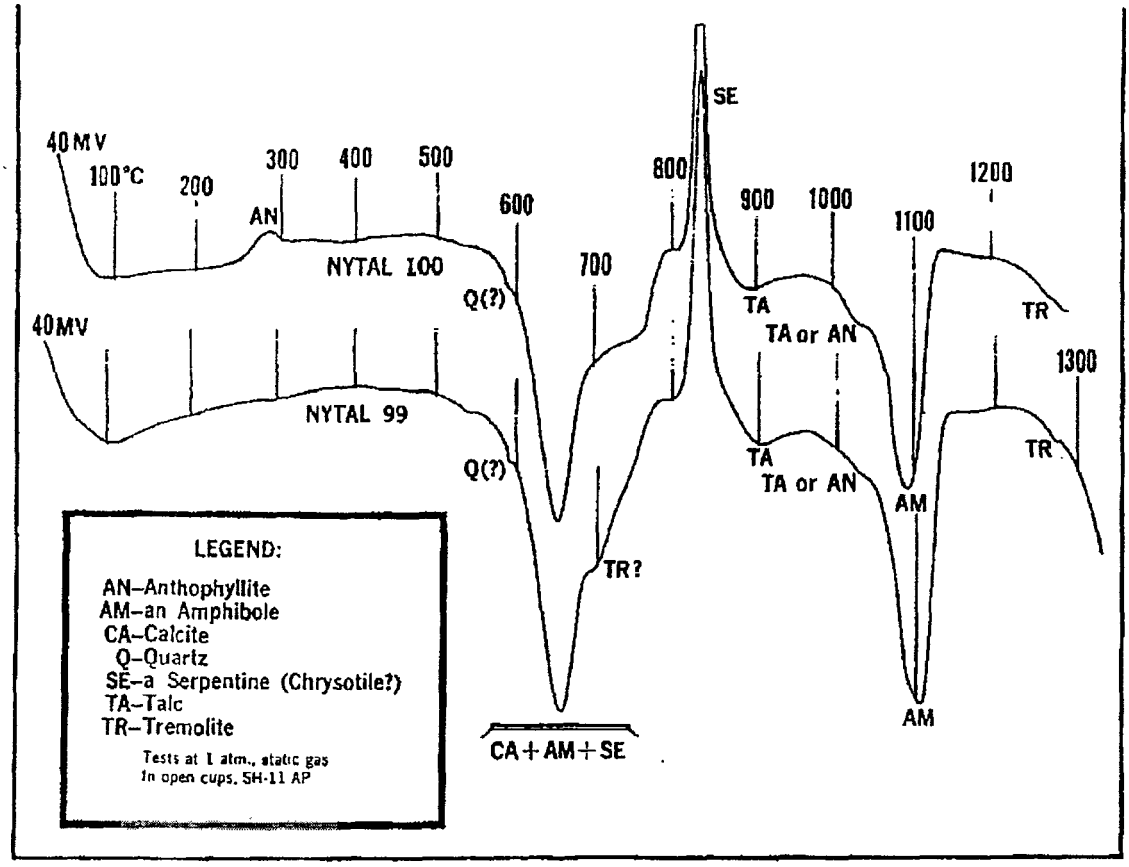


Figure 22—**Differential Thermal Analysis**

tite and cristobalite. There was a further gradual increase in the true specific gravity from 2.91 to 3.01 on heating from 840° up to the highest temperature, 1,435°C.

The data support the hypothesis of Foshag and Wherry that water in talc in excess of 1 molecule is not constitutional and may be held electrostatically between basal cleavage planes."

Paul Eno[11] reports from his study of NYTAL 100 that

> "The principal phase present in the fired talc is clinoenstatite. This polymorph of enstatite is found to form pseudomorphically from the talc with the original form and grain size of the talc remaining essentially unchanged."

An unusual phenomenon occurs in the heating up of New York talc which aids in it being used as a reliable ceramic raw material. As stated previously when talc is heated above Cone 06 it inverts to clinoenstatite and cristobalite. Tremolite inverts to clinoenstatite, diopside and cristobalite[12]. No information has been published on the action of Antigorite under heat but thermal expansion curves indicate it also inverts to clinoenstatite.

Therefore, it is to be noted that although one starts with three different minerals, upon heating above Cone 06, only one principal mineral phase remains, namely clinoenstatite.

This is graphically shown in Figure No. 23 where the moisture expansion is affected considerably by firing a high talc body to Cone 06 and 05 with little or no change in shrinkage and absorption.

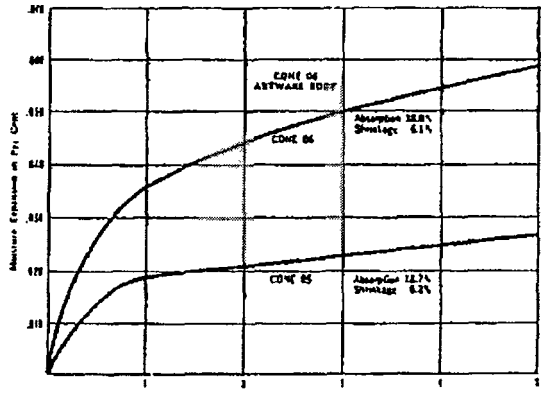
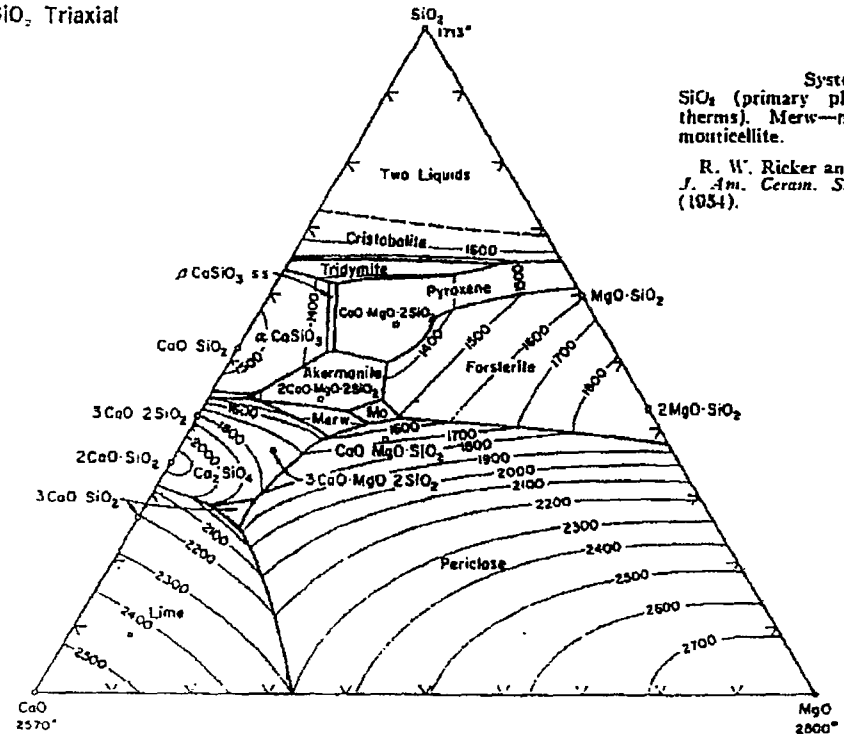


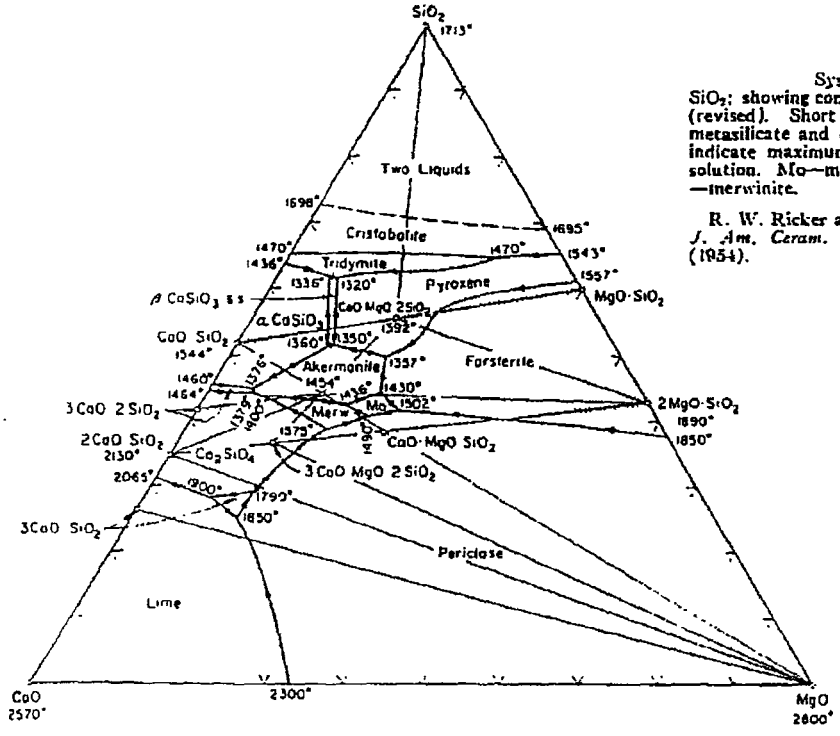
Figure 23

8. CaO-MgO-SiO_2 Triaxial



System CaO–MgO–SiO_2 (primary phases and isotherms). Merw—merwinite; Mo—monticellite.

R. W. Ricker and E. F. Osborn, *J. Am. Ceram. Soc.*, 37 [3] 134 (1954).



System CaO–MgO–SiO_2: showing composition triangles (revised). Short cross lines along metasilicate and orthosilicate joins indicate maximum extent of solid solution. Mo—monticellite. Merw—merwinite.

R. W. Ricker and E. F. Osborn, *J. Am. Ceram. Soc.*, 37 [3] 134 (1954).

Figure 24

Use in Whiteware

1. Semi-Vitreous Ware

Emrich[14] reports that the greatest amount of ceramic grade New York talc goes into the semi-vitreous whiteware field, especially wall tile. It has been found to be an ideal raw material for the following reasons:

1. The formation of enstatite produces high thermal expansion bodies resulting in glazes being put in compression which in turn tends to prevent crazing.

2. Low moisture expansion bodies are produced resulting in good resistance to delayed crazing.

3. The hard, massive nature of the ore aids in either dry-pressing or in the making of good casting slips.

4. Low firing temperatures are possible.

5. Fast firing schedules are possible—as fast as one hour cold to cold.

6. Shrinkage and absorption of bodies are fairly constant over a long temperature range.

7. Good white fired bodies are possible.

8. Glazes of unusual brilliance and attractiveness can readily be fitted to high talc bodies.

As far back as 1936 Hagar[15] reported the improved craze-resistance of semi-vitreous bodies when New York talc was used.

A minor use of talc is as an addition to the clay-flint-feldspar type of dinnerware bodies. It is added up to 6% of the body resulting in greatly improved craze resistance.

TYPICAL SEMI-VITREOUS BODIES

	Wall Tile	Wall Tile	Wall Tile	Art Pottery	Art Pottery	Dinner-ware
Flint	17			5		33
NYTAL 99	35	70	67			
NYTAL 100HR				43	64	4
Ball Clay	24	30	28	30	32	32
HS PYRAX Pyrophyllite	16					
Whiting	8				4	
Wollastonite			5			
PEERLESS Kaolin				12		10
Feldspar				10		11
Georgia Kaolin						10
Firing Range-Cones	3-5	03-1	03-1	02-1	06-04	7-8
% Shrinkage	0.0	1.0	0.7	8.5	6.2	11.0
% Absorption	16.5	13.0	13.4	10.0	18.7	8.5

2. Vitreous Ware

Another minor use of talc is as an auxiliary flux. Emrich and Hannon[6] state there are two factors which influence the effect of talc:

(1) Its eutectic point with the principal fluxing agent

(2) The fineness of grind of the talc

Both of the above factors were taken up earlier in this booklet.

TYPICAL VITREOUS BODIES

	High Alumina	High Alumina	Electrical Porcelain	Vitreous China	Sanitary Ware	Translucent Artware
Dolomite	3					
Al_2O	85	90				
Flint			22	36	18	5
Feldspar	3		30	17	27	
Nepheline Syenite						46
Ball Clay			25	8	25	15
PEERLESS Kaolin	6	5.5	10		16	25
N. Carolina Kaolin			10	10	8	
Florida Kaolin				10		
English China Clay				11		
NYTAL 100	3	4.5	3	8	6	9
Firing-Cone	18	27	9	10	10	4
% Shrinkage	18.5	13.0	13.3	14.8	12.0	14 7
% Absorption	0.0	0.0	0.0	0.0	0 0	0.0

3. Preparation of Cone 06-04 Artware Casting Slip

Batch:	
NYTAL 100 HR Talc	64.0 lbs.
Tenn. #5 Ball Clay	16.0
Kentucky OM #4 Ball Clay	16.0
Imported Whiting	4.0
	100.0
Water	44.0 lbs.
DARVAN #7 dispersing agent	0.0 lbs. 14 oz.
Sp. Gr. 1.800 Oz./Pint	29.98

Mix 4 oz. of DARVAN with all the water. Due to the slower wetting property of talc, it should be soaked prior to making up the complete slip. Slowly add the NYTAL to the water while stirring and then allow the talc to soak for at least ½ hour.

After soaking, the remainder of the DARVAN is added. Then the ball clays and whiting are added while stirring and the batch is thoroughly mixed until a smooth slip is produced.

The amount of DARVAN may vary due to differences in local waters.

When made up in this way, an excellent, stable casting slip for both drain and solid cast is produced.

Figure No. 25 shows the effect of soaking of talc on the amount of dispersing agent required.

Figure No. 26 shows the effect on the viscosity of sanitaryware slip when talc is added to the body.

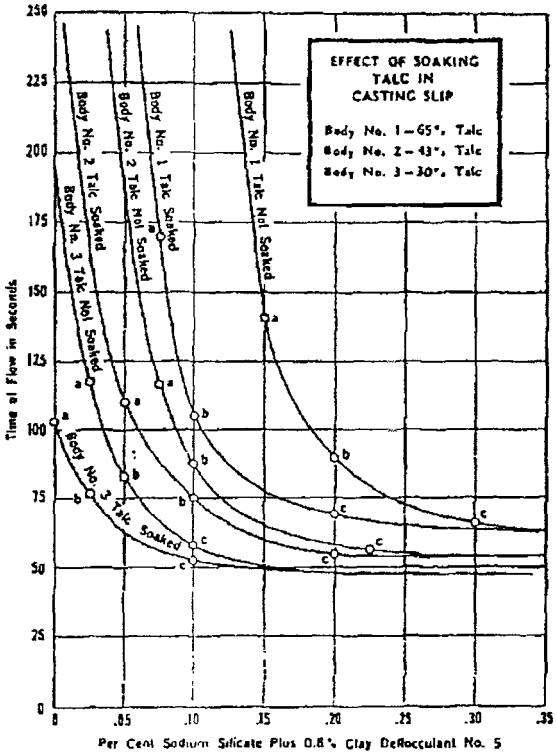


Figure 25—Effect of Soaking of Talc on the Amount of Dispersing Agent Required

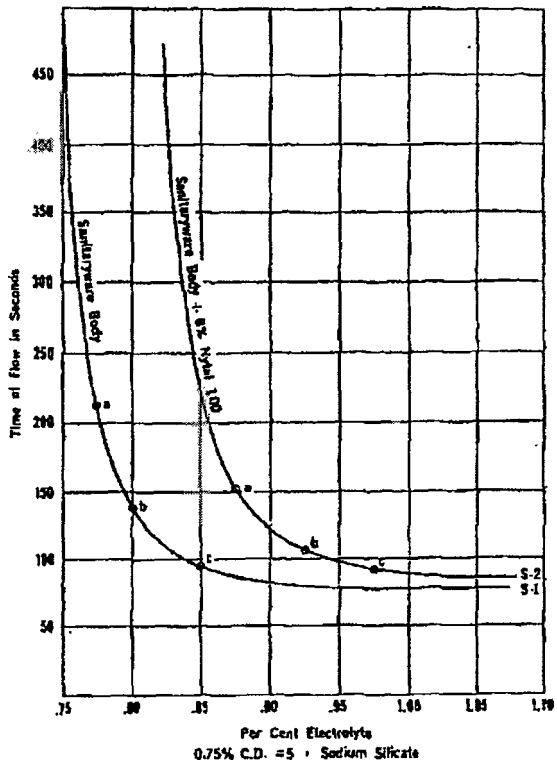


Figure 26—Effect on the Viscosity of the Sanitaryware Slip When Talc Is Added to the Body

	S-1	S-2
"Jasper" Flint	18.0%	18.0%
A-2 Feldspar	33.0	25.0
Ky. Tenn. Clay Co. #4 Ball	10.0	10.0
Victoria Ball Clay	8.0	8.0
Martin #5 Ball Clay	7.0	7.0
Lunday N. C. Kaolin	8.0	8.0
"PEERLESS" Kaolin	16.0	16.0
"NYTAL" 100 Talc		8.0

4. Glaze Ingredient

Talc is used in glazes as a cheap source of MgO whenever magnesia is called for in the formulation.

5. Mold Dusting Compound

To help mold release of large castware pieces finely ground talc is used to dust the plaster molds before pouring of the slip.

Use in Refractories

1. Theory Of Cordierite Bodies

Whereas high talc bodies give the high thermal

expansion characteristic of enstatite, these are undesirable where a material is exposed to frequent temperature changes. Thurnauer[4] has this to say on the formation of low expansion cordierite bodies:

"Strangely enough, talc again comes to the aid of the ceramist and ceramic materials with extremely low coefficients of thermal expansion are made by using talc in correct proportions and in combination with other raw materials.

For a better understanding and explanation of this fact, let us look at the three component system $Al_2O_3 \cdot MgO \cdot SiO_2$, shown in Figure 27. We have drawn a straight line between two points, "A" and "B". Point "A", situated on the $MgO \cdot SiO_2$ axis, represents the position of pure fired talc and point "B", on the $Al_2O_3 \cdot SiO_2$ axis, shows the position of fired kaolin in the triaxial system. All possible combinations of mixtures talc-kaolinite fall on the line connecting the two points "A" and "B". It can be seen that bodies high in talc fall into the field of clinoenstatite crystallization and it is a known fact that clinoenstatite crystals are prominent in steatite bodies and their interlocking structure gives the high mechanical strength peculiar to this type of ceramic material. The high thermal expansion of steatite bodies is also due to clinoenstatite formation.

If the magnesium silicate content is decreased and aluminum silicate increased correspondingly, we come into the field of solid solutions of cordierite crystals, which is surrounded by the five eutectic points of the three component system. Mixtures within this field have a very short firing range and, therefore, are extremely hard to fire to vitrification. It is a generally known fact that ceramic bodies whose chemical composition are close to a eutectic mixture are commercially not practicable. Accordingly, in order to get workable bodies, it is necessary to move down the line further until we get into the field of mullite crystallization. Bodies within this field and with a talc content of 30 to 40 per cent can be fired satisfactorily. The optimum proportions of magnesium silicate and aluminum silicate vary, depending upon purity, crystalline structure, fineness of raw materials, etc. Bodies containing talc up to 40 per cent and fired to approximately 1300 deg. C. contain cordierite crystals in appreciable quantities. Cordierite is known for its low coefficent of thermal expansion and such so-called "Cordierite materials" have indeed very low coefficients of thermal expansion. They can be heated to red

2. MgO-Al_2O_3-SiO_2

System MgO–Al_2O_3–SiO_2; revised. Based on the original work of G. A. Rankin and H. E. Merwin, *Am. J. Sci.*, 4th Ser., 45, 322 (1918); modified by N. L. Bowen and J. W. Grieg, *J. Am. Ceram. Soc.*, 7, 238 (1924); modified by J. W. Grieg, *ibid.*, 13, 12 (1927); modified by J. F. Schairer, *ibid.*, 25, 241 (1942); modified by W. R. Foster, *ibid.*, 33, 73 (1950); and by Keith and Schairer (below). Recent studies by W. R. Foster, *ibid.*, 34, 255 (1951) indicate that the field labeled "Clinoenstatite" should read "protoenstatite."

M. L. Keith and J. F. Schairer, *J. Geol.*, 60 [2] 182 (1952).

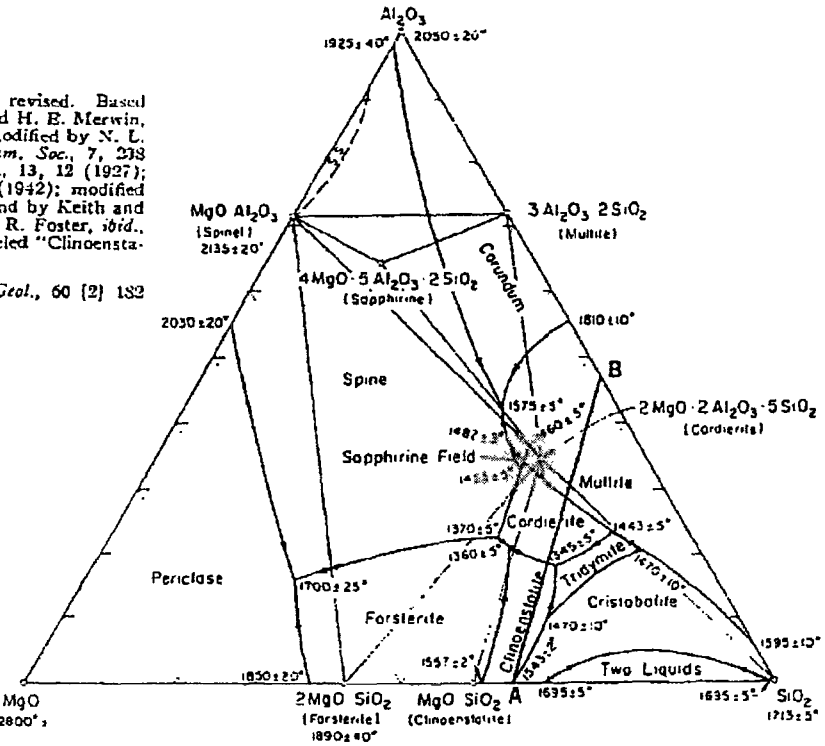


Figure 27

heat and then dropped into cold water without spalling or cracking.

In the process of firing ceramic products, a complete, or even nearly complete, equilibrium according to the phase diagram, is never obtained and usually certain crystal formations, traceable back to the raw materials, remain unchanged in the fired article and have a pronounced effect upon the properties and crystal structure of the fired product. Furthermore, the raw materials used for ceramic bodies are by no means chemically pure, but contain impurities such as iron oxides, alkaline oxides, titanium dioxides, etc. These impurities may act as fluxes, lowering the firing temperature of the ceramic material and increasing the amount of glassy matter in the fired product, or they may act as mineralizers for a certain crystalline phase. In our case, therefore, the three-phase diagram, $MgO \cdot Al_2O_3 \cdot SiO_2$, serves only as a guide for what can be expected in a ceramic body consisting of talc clay mixtures. In actual practice, reactions occurring in a ceramic body during firing are much more complicated and it is only by empirical methods that the most suitable composition of a ceramic body can be determined."

Hagar & Thiemecke[1] both showed in early investigations the longer service life resulting when New York talc was added to saggers.

TYPICAL REFRACTORY BODIES

	Heater Plate	Radiant	Sagger	Lab Sagger
Low CaO Talc	35	30	9	8
Ball Clay	20	15		21
PEERLESS Kaolin	30	20		
HS PYRAX Pyrophyllite	10	10		
Calcined Al_2O_3	5			
Calcined Georgia Clay		10		
Saw Dust		15		
PEERLESS Sagger Clay			29	13
Oak Hill Fire Clay			20	
Medium Grog			21	26
Coarse Grog			21	16
PYRAX Granules				16
Firing Cone	11	10	6	8

VI PAINT SECTION

A. What Is Talc?

The word talc means different things to different people. There are many materials that are like talc in appearance, or feel, or other properties. Among these are pyrophyllite, asbestos, diatomaceous silica, pumice, calcium silicate, and some forms of mica. However, to the paint chemist and paint formulator, talc is hydrous magnesium silicate. Furthermore, talc is so defined in the four popular specifications which will be mentioned later in this discussion.

B. Unusual Paint Properties of Talc

1—Talc is chemically inert in paint systems.

2—Talc has excellent suspension in paint, rarely settling to more than a soft pigment layer that is easily reincorporated.

3—Talc is probably the easiest pigment to disperse—most all grades wet down and disperse to their ultimate fineness by simply stirring or low speed mixing with the vehicle.

C. The Paint Grades of NYTAL

1—NYTAL 200 is a relatively coarse grade of talc as indicated by its screen analysis which runs between 1 and 2% retained on a 325 mesh sieve. It produces medium consistency in paints. This is an inexpensive NYTAL for use where paint fineness and film smoothness are relatively unimportant.

2—NYTAL 300 is a smooth talc giving medium paint consistency. It stirs in to a 4 Hegman fineness. It is the popular talc for house paint, flat paint, emulsion paint, and all coatings where paint fineness and film smoothness are important considerations.

3—NYTAL 400 is a superfine talc with an average particle size of about 3 microns. It stirs in to a 5 Hegman fineness. This talc is generally used by a mix-in process to increase body or to decrease luster without hurting film smoothness.

D. Functions and Uses of NYTAL in Paint

1—NYTAL has many functions in paint. The formulator uses it as an extender pigment to build proper consistency and application properties—to give desired flow and leveling without sagging. NYTAL literally gives paint the "painty" feel under the brush. It disperses so easily it may be stirred into an otherwise finished paint for the pur-

pose of raising the consistency a few points—or to adjust gloss and sheen.

2—NYTAL has a variety of desirable characteristics. The dry brightness is high, color in oil is good, color in water is good, tinting strength is very low—thus it does not impart muddiness or grayness to whites or light tints. NYTAL wets very easily in all paint liquids such as organic solvents, varnishes, alkyds, water. It disperses readily in paint systems, frequently requiring no more than moderate stirring. NYTAL is chemically inert in paint systems. It has excellent suspension and helps suspend other pigments, thus retarding their possible tendency to settle hard.

3—NYTAL is used in nearly all types and kinds of paint — primers, undercoaters, flats, eggshell, semigloss — interior and exterior — lacquer, floor paint, traffic paint, roof paint, house paint, trim and trellis, patio—paints for all surfaces—organic solvent thinned paints; water thinned paints.

4—NYTAL 200 is used in coatings where paint fineness and film smoothness are either not important or where some film roughness or "tooth" is most desirable such as, for example, interior wall primers, undercoaters, and texture paints. Large quantities of these talcs go into traffic paints as specified by the various states.

5—NYTAL 300 is the general-purpose extender for all kinds of paints. Its popularity is due as much to its uniformity of quality as to its ease of dispersion, good film smoothness, and all-around talc properties. Probably, the largest single use of NYTAL 300 is in linseed oil house paint. Most white house paints contain a substantial amount of talc—on the dry film basis about 15% talc by volume and 25% by weight. Yet this amounts to only 4% of the raw material cost. There is usually more talc than titanium dioxide, or lead, or zinc, or any other pigment in the film. Only the binder is present in greater amount. What does all this NYTAL do in paint? Well, first, as noted before though not necessarily of prime importance, it helps pigment suspension in the can and provides the desirable consistency for good application properties. Further, in combination with the other pigments present, the NYTAL promotes excellent durability: the film weathers slowly and uniformly by gentle erosion or chalking, and eventually provides a most desirable repaint surface. Also, whiteness is maintained throughout the long film life because NYTAL is not discolored by wash-down from iron or copper screens or hardware.

Many white exterior latex and emulsion paints contain NYTAL as the extender pigment. The reasons are the same as for the linseed oil paints, namely, good pigment suspension in the can, proper application consistency and feel under the brush, good white color throughout the life of the paint film, and desirable repaint surface.

6—NYTAL 400 is used wherever high paint fineness and a smooth paint film is required. This stir-in pigment can be incorporated as the last ingredient, if desired, by simply mixing into the otherwise finished paint. In this way it serves as a formulating tool to adjust a batch of paint to the desired consistency, sheen, or other special property. A popular use is in semi-gloss paints, enamels, and lacquers where it functions as a dulling agent to provide the desired level of sheen or gloss. Since NYTAL 400 may be stirred into the finished paint, it is very handy as a means of adjusting the batch to the requisite gloss level. At the same time, it contributes to good brushing and sag resistance as well as aids suspension of all pigments. Table 1 shows the dulling effects of increasing amounts of NYTAL 400 when added to a high-gloss alkyd enamel. Note that about a half-pound of the NYTAL produces a semi-gloss, and one pound or so dulls the paint into the flat range. Furthermore, the film smoothness is maintained because the NYTAL 400 has a high stir-in Hegman fineness.

Table 1
NYTAL 400 Reduces the Gloss of Oleoresinous Enamels

Pounds of NYTAL 400 per Gallon	60° Gloss
None	85
0.4	80
0.6	54
0.8	37
1.0	24
1.2	14

7—Another popular use of NYTAL 400 is to adjust consistency of finished paint. NYTAL 400 has high binder demand, or oil absorption, so a few tenths of a pound per gallon stirred into the paint will raise the consistency appreciably. This scheme is becoming more and more popular in the manufacture of linseed oil house paints.

Table 2 gives an example of such a paint to which were added increasing amounts of NYTAL

Table 2
NYTAL 400 Increases the Consistency of Linseed Oil House Paint

Pounds of NYTAL 400 per Gallon	Consistency KU
None	76
0.2	79
0.4	83
0.6	87
0.8	91

400. Each two-tenths of a pound of talc caused a consistency increase of about 4 KU.

8—NYTAL 400 is gaining attention as an extender pigment. It is being used in high loadings—in several cases as high as four pounds per gallon. Here the paint chemist is taking advantage of the easy dispersion of NYTAL. He can grind his prime pigment and then simply stir in the NYTAL 400 to give a fineness of 5 Hegman. Or he can easily push the fineness up a Hegman unit by normal milling on roller, pebble, or high speed stone equipment. These paints have outstanding properties of suspension, brushability, leveling, controlled sag, and uniformity of film sheen or semi-gloss.

E. Production of Paint Grades of NYTAL

1—The production of NYTAL is carefully controlled with regard to color, screen residue, paint fineness, dulling efficiency, and paint consistency or binder demand. The minerals are processed in several steps—by crushers, pebble mills, fluid energy mills, separators, classifiers—all are used in our modern talc plant. At regular intervals, automatic sampling devices withdraw portions for laboratory testing. Each step of the process is carefully controlled so that the NYTAL entering the finished product silos is uniform within narrow specification limits.

2—Our plant engineers have developed a novel procedure for filling these silos in such a way that the incoming NYTAL is intimately mixed with the talc already present in the silo. Anyone who has tried to mix two dry powders will appreciate the importance of this discovery. What does this do for uniformity? Let us consider the consistency control test we use at our plant. A complete linseed oil house paint is prepared with each mill sample. The titanium and zinc pigments are predispersed in some of the oil to form what we call "white base." The mineral spirits, the drier, and the balance of the oil are mixed together. The NYTAL sample is simply stirred into this vehicle. Then the "white base" is stirred in to finish the paint. After adjusting the paint to proper temperature, the Stormer consistency is determined. Our specification limits for our NYTAL 300 grade are plus or minus three Krebs Units from our standard NYTAL. This means that the consistency of the NYTAL entering the finished product silo is within three Krebs Units of standard. As it enters the silo, it is blended with similar material. The net result is that the NYTAL 300 coming out of the silo for bagging and shipment is even more uniform—its consistency spread is now only plus or minus one Krebs Unit.

F. Uniformity of NYTAL

1—This uniformity of NYTAL is of utmost importance to both paint chemists and paint manufacturers. The zincless linseed oil primer TT-P-25a is a good paint to illustrate the importance of uniformity of a raw material such as NYTAL 300. A typical formula meeting the requirements of this specification contains almost three and a half pounds of talc per gallon. This formula was prepared with seven samples of NYTAL 300 representing the allowable deviations from our standard. Table 3 shows these listed as A through G. The

Table 3

NYTAL 300 in TT-P-25a Linseed Oil Primer

NYTAL 300	Relative NYTAL Consistency	TT-P-25a Formula Consistency KU	Critical PVC
A	Plus 3 KU	85	48.3
B	Plus 2 KU	83	49.7
C	Plus 1 KU	82	50.3
D	Standard	80	51.4
E	Minus 1 KU	79	52.2
F	Minus 2 KU	77	53.5
G	Minus 3 KU	76	54.5

second column shows that these samples deviate by one, two, or three KU from our standard by our consistency control test. The consistencies of the TT-P-25a Specification formula made with these talcs are given in the third column. Note that the increments of consistency are very much like those listed in column two. But the last column might be of most interest to the paint chemist. This shows that a NYTAL 300 uniformity of plus or minus one KU (samples C and E) will be equivalent to a variation of only plus or minus 1% critical pigment volume concentration. Even at plus or minus 3 KU spread (samples A and G) the NYTAL 300 produces a variation of only plus or minus 3% critical PVC. It should be noted in passing that TT-P-25a allows a consistency spread of 75 to 90 KU.

2—Another example to illustrate the importance of this uniformity is given in Table 4. The same seven samples of NYTAL 300 were used to make an acrylic emulsion paint. The formulation con-

Table 4

NYTAL 300 in Acrylic Emulsion Paint

NYTAL 300	Relative NYTAL Consistency	Consistency KU	Critical PVC
A	Plus 3 KU	79	52.6
B	Plus 2 KU	79	53.0
C	Plus 1 KU	79	53.5
D	Standard	78	54.0
E	Minus 1 KU	78	54.6
F	Minus 2 KU	78	55.2
G	Minus 3 KU	78	55.6

tained two pounds of titanium dioxide and two and one-quarter pounds of NYTAL 300 per gallon at a pigment volume concentration somewhat below the critical level. The data show that these seven paints had essentially the same consistency —the maximum difference being just one KU. Of even more importance was the narrow range of critical pigment volume concentration—only three per cent. Furthermore, where the NYTAL 300 uniformity is plus or minus one KU (samples C and E) the variation in critical PVC is little more than plus or minus one-half of one per cent.

G. NYTAL Meets Talc Specifications

1—Many federal, state, and municipal paint specifications require or allow the use of magnesium silicate talc pigments. Frequently the type of talc is specified. Usually these paint specifications allow the paint chemist reasonable latitude in the selection of the talc. Since most of the paint specifications have fineness requirements, it is usually advantageous for the paint chemist to choose the talc that has a stir-in fineness similar to that required by the paint specification. In fact, one of the reasons for the development of smooth talcs and superfine talcs was for the use in specification paints having high Hegman fineness requirements.

2—NYTAL meets the four popular talc specifications as follows:

ASTM D605	NYTAL 200, 300, 400	
Federal TT-P-403a	NYTAL 200, 300, 400	
Maritime 52-MA-523a	Type I	NYTAL 200, 300
	Type II	NYTAL 400
Military MIL-P-15173A	Type A	NYTAL 300, 400
	Type B	NYTAL 200, 300

H. Particle Size

1—There are various methods for measuring particle size, such as air-permeation, gas adsorption, microscope count, and sedimentation. Actually the first two named measure merely total pigment surface area and provide no information on size distribution. Pigment surface area, or specific surface, is a useful figure because it indicates relative binder demand, or oil absorption, and therefore consistency. Microscope counting is so intricate and difficult as to be impractical. Under the microscope, one can see the individual particles and count them according to size. But the observer must be sure he is examining a representative field. We know that talc pigments are made up of particles of many shapes and an infinity of sizes; therefore, perhaps as many as a dozen different fields would have to be counted to assure an average distribution. This would be an extremely tedious and time-consuming job. Furthermore, it is most difficult to relate microscope count data to per cent distribution by weight, or volume, or to specific surface. Another drawback is the infinitesimal sample used in the microscope count. What assurance is there that the sample is representative of a pound, much less a bag, of the talc? The same objection applies to both air permeation and gas adsorption methods — only a very few grams of sample are used per test.

2—Probably water sedimentation is the best of the available methods. For one thing, a sizeable sample is used per test. Secondly, it is rather simple to run. And most important, the measured data indicate particle size distribution. The word indicate is used here because the sedimentation method assumes that all particles are spheres. However, we are dealing with anything but spherical particles as Figure No. 28 shows. Note the dominant shapes are fibres, rods, plates, and irregular nodules. You could probably count on the fingers of one hand the total number of truly spherical particles in a 50-pound bag of talc. It should be pointed out that Figure No. 28 does not necessarily indicate either the size or the frequency of the particles—only their various shapes.

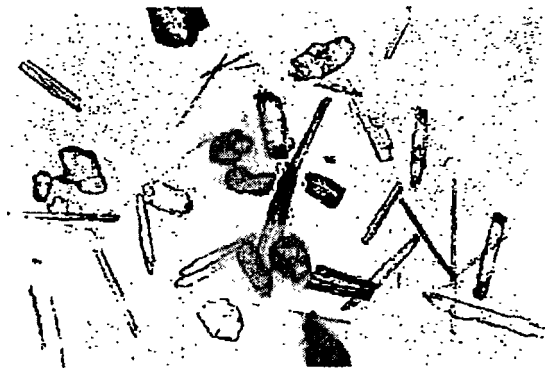


Figure 28—Shapes of Nytal Particles

3—A deficiency of the water sedimentation method is that it does not accurately indicate the size of particles much smaller than two microns. After all, there is Brownian movement at that particle size and smaller, and this behavior upsets the settling laws upon which the sedimentation test is based. Now the smaller the particles the greater is their percentage of specific surface. For example, let us assume that 10% by weight of a talc consists of particles less than one micron and that there is a gradual decrease in size to almost zero. It can be demonstrated by rather simple calculation that *that* 10% would account for a larger percentage of specific surface than the 90% larger than one micron. And yet the sedimentation method does not measure this important 10% of the talc. The effects of relative specific surface are manifest as oil absorption, liquid demand, and paint consist-

ency and these properties are more easily, directly, and quickly measured by actually making a paint with the talc sample. Finally, the coarse end of the particle size distribution can be measured more easily and directly by screen tests of the talc and/or Hegman fineness of the talc stirred into vehicle or paint.

4—The purpose of this brief discussion on particle size distribution of talc is to bring out three points with regard to production and use of these pigments. First, such data as can be measured do frequently indicate similarity, or differences, among various talcs as materials but all too seldom are the data relatable to pigment and paint properties. Second, in the production of talc, particle size distribution is an impractical control test because it requires hours for one determination whereas control tests must be run in minutes. Third, we rely on more direct pigment tests to control production so as to supply our customers with NYTAL pigments that give uniform performance in the coatings made by those customers.

VII RUBBER SECTION

Uses In Rubber And Vinyl

Talcs are used by the Rubber Industry as dusting agents to permit easy factory handling of normally tacky compounds in process, and as fillers in compound design. Vinyl formulations also list talc as a filler in such applications as insulations, extruded gaskets, calendered films and tile.

In handling uncured stocks in process, the talc may be spread over the rubber by brushing or other suitable means. It may also be applied by dipping in a water suspension of the dry powder. In making up talc slurries for dip tank use, a small quantity of DARVAN No. 1 (1% by weight in the talc) is recommended as the wetting agent. Mechanical agitation is generally used to hold the talc in suspension.

Butyl rubber insulation and latex foam are typical applications for talc in commercial compounding. The following are representative formulas:

HEAT and MOISTURE RESISTANT INSULATION

Butyl 035	100
Stearic Acid	1
Zinc Oxide	5
Paraffin	2
NYTAL 400	50
Calcined Clay	100
Litharge	5
SULFADS	3
METHYL ZIMATE	3
CAPTAX	1.5
	270.5

LATEX FOAM CUSHIONING

Rubber (50/50 Natural/SBR)	100
Potassium Oleate	1.4
Zinc Oxide	5
Sulfur	2
AGERITE WHITE	.25
AGERITE SPAR	1
ETHYL ZIMATE	1
ZETAX	1
Sodium Silicofluoride	.6
NYTAL 200	50
	162.25

Talc filler applications in Vinyls are as listed:

INSULATION

PVC (Electrical Grade)	100
Phthalate Plasticizer	55
Whiting	15
NYTAL 200	15
VANSTAY Stabilizer	1.5
Color	q.s.

REFRIGERATOR GASKET

PVC Resin (Extrusion Type)	100
Polymeric Plasticizer	80
Epoxy Plasticizer	10
Whiting	25
NYTAL 200	50
Color	q.s.
VANSTAY Stabilizer	2

VINYL-ASBESTOS TILE

PVC Copolymer Resin	100
Phthalate Plasticizer	25
Epoxy Plasticizer	10
Stearic Acid	1
Whiting	125
NYTAL 100	100
7R Asbestos	100
Titanium Dioxide	15
VANSTAY Stabilizer	4

SHEETING

PVC Resin	100
Phthalate Plasticizer	30
Polymeric Plasticizer	5
Epoxy Plasticizer	5
Fatty Acid Phthalate	4
Calcium Stearate	.5
NYTAL 200	20
Whiting	15
VANSTAY Stabilizer	2

VIII PAPER SECTION

The Use Of Nytal In The Paper Industry

NYTAL is used as a filler in some grades of paperboard and molded pulp products because of its good retention, chemical inertness, white color, and TAPPI Brightness of 88 to 90.

NYTAL 200 is the most common grade of talc that is used for this filler application. Since NYTAL tends to be abrasive in nature, the amount used is limited to small percentages. Generally, about 5% NYTAL (based on the weight of the fiber) is considered maximum in board mill applications.

IX SPECIALTIES SECTION

The ultrafine, airmilled grades, NYTAL 300 and NYTAL 400, are suggested for pharmaceutical and cosmetic applications. Their excellent white color and fine particle size permit these talcs to be readily and uniformly mixed with pigments and modifiers for use in cosmetic and pharmaceutical formulas. They are easily suspended in liquid media and dispersed in creams and pastes. Specialties Department Technical Literature contains many product formulas illustrating the use of NYTAL 300 and NYTAL 400 such as Liquid Matte Make-Up Base, Cream Eye Shadow, Pre-Shave Talc Stick, Acne Cream and Aerosol Foot Powder.

CREAM EYESHADOW #128

		% by wt.
A	VEEGUM (Vanderbilt)	1.75
	Water	33.45
B	Sodium carboxy-methylcellulose (low visc.)	0.10
	Water	9.90
C	DARVAN #1 (Vanderbilt)	0.30
	Propylene glycol	5.00
	Triethanolamine	0.40
	Water	6.00
D	NYTAL 400 (Vanderbilt)	18.00
	Kaolin	2.00
	Titanium dioxide	5.50
	Iron oxides	4.50
E	Stearic acid	0.80
	Glycerol monostearate	2.00
	Lanolin	4.00
	Sesame Oil	2.00
	Olive Oil	1.00
	Isopropyl myristate	3.00
F	TRUODOR Jasmin #6 (Vanderbilt)	0.30
	Preservative	q.s.

Procedure:

I. Add the VEEGUM to the water slowly, agitating continually until smooth.
II. Disperse the CMC in water.
III. Add I and II to C.
IV. Micropulverize D.
V. Heat E to 70°C.
VI. Add IV to III. Homogenize. Heat to 60-65°C. Maintain temperature for 10 minutes to allow air to escape.
VII. Add V to VI and mix until 45°C.
VIII. Add F and mix until cool.

R. T. Vanderbilt Bulletin #44. p. 17. 1964

ACNE CREAM #137

		% by wt.
A	VEEGUM (Vanderbilt)	1.75
	CMC (7 MSP)	0.40
	Water	34.60
B	Glycerin	5.00
	Allantoin	0.25
	Resorcinol	3.00
	Triton X-100	0.20
	Water	29.70
C	NYTAL 300 (Vanderbilt)	16.00
	Titanium dioxide	2.90
	Iron oxides	1.10
	Sulfur	5.00
D	Zinc pyridinethione	0.10

Procedure:

I. Dry blend VEEGUM and CMC and add to the water slowly, agitating continually until smooth.
II. Add B to I.
III. Pulverize C and add to III.
IV. Incorporate D by making up concentrate in portion of finished cream, triturating thoroughly. Add this to product, milling or homogenizing finished cream.

R. T. Vanderbilt Bulletin #44. p. 23. 1964

PRE-SHAVE TALC STICK #77

		% by wt.
A	VEEGUM (Vanderbilt)	1.90
	Water	q.s.
B	Zinc stearate	4.70
	Light magnesium carbonate	1.90
C	NYTAL 300 (Vanderbilt)	91.50

Procedure:

I. Add the VEEGUM to about 30 parts of water slowly, agitating continually until smooth.
II. Blend B and add to C.
III. Add I to II. Work into a smooth paste (add more water if necessary).
IV. Pack in stick mold and allow to dry.

R. T. Vanderbilt Bulletin #44, p. 21, 1964

LIQUID MATTE MAKE-UP BASE #142

		% by wt.
A	VEEGUM (Vanderbilt)	0.50
	Water	9.50
B	CMC (7LP)	0.50
	Water	49.50
C	DARVAN #1 (Vanderbilt)	0.30
	Triethanolamine	1.00
	Propylene glycol	5.00
	Water	8.40
D	NYTAL 400 (Vanderbilt)	6.00
	Kaolin	0.80
	Titanium dioxide	3.00
	Iron oxides	0.20
E	Stearic acid	2.00
	Propylene glycol monostearate	0.50
	Lanolin	3.50
	Mineral oil	4.00
	Isopropyl myristate	5.00
F	TRUODOR Oriental Bouquet #3 (Vanderbilt)	0.30
	Preservative	q.s.

Procedure:

I. Add the VEEGUM to the water slowly, continually agitating until smooth.
II. Disperse the CMC in water.
III. Mix A, B and C together.
IV. Micropulverize D. Add to III. Heat to 60-65°C.
V. Heat E to 70°C. Add to IV. Mix until cool. Add perfume.

American Perfumer and Cosmetics, 79, 68, Oct. 1964 "Make-Up Formulas"

R. T. Vanderbilt Bulletin #44, p. 18, 1964

AEROSOL FOOT POWDER #134

Concentrate	% by wt.
NYTAL 400	86.0
Magnesium carbonate	5.0
Kaolin	5.0
Zinc Stearate	3.0
METHYL TUADS (Vanderbilt)	0.5
Isopropyl myristate	0.5

Packaging:

Concentrate	10
Propellent 12/11 (50/50)	90

Procedure:

I. Add to the NYTAL 400 each component in the order listed with high speed mixing after each addition. Mix until uniform.
II. Fill concentrate into appropriate containers.
III. Pressurize with propellent.

R. T. Vanderbilt Bulletin #42, 1962

P. V. Wells and Irwin I. Lubowe, M.D., *Cosmetics and the Skin*, p. 521, (Reinhold Publ. Corp., N.Y.)

ACNE LOTION #122

		% by wt.
A	VEEGUM (Vanderbilt)	0.80
	Water	20.00
B	Sodium carboxymethylcellulose (type 7 MSP)	0.80
	Water	15.00
C	Glycerine	5.00
	VANCIDE BN (Vanderbilt)	0.25
	Allantoin	0.25
	Resorcinol	3.00
	Water	20.00
D	NYTAL 300 (Vanderbilt)	8.00
	Titanium dioxide	2.90
	Iron oxides	1.10
	Sulfur	5.00
	Triton X-100	0.20
	Water	16.70
E	TRUODOR Aphra Bouquet #9 (Vanderbilt)	1.00

Procedure:

I. Add the VEEGUM to the water slowly, agitating continually until smooth.
II. Disperse the CMC in water.
III. Mix A and B together.
IV. Add C to III. Add D and mix thoroughly.
V. Add E.

R. T. Vanderbilt Bulletin #32, 1962

Hercules Powder Co. Bulletin #VC-441 "Hercules Cellulose Gum & Natrosol 250 in Pharmaceuticals"

MEDICATED CREAM MAKE-UP WAFER #125

		% by wt.
A	Disodium bithionol	0.5
	Resorcinol	1.0
	Allantoin	1.0
	Sulfur (colloidal)	2.0
	NYTAL 400 (Vanderbilt)	20.0
	Zinc oxide	10.0
	Iron oxides	0.5
B	Polyethylene glycol 1,000	40.0
	Polyethylene glycol 400	25.0

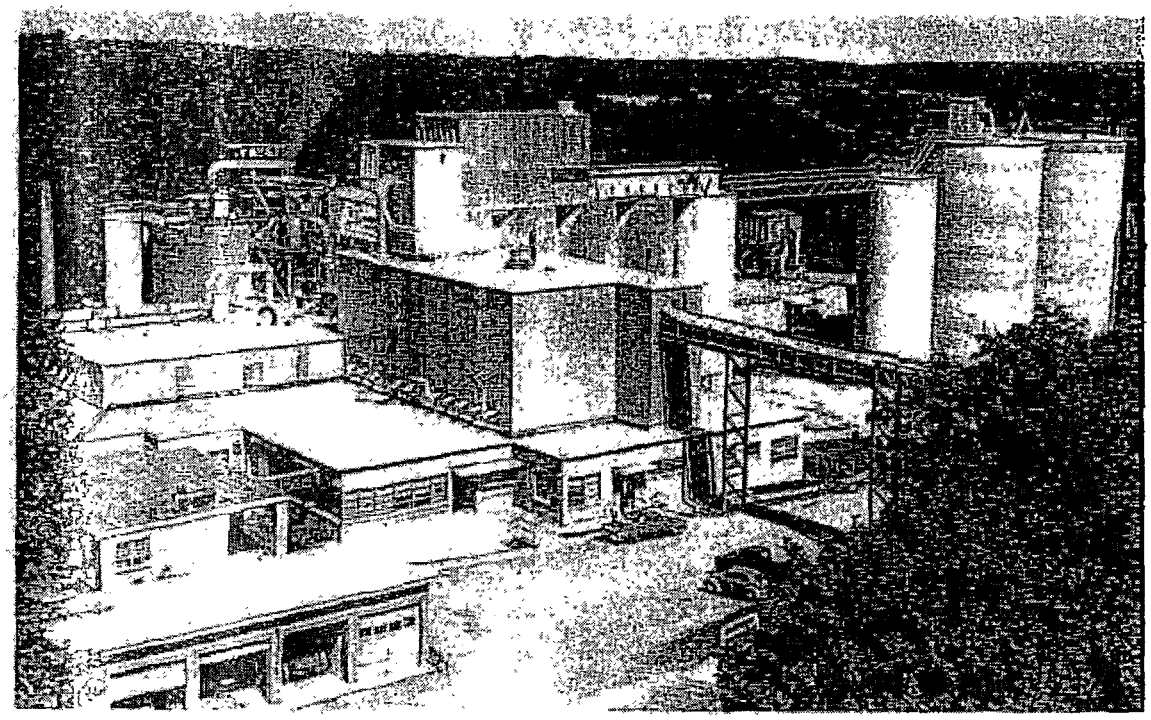
Procedure:

I. Blend A until uniform.
II. Melt B and mix.
III. Add A to B and stir until solids are uniformly wet. Pass through a roller mill.
IV. Heat to 60-70°C. to release trapped air.
V. Allow to cool (45-50°C.) and pour into containers.

Mecca, S. B., *Proc. Sci. Sect. TGA*, 39, May 1963. "The Function and Applicability of the Allantoins."

Tarnoff, B., *American Perfumer 77*, 35-38, Sept. 1964 "Dermato-Applications of Sulfur-bearing Organic Bactericide-Fungicides"

X GOUVERNEUR TALC COMPANY PLANT



Gouverneur Talc Company Plant at Balmat, New York

A. NYTAL Control

As the mineralogy of the Gouverneur area indicates, constant testing and blending of the various ores are necessary to produce a satisfactory commercial product. This is done from the testing of the ore in the mine right through the blending of the finished product by bottom loading of the storage silos.

Mine samples are first tested for ceramic or paint suitability. Then ore samples are taken every three hours and tested again for proper blending. Ground samples of NYTAL from the mill are collected automatically and rushed to the laboratory every hour by pneumatic tubes. The laboratory never closes. No shipment leaves the plant until a check reveals that it meets all grade specifications.

From the very beginning of our operations at Gouverneur it was evident that chemical analysis, with the exception of a lime determination, was of no value for control purposes. As a matter of fact, Treischel[1] shows such data could be very misleading.

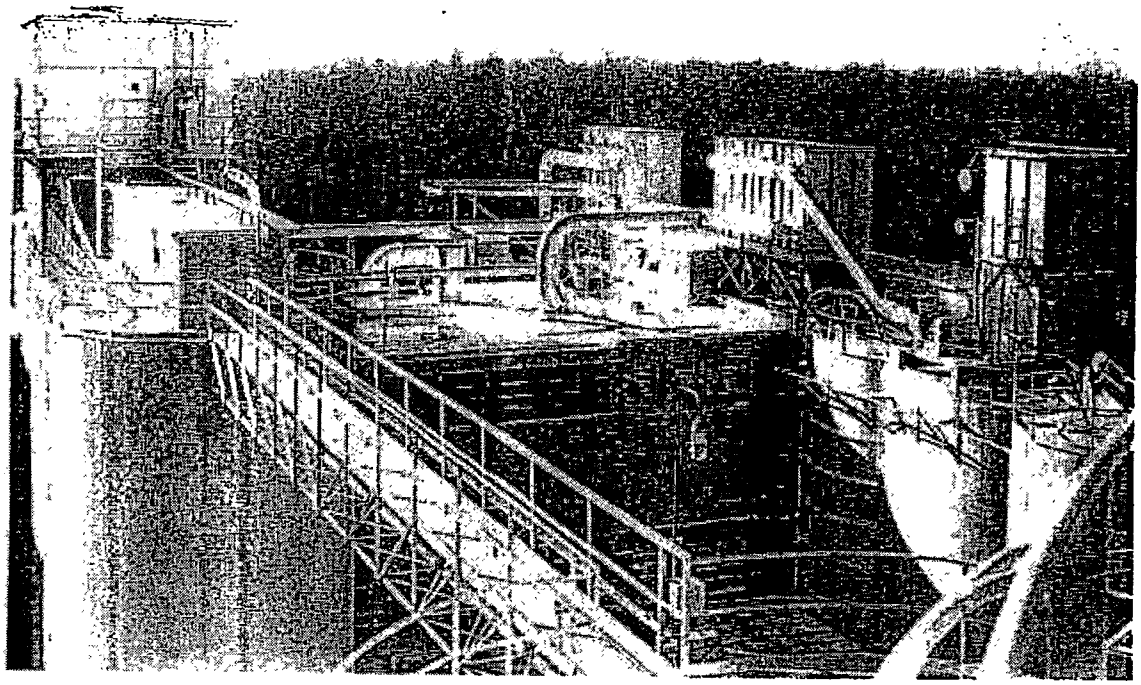
The following physical and chemical tests are made at the plant and are the basis of ceramic control specifications:

1. CaO determination
2. Acid solubility
3. Bulking
4. Screen residue
5. Fired color
6. Specific Resistance

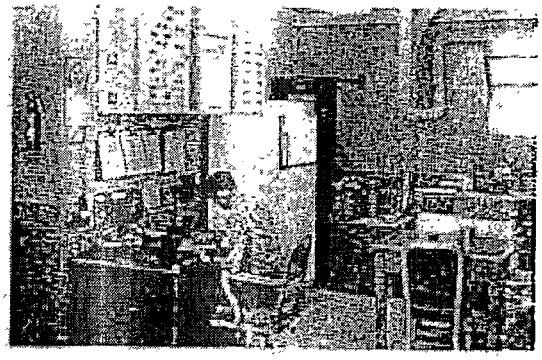
In addition shrinkage, absorption, crazing and shivering tests are made weekly at our East Norwalk, Connecticut laboratory by introducing a weekly sample into a standard 70% NYTAL tile body fired to Cone 1.

In this way we have been able to produce a very uniform talc over the past eighteen years.

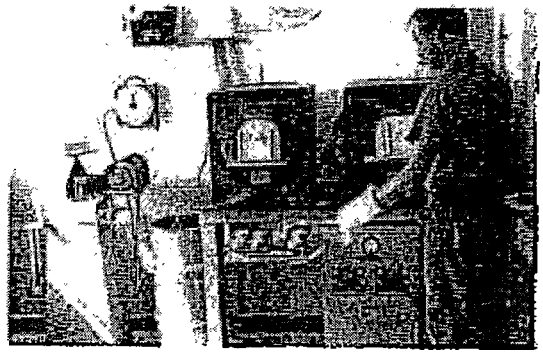
The Nytal control for grades other than ceramic is described under Section VI—Paint.



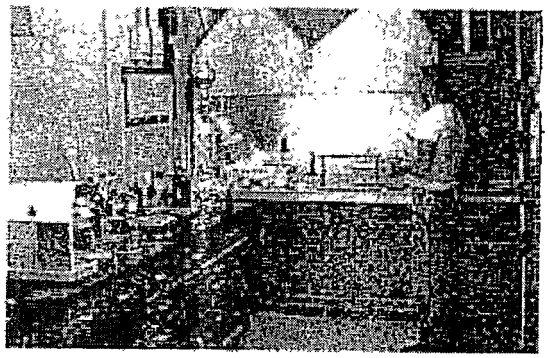
View from silo top shows others at right for finished products. Dust collectors are mounted on silo tops. Dry ore silos can be seen at the left. In all there are 13 finished product silos at the Gouverneur Talc Company plant.



Section where physical tests on paints are made. Note: Vacuum tube for rapid receipt of plant samples.



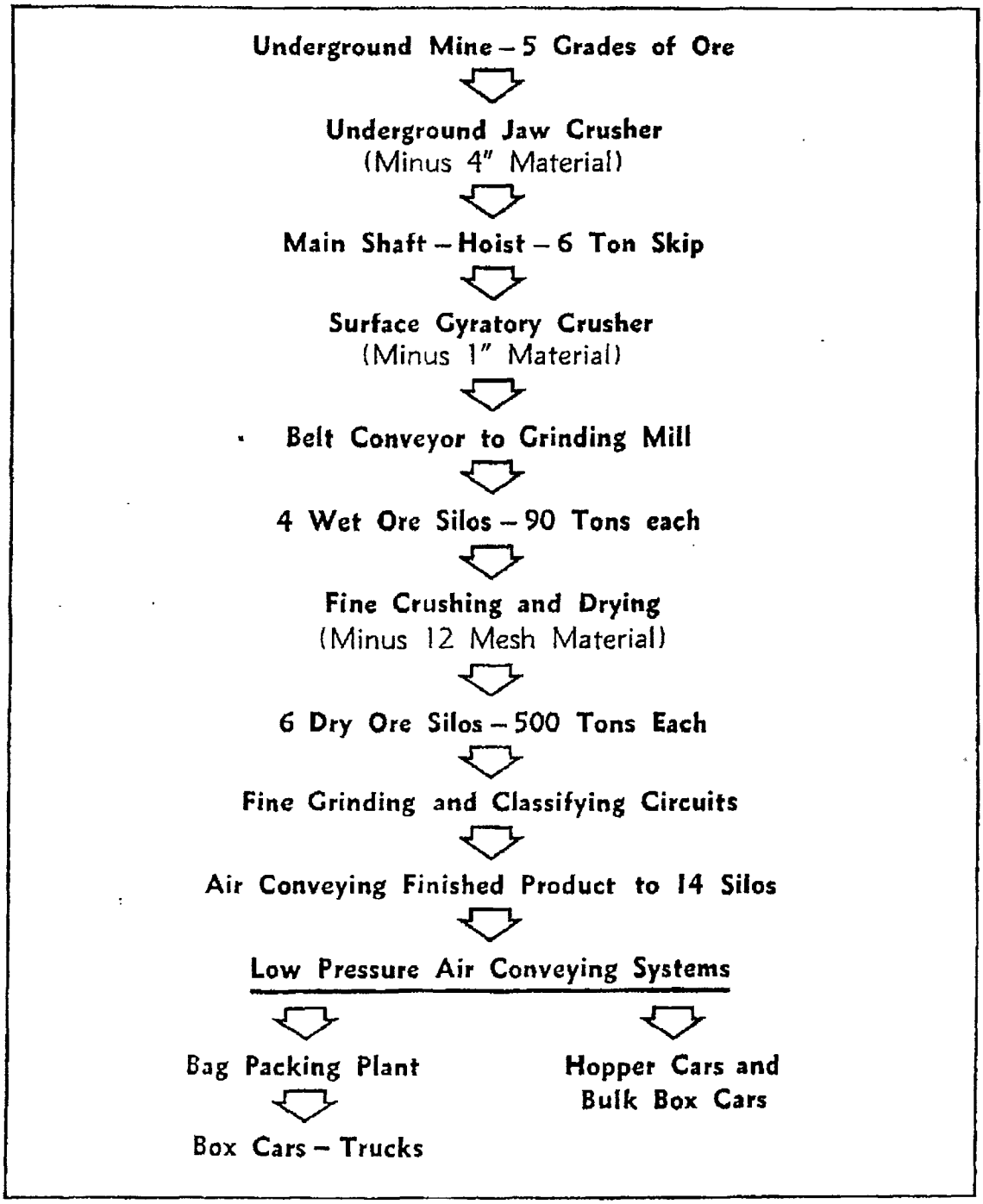
Section where Talc destined for shipment to the ceramic industry is tested for fired color and for bulk density.



Chemical analysis section

Gouverneur Talc Company, Inc.

Simplified Flow Sheet



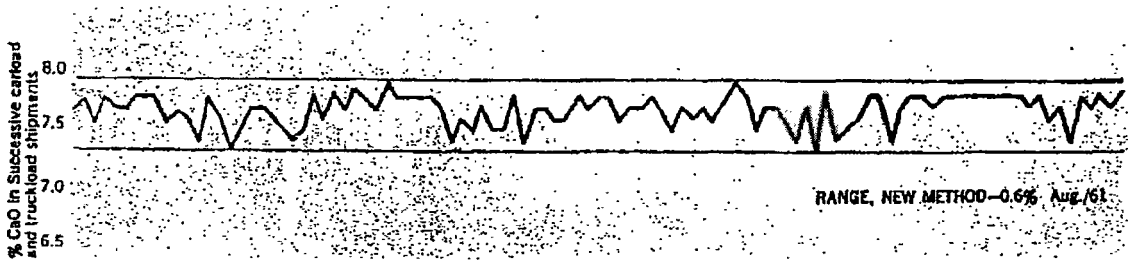


Figure 29—Per Cent CaO of Talc in Consecutive Shipments Under Old and New Systems

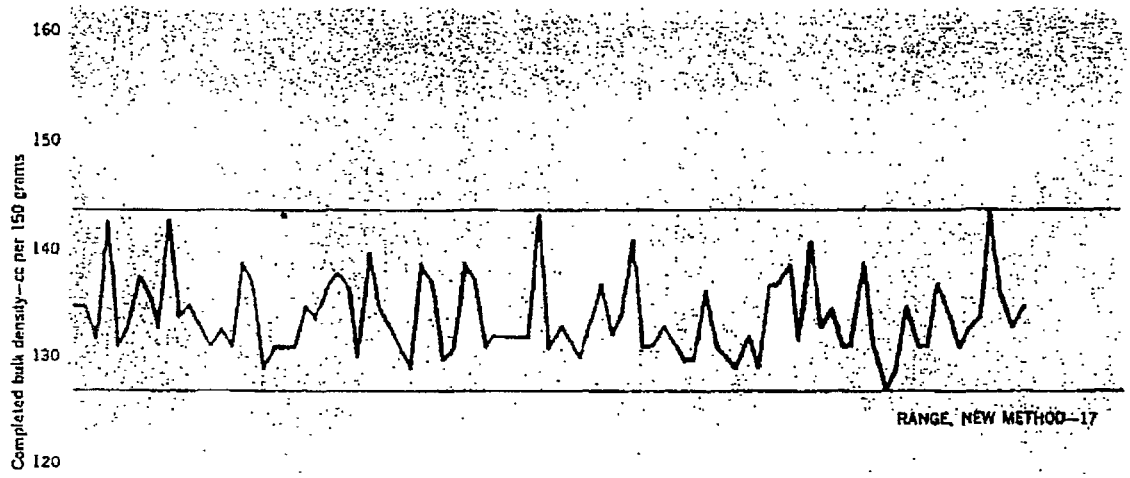


Figure 30—Compacted Bulk Density of Talc in Consecutive Shipments Under Old and New Systems

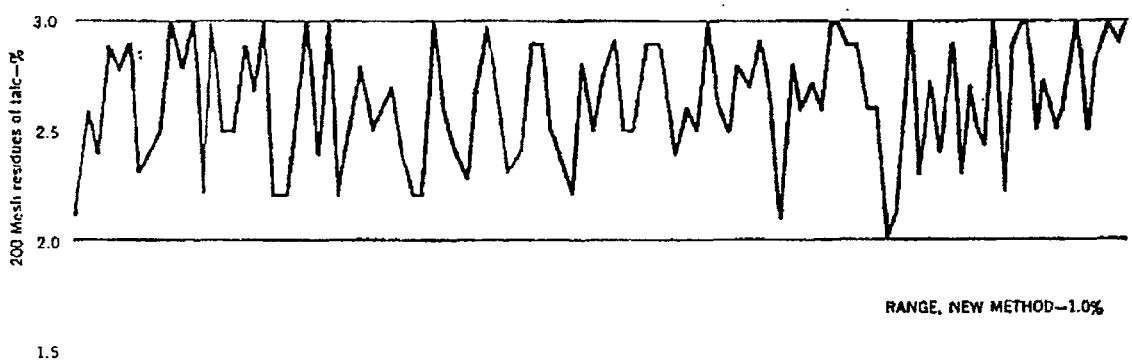
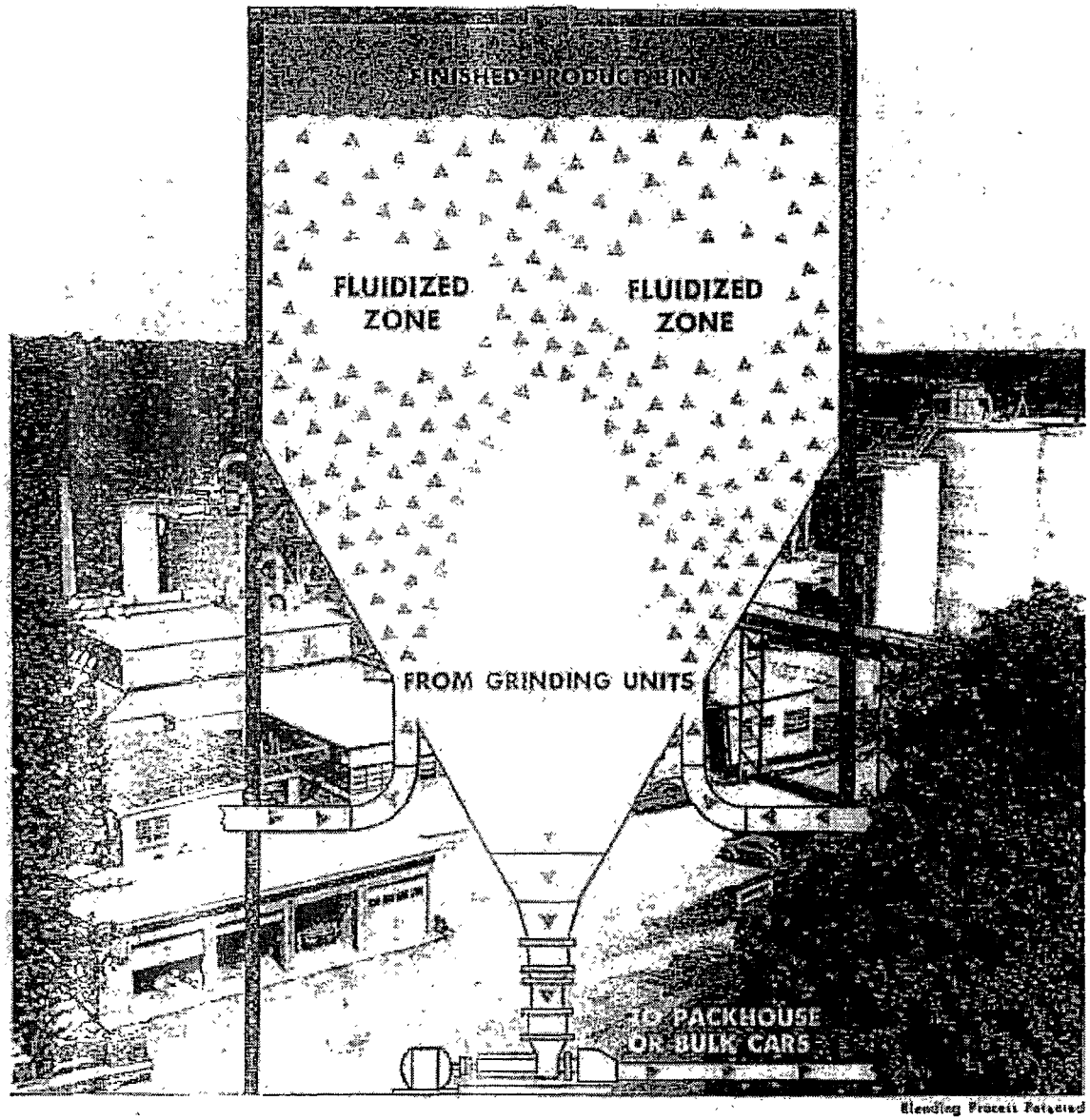


Figure 31—200 Mesh Residue of Talc in Consecutive Shipments Under New and Old Systems



Blending Process Patented

NYTAL TALC is Bottom Loaded for Better Blending

Bottom Loading Of Silos

A word should be said on the revolutionary method of bottom loading of silos for the maximum blending of finished ground NYTAL. The first such idea anywhere was developed and put into commercial operation by Gouverneur Talc Company.

McClellan reports[1] that variations in CaO content, 200 mesh screen analyses and bulking have been cut in half by this new blending method.

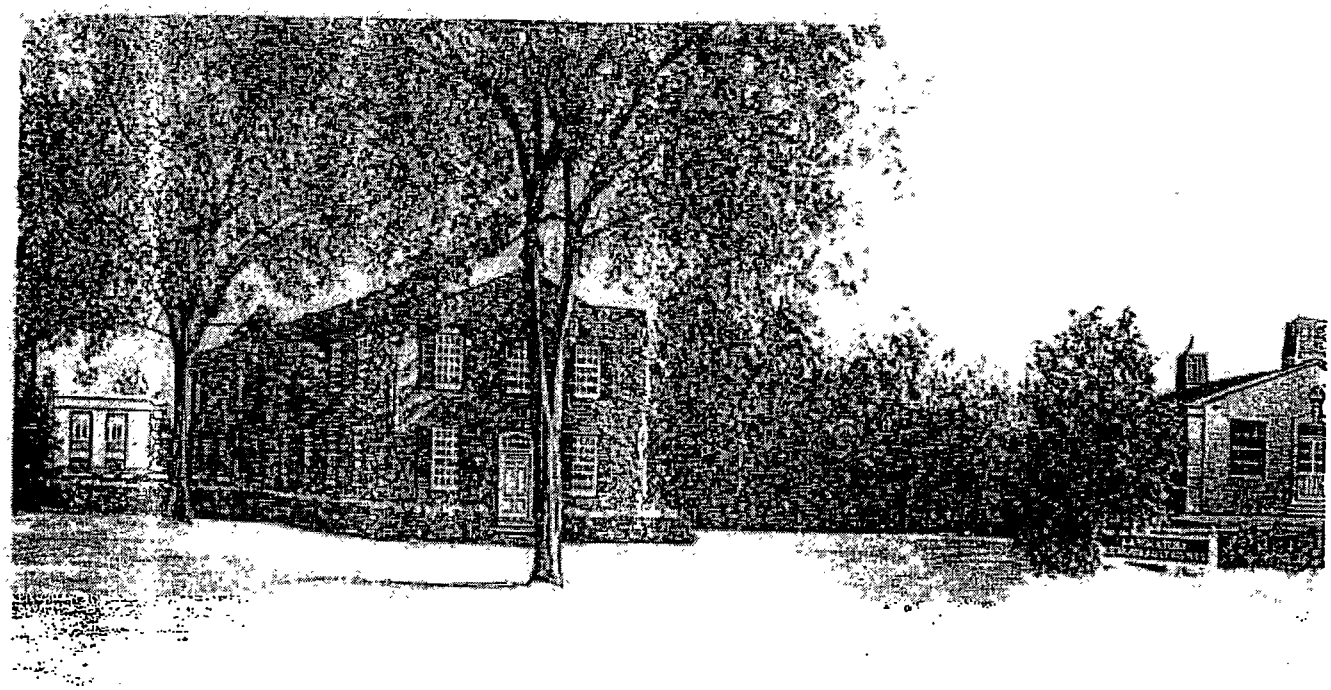
See Figures No. 29, 30 and 31.

Vanderbilt Research Laboratory

XI
VANDERBILT NORWALK LABORATORIES

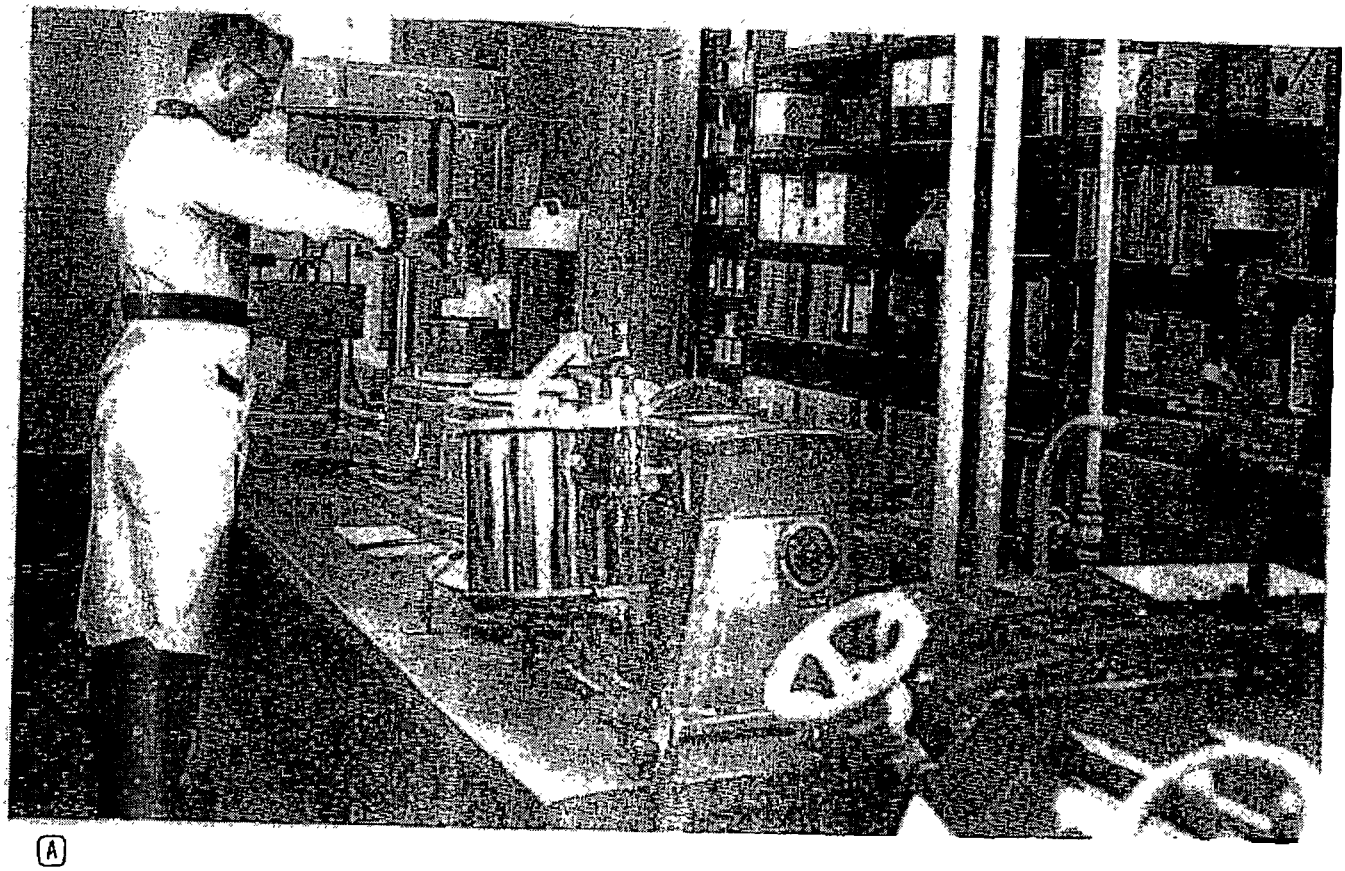
The R. T. Vanderbilt Company laboratories are located at East Norwalk, Connecticut. Here research is carried on in many fields, including ceramics, rubber, paint, paper, fungicides, insecticides, plastics, petro-chemicals, foods and pharmaceuticals.

On the following pages we present a pictorial description of our ceramic and paint laboratories.



t East Norwalk, Connecticut

General View of Ceramic Laboratory



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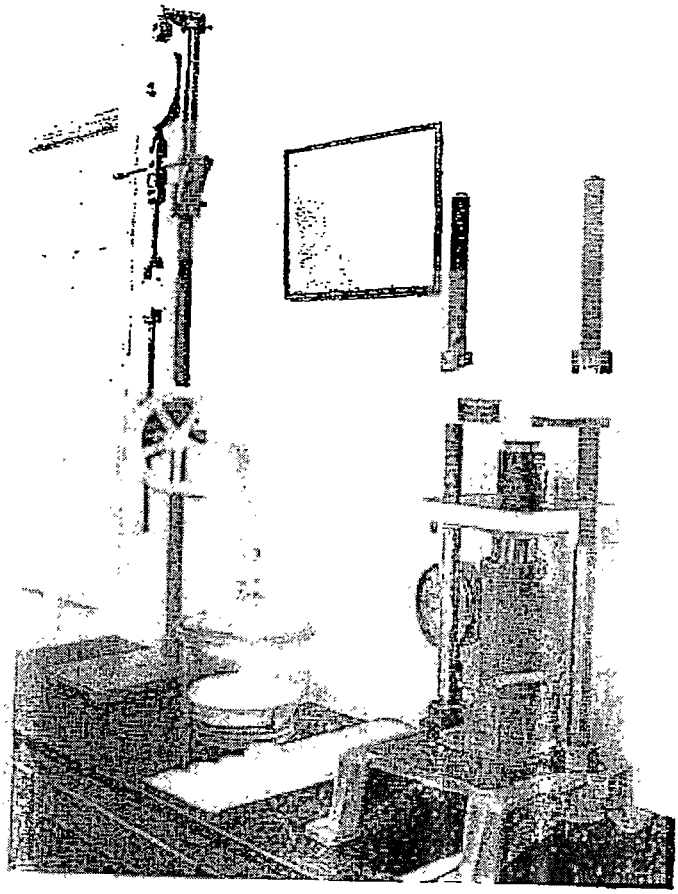

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General View of Paint Laboratory

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Dry Modulus of Rupture Machine and Carver Press

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Casting Slip Shaking Machine

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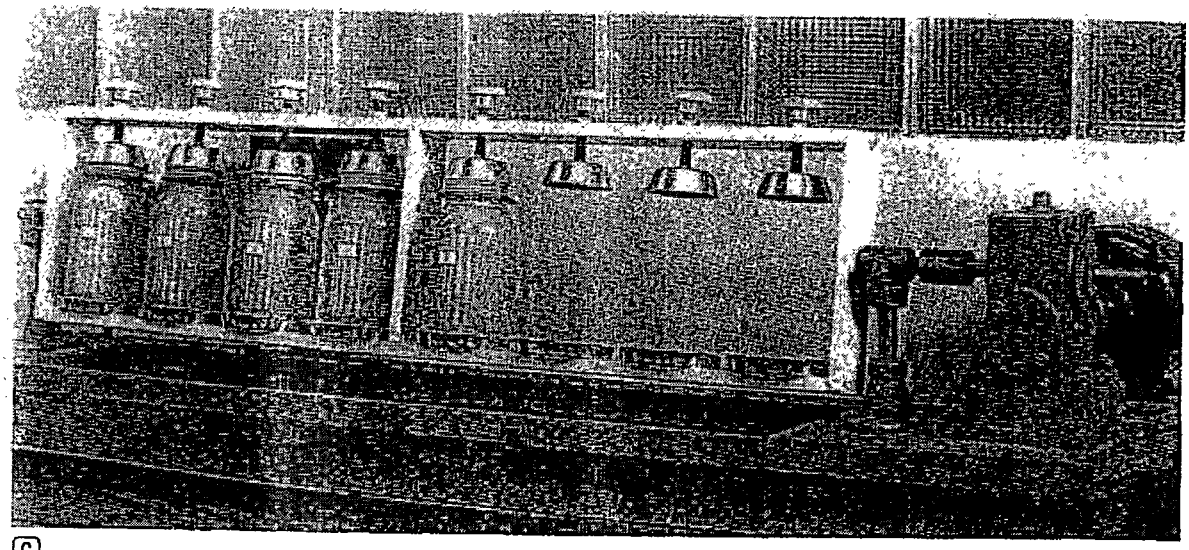
De-airing Pug Mill



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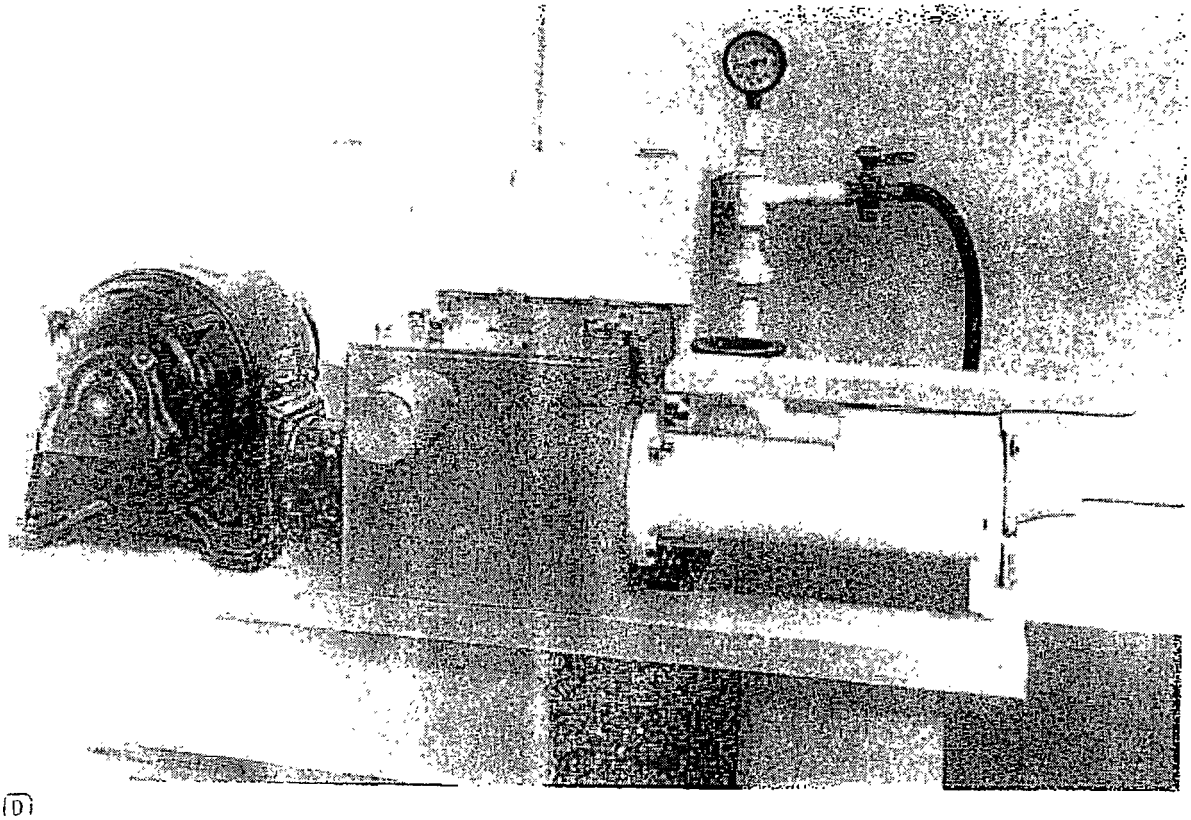

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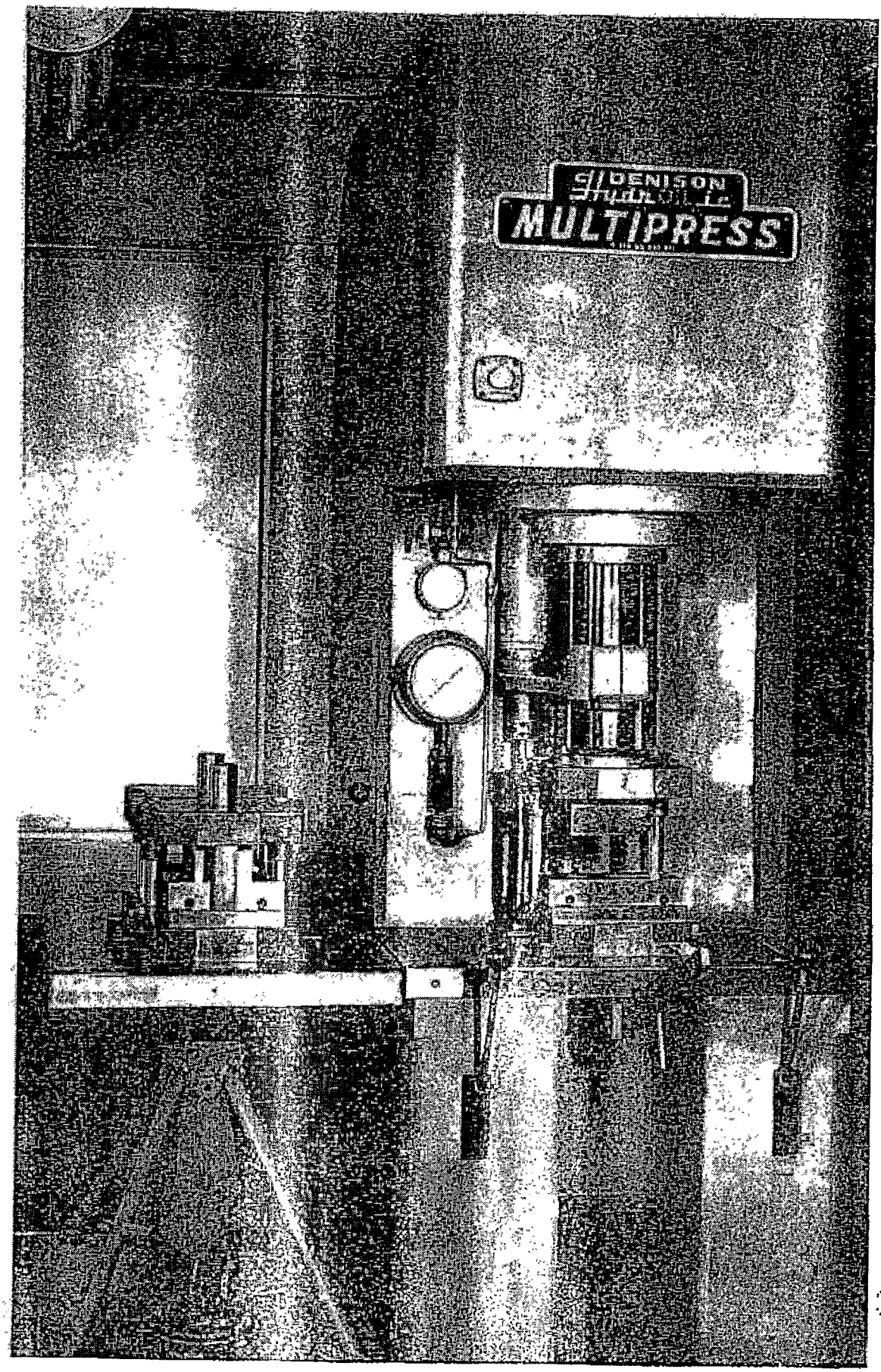
DENISON
MULTIPRESS

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Hydraulic Tile Press

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Marriott Tube Viscosimiter, Brookfield Viscosimiter and Stormer Viscosimiter

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Tinius Olson Hydraulic Modulus of Rupture Machine

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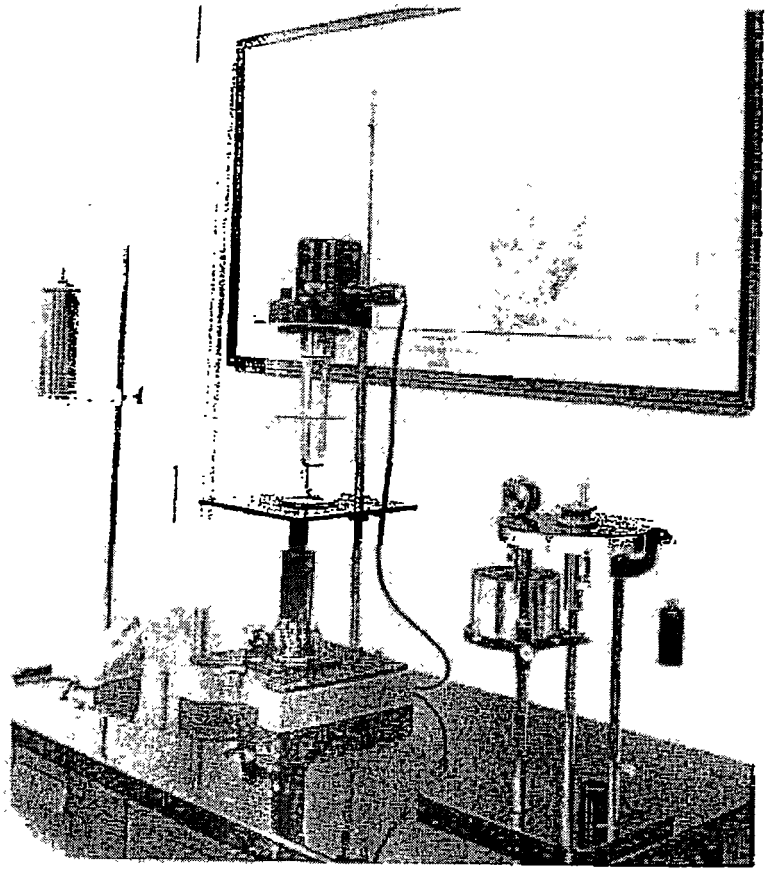

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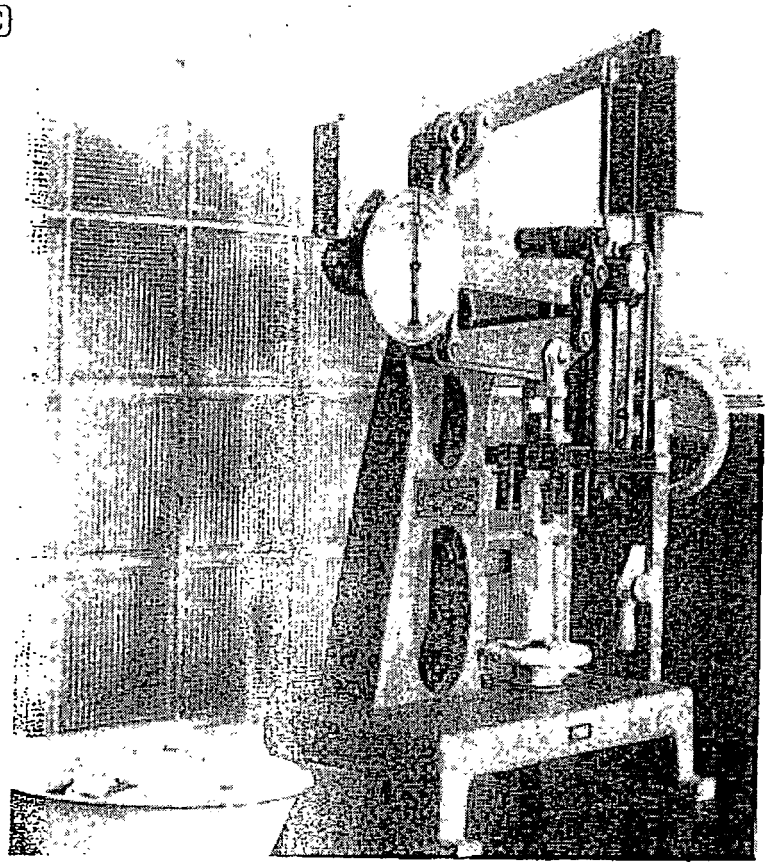

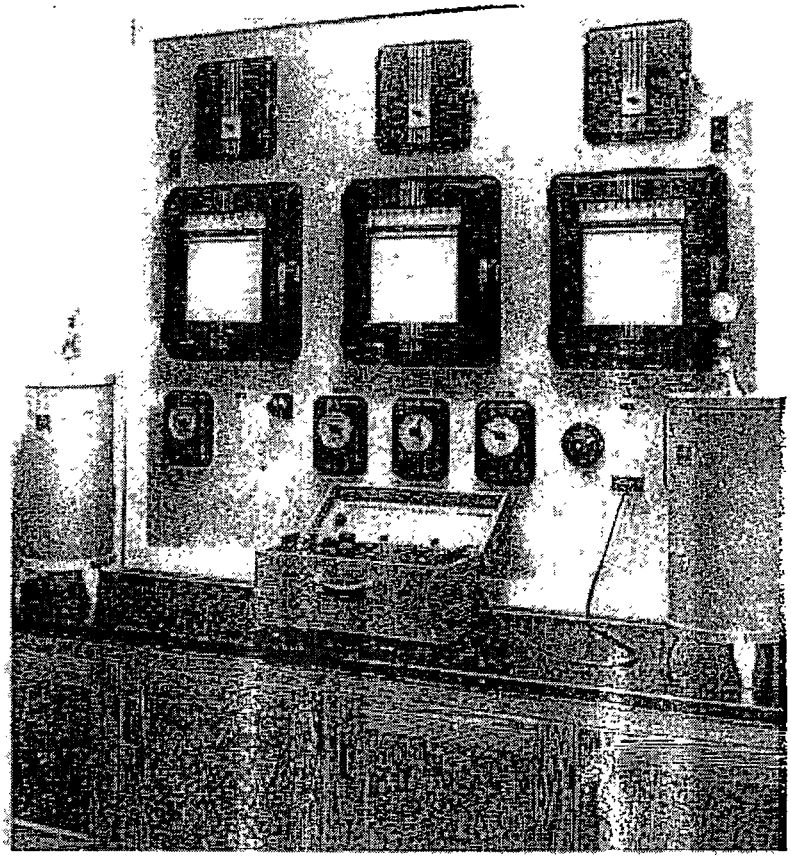

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Control Panel for Kiln and Thermal Expansion Furnaces

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Pereny Laboratory Tunnel Kiln for Fast Fire Tile

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Stone Temperature Gradient Furnace

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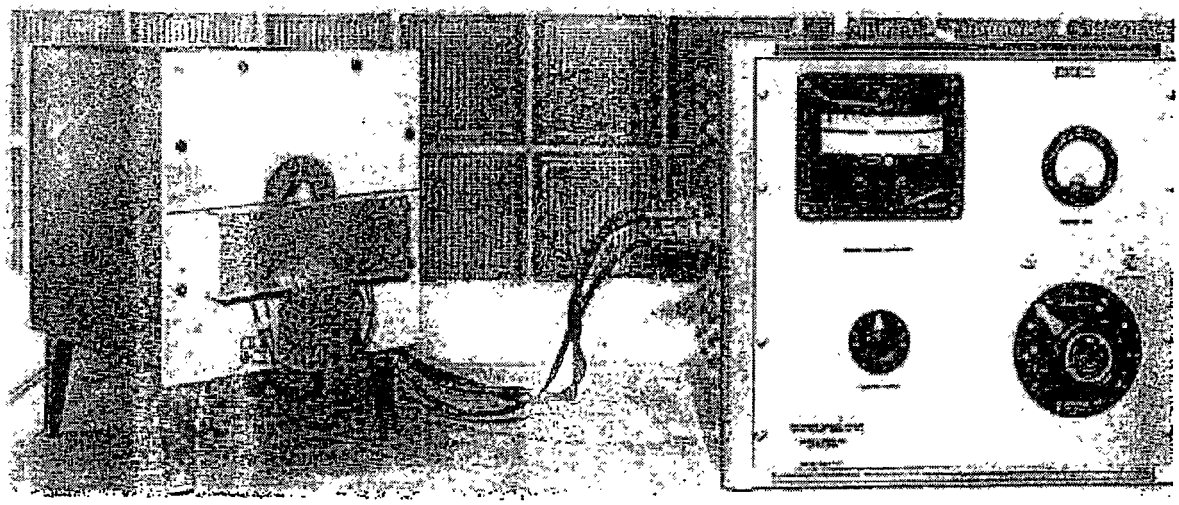
Pereny Test Kilns



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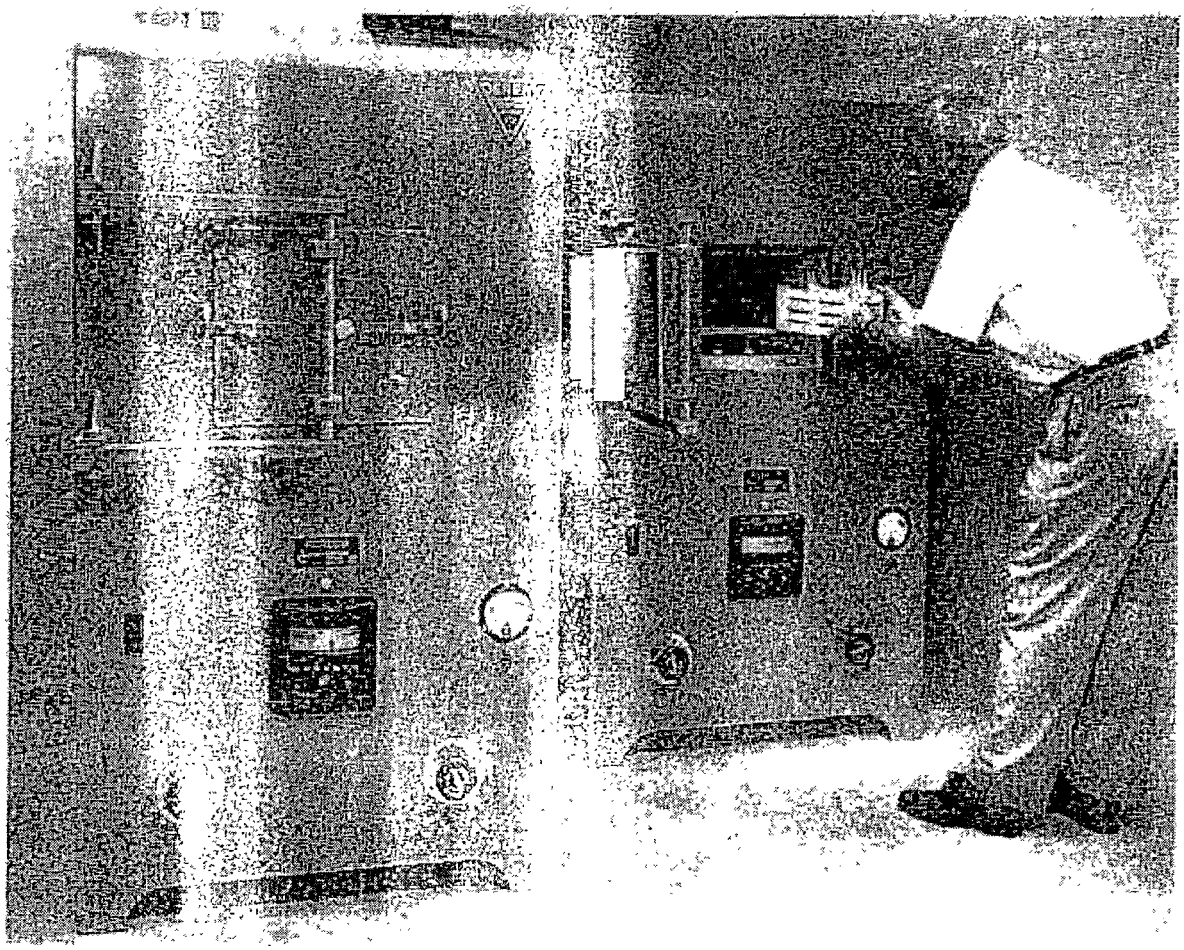

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