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WAREHOUSE STOCKS

San Francisco, Calif.

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(5)

Results

SEVEN YEARS OF EXTERIOR PAINT DEVELOPMENT

KREBS PIGMENT & COLOR CORP.
GENERAL OFFICES
1007 ORANGE STREET WILMINGTON, DELAWARE

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EXTERIOR PAINTS

Following preliminary exploratory work, which extended over a period of more than two years, Krebs Pigment & Color Corporation started in January 1932 a systematic and extensive study of the exposure characteristics of exterior paints and the development of improved products based on the information obtained from these exposure studies. The objectives of this program fall into three classes. First, a determination of the characteristics and relative durability values of the various commonly used prime pigments, modifying agents, and extenders. Second, the development of the best possible exterior paint formulas from the materials available. Third, the use of the information obtained to assist established paint manufacturers and to guide the development of improved pigments designed to give more satisfactory results in exterior paints.

In a comprehensive study of this sort it is necessary to observe the durability characteristics of exterior paints in a variety of climates and under various conditions of exposure. Test fences were erected near Wilmington, Delaware; Hialeah, Florida; and Amarillo, Texas. Exposures were made with panels inclined 45° facing South and with vertical panels facing both North and South. Paints giving promise of good durability were also exposed on houses, as will be described in greater detail later in this booklet.

The panels used, except in instances where the studies involved various woods, were selected edge grain white pine. The panels were painted on the backs and edges with a good protective coating prior to the application of the test paint to the front of the panel. In general, three-coat self-primed systems were used.

In order to reduce the number of variables involved in these tests, certain factors in the paints were held constant. These constants are vehicle composition, type and amount of drier, pigment volume calculated on the non-volatile vehicle, consistency, and method of application.

In this three-coat self-primed system, the following reductions were used for the various coats. First coat—paint thinned with one pint of linseed oil per gallon. Second coat—paint thinned with one-half pint of linseed oil per gallon. Third coat—paint used without thinning.

In preparing the panels, the following painting schedule was followed as closely as possible. The paint applied for the first coat was allowed to dry for two days before application of the second coat. A drying period of three days was allowed after the application of the second coat before the third coat was applied. The panels were placed on the fences as soon as possible after the third coat had dried.

Various climatic conditions have a marked effect, both upon the rate of failure of an exterior paint and upon the type of failure. For instance, paints exposed in Florida at 45° South show earlier chalking, fading, and mildew, as well as dirt collection. The Florida climate represents conditions of continually high humidity with relatively high temperatures and with moderate temperature variations. Texas exposures have consisted largely of yellow pine panels at 45° South and were designed to give information on the effects of a climate predominantly low in humidity with severe temperature variations. Such climatic conditions tend to accelerate checking and cracking failures. Both the yellow pine panels and the 45° position also tend to accelerate failure. The accelerated results do not always parallel the effects noted on subsequent house tests, but are sufficiently accurate for preliminary weeding out of poor combinations.

The Delaware exposures have consisted of panels placed in 45° South, South vertical, and North vertical positions. The climatic conditions of Delaware approximately duplicate those of a large portion of the United States without accenting any one of the various types of paint failures.

The exposed panels have been inspected periodically with particular attention being given to such paint film changes as chalking, checking (including microscopic checking), cracking, flaking, erosion, dirt collection, mildew, and general appearance. In the case of tinted paints, special consideration was given to tint retention and discoloration. In certain instances, screen staining has also been investigated. The progress of each of the paint films was followed throughout the life of the paint, the final observation being directed to the type of surface left for repainting after the failure of the original paint. Such tests as these have permitted the accumulation of exhaustive data from the thousands of paints exposed. Naturally, certain combinations of materials have displayed more promising results than others and these more promising paints have been subjected to additional tests by actually painting houses with them. These houses, situated in various parts of the United States, have been carefully selected and prepared for these tests. Whenever possible, the previous painting history of these houses has been ascertained. If the earlier paint was in suitable condition, the test paint was applied over it. If the house was not suitable for repainting because of bad paint failure, severe moisture conditions or for other reasons susceptible of correction, the proper preliminary steps were taken including removal of old paint, elimination of leaks, special treatment of sappy wood, etc., before application of the test paint. In the case of each house painted, several control paints were applied so that relative paint failures could be observed under similar conditions of application and exposure.

The painting of test houses has in each case been carefully controlled to assure that the test paints were applied for each coat strictly in accordance with the above mentioned reductions. Great care was also exercised to assure that the control paints were applied with equal care and with strict avoidance of any contamination of one paint with another. When commercial paints were used as controls, they were reduced according to the manufacturer's instructions.

As in the case of the panels on the test fences, these especially painted houses have been inspected at regular intervals and records made of the condition of each paint on each side of the house, with particular attention being directed to any defects as these became evident. Comparisons between the test paints and the control paints have been regarded as highly important in every instance.

Throughout this extensive study of exterior exposures every effort has been made to obtain a complete and unbiased record of the relative merits of various pigment and vehicle combinations used by the paint industry. A wide range of pigment and extender combinations, both those long used and those newly developed, has been investigated. There has been a constant effort to develop new and better exterior paints. New ideas in paint construction, new pigments, and new vehicles have been evaluated. Every precaution has been taken to assure the accuracy of the data accumulated. No effort has been made to acquire a mass of data designed to substantiate any preconceived ideas regarding the merits of any specific pigments, or of any particular types of paint. Decisions were reserved until conclusive data were available. These data, moreover, are open to all members of the paint-making industry, who are cordially invited to inspect our test fences, house painting tests and exposure records and are urged to draw their own conclusions from the data and exhibits at hand. Many paint manufacturers desirous of improving the characteristics of their exterior paints have found such a review to be of great assistance.

It might be of interest to point out that the exposure information obtained indicates marked differences in type and rapidity of failure as the result of various climatic conditions and it is therefore necessary to correlate, intercompare, and interpret individual observations as received, in order to arrive at reliable conclusions. The variations in climatic conditions from year to year in any locality are sufficient to change somewhat the durability of any particular paint and it has therefore been found to be desirable to repeat tests in any given exposure area before drawing final conclusions. Further, there are likely to be differences between panel exposures and house tests, to say nothing of the differences which develop between 45° and vertical panels, although the South vertical panels usually give results in close agreement with house tests. Repeated tests on numerous panels are also necessary to differentiate between wood failures and paint failures.

Turning again to the effects of climate, it has been noted that exposures in Florida show more rapid chalking and erosion with less evidence of checking and cracking failures than are exhibited by the same paints exposed in the same manner in Delaware. This indicates that paints prepared for use in Florida and in similar climates should be slightly harder than paints prepared for use in Delaware and the Middle West.

A climate such as that in Amarillo, Texas, on the other hand, produces earlier checking and cracking, with a greater degree of cracking and flaking. than does the Florida climate and it therefore seems evident that paints designed for a Texas type of climate should be of the softer and more flexible type.

With regard to the type of panel exposures, it may be mentioned that panels inclined 45° to the South exhibit such an acceleration of failure that such panels can often be used to provide helpful preliminary evaluations in a limited time, but this acceleration of failure indicates that the results obtained from 45° exposures should not be accepted as final without very definite reservations. In fact, it is often true that the durability results, as well as information on dirt collection and general appearance as obtained from 45° South panels, are very misleading. 45° exposures may show widely different relative dirt collection as compared to the relative dirt collection on the same paints exposed on South vertical panels. This affects durability and makes the 45° results unreliable. With experience, however, the 45° exposures can be so read and interpreted as to yield preliminary valuable information.

North vertical exposures are particularly helpful in making accurate evaluations of dirt collection, mildew, and variations in paint appearance. These phenomena are usually accentuated and prolonged on such exposures.

Experience indicates that data from prolonged vertical exposures, supplemented by repeated tests on both test fences and test houses, are required before it is possible to obtain a reliable evaluation of any exterior paint.

EVOLUTION OF EXTERIOR PAINTS

There has been a gradual evolution in the construction of exterior house paints, activated by the constant desire of manufacturers to produce improved products having better durability and lower cost, with greater consumer satisfaction. The evolution of these paints has carried them from lead-in-oil to lead-zinc paints, subsequently to lithopone exterior paints, and finally to those carrying titanium pigments.

The lead-zinc paints, in comparison with lead-in-oil paints, show less dirt collection, greater resistance to mildew, and an improved tint retention. The advantage achieved in the way of reduction of dirt collection is not adequate, however, to counterbalance the sacrifices in durability which result from the greater tendency of lead-zinc paints to fail by cracking and flaking, since this type of failure results in poor repaint surfaces.

The adoption of lithopone or zinc sulfide type paints, in which these pigments are combined with leaded zinc oxide and extender in the optimum proportions, gives improvements in hiding power, cleanliness, and whiteness, as compared with lead-zinc paints, and at the same time yields durability characteristics essentially equal to those shown by lead-in-oil paints. Actually, the lithopone paints retain the good tint retention characteristics of lead-zinc paints and offer at the same time significantly superior durability, with better surface for repainting.

The titanium type paints, which are the latest stage of this evolution, give still further improvements in hiding power, whiteness, and freedom from dirt collection, with still better durability than is exhibited by the lithopone paints. Paints containing titanium pigment properly combined with other pigments and extenders have exhibited properties far superior to those of any of the older type paints. Recent developments in house paint technology have dealt primarily with the production of improved titanium pigments and the methods of incorporating them most advantageously into exterior paints.

Present-day house paints can be divided into three classes—first, white paints; second, tinted paints; and third, paints which may be used as either whites or tints.

...WHITE PAINTS

White exterior paints which are exceptionally clean and have outstanding whiteness, as well as good durability, can be made from titanium pigments. "Ti-Sil" titanium magnesium pigment offers peculiar advantages over other extended titanium pigments because it contributes to exterior paints unusual resistance to checking and cracking. "Ti-Sil" is an extended titanium pigment, consisting of approximately 30% of titanium dioxide and 70% of selected magnesium silicate, intimately blended and treated to give easy working properties in the paint plant and exceptional results in the finished paint.

Exterior house paints with highly desirable characteristics can be made with the "Ti-Sil" content ranging between 35% and 50% of the total pigment. The amount of "Ti-Sil" used will depend to some extent on the hiding power desired. A second ingredient of these "Ti-Sil" exterior paints should be cofumed 35% leaded zinc oxide. The leaded zinc oxide content should range between 40% and 50% of the total pigment, to provide sufficient resistance to chalking and to inhibit mildew. The balance of the pigmentation for best results should consist of selected extenders, particularly of the magnesium silicate type. The third component can be basic carbonate white lead, instead of extender, but it should be recognized that the substitution of white lead for extender will be accompanied by a slight but noticeable impairment of paint durability in the form of slender cracking at about three years. Good repaint surfaces remain, however.

In developing formulas for exterior paints, it is necessary to maintain pigment-binder ratios within reasonable limits. As a guide, it may be stated that a pigment-binder ratio by volume of 1:2.5 (which is equivalent to 28.5% pigment by volume based on the non-volatile portion of the paint) generally yields a normal consistency paint with the addition of thinner in amounts ranging from 0% to 15% by volume of total paint.

It is generally recognized that the pigment volume in exterior paints, calculated on the non-volatile portion, should not be significantly less than 28.5%. It will be noted that the formulas given subsequently in this booklet show pigment volumes of approximately that percentage.

If the pigment volume is increased significantly, the paints show a greater tendency to chalk, with resultant shorter life. Too low pigment volumes may lead to an "alligator" type of cracking. As a compromise, 28.5% pigment volume is regarded as a reasonable standard for orthodox exterior paints.

It has been mentioned previously that one of the factors held constant in this study of exterior paints is the vehicle. The vehicle used consisted of 92% alkali refined linseed oil and 8% kettle bodied linseed oil, body "Q." With this binder there was incorporated the required amount of high lead-low manganese linoleate type of drier and sufficient mineral spirits to yield satisfactory consistency for application.

It is recognized that acid refined linseed oil is used to a considerable extent, but its use should be surrounded by sufficient precautions to assure a fairly low and constant acid number, to secure uniform consistency and avoid the possibility of granulation on aging. These precautions are particularly important if reactive materials are present in the pigmentation because of the danger of the formation of metallic soaps with excessive free fatty acids. The same comments may well be applied to the use of raw oil.

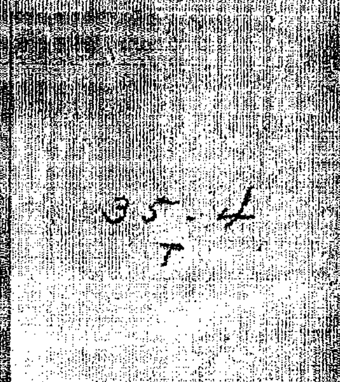
For those who desire to test a typical white exterior paint, based on the pigment "TI-SIL," the following formula is suggested for consideration:

	1 Gallon	100 Gallons
"TI-SIL"	3.08 lbs.	308 lbs.
"TOMAHAWK" Cofumed 35% Leaded Zinc Oxide	3.70 "	370 "
Magnesium Silicate	1.47 "	147 "
Alkali Refined Linseed Oil	4.43 "	52.7 gals.
Kettle Bodied Linseed Oil (Body "Q")	.38 "	4.8 "
Drier "P"	.25 "	2.8 "
Mineral Spirits	.61 "	9.4 "
	13.92 lbs.	

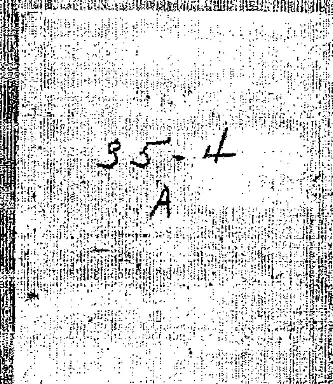
In this formula, the pigment ratios are: 37.3/45/17.7—"TI-SIL"/cofumed 35% leaded zinc oxide/magnesium silicate. This formula under normal conditions of exposure gives excellent durability and a clean, white appearance. Ultimate failure is by slow chalking, but its resistance to checking and cracking is outstanding, thus leaving an excellent surface for repainting.

1

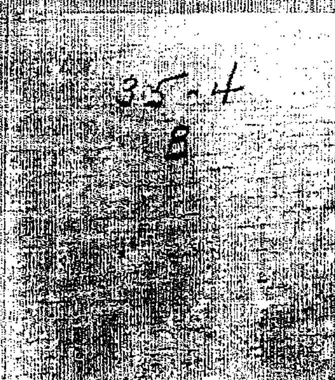
House Test
Avondale, Penna.
33 Months
South Vertical



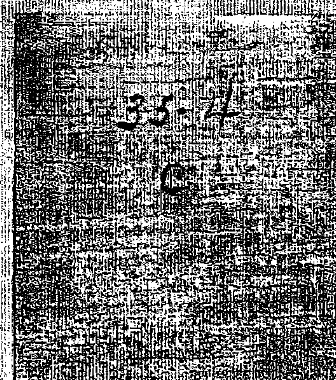
37.3/45.0/17.7—"TI-SIL"/ cofumed 35% leaded ZnO/ magnesium silicate



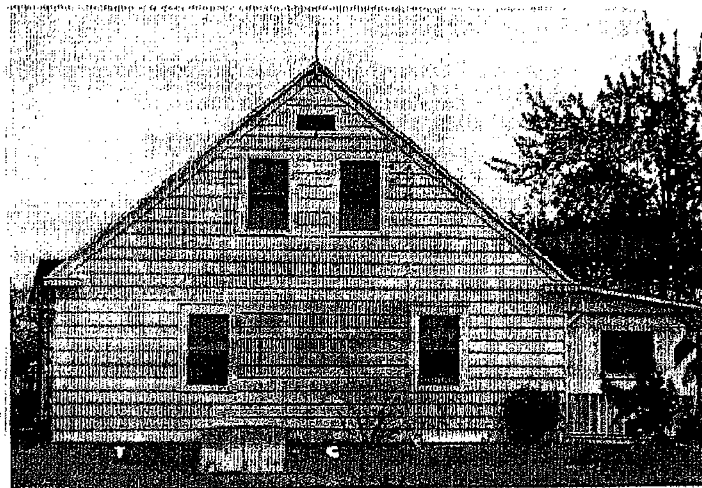
30/30/30/10—"TI-BAR"/ BCWL/ZnO/magnesium silicate



60/30/10—BCWL/ZnO/ magnesium silicate

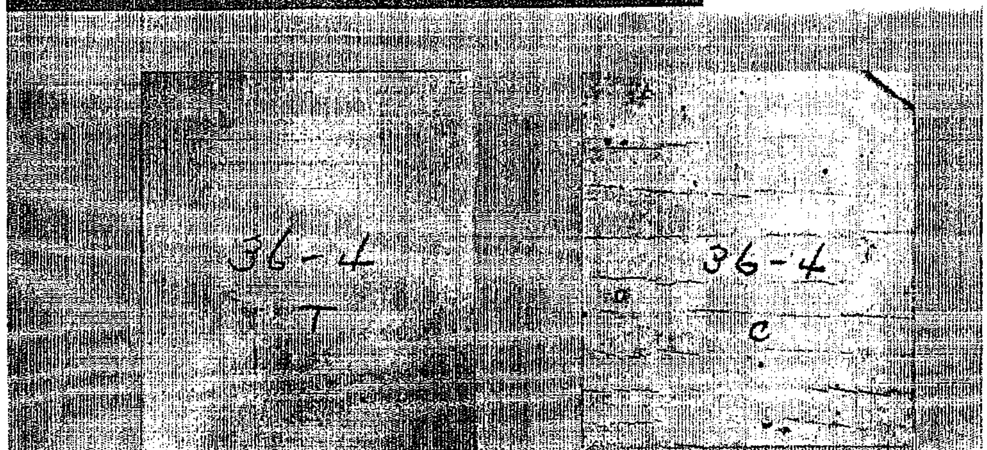


BCWL in Oil



1A

House Test
Avondale, Penna.
19 Months
North Vertical



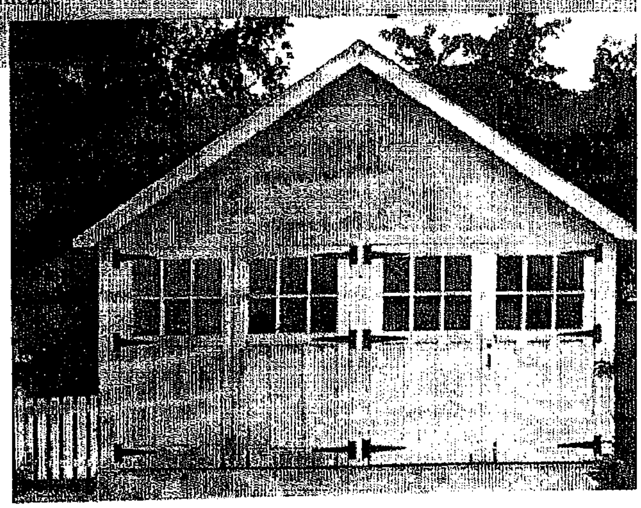
T—37.3/45.0/17.7—"TI-SIL"/
cofumed 35% leaded ZnO/
magnesium silicate

C—BCWL in Oil

1B

Garage Test
Wilmington, Del.
12 Months
South Vertical

Left door—Zinc sulfide magnesium pigment.
Right door—"TI-SIL."



See Illustrations Nos. 1, 1A, and 1B. It should be noted that the "TI-SIL" and "TI-BAR" type paints, as shown by these photographs, are exceptionally white and clean. This is due to the inherent self-cleaning characteristic of these paints. The darker portions of these same photographs show the dingy appearance common to many paints which collect dirt excessively and which do not have this inherent self-cleaning property.

Two modifications of the above paint have found considerable use. They are as follows:

First Modification—A revision of the pigmentation toward a 50/50—"TI-SIL"/cofumed 35% leaded zinc oxide combination to achieve greater hiding power can be made without any sacrifice in either durability or appearance.

Second Modification—The magnesium silicate extender can be replaced by white lead to achieve a pigment combination of 32.5/45/22.5—"TI-SIL"/cofumed 35% leaded zinc oxide/basic carbonate white lead, for the purpose of increasing the gallon weight, and for the purpose of having basic carbonate white lead present to satisfy some trade requirements in this direction. Such a substitution of white lead for extender causes a noticeable decrease in durability, but gives a slight improvement in brushability as compensation.

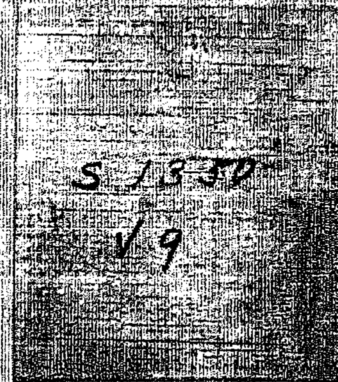
These two modifications are illustrated by the following formulas:

	First	Second
"TI-SIL"	4.25 lbs.	3.14 lbs.
"TOMAHAWK" Cofumed 35% Leaded Zinc Oxide	4.25 "	4.37 "
Basic Carbonate White Lead	—	2.19 "
Alkali Refined Linseed Oil	4.32 "	4.26 "
Kettle Bodied Linseed Oil (Body "Q")	.38 "	.37 "
Drier "P"	.25 "	.24 "
Mineral Spirits	.75 "	.81 "
Total weight in pounds per gallon	14.20 "	15.38 "

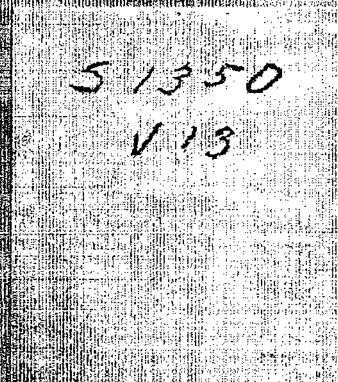
"TI-BAR" titanium barium pigment or "TI-CAL" titanium calcium pigment may be substituted for "TI-SIL" on an equal TiO_2—equal volume basis in any of the formulas given above, with slight but noticeable sacrifice

2

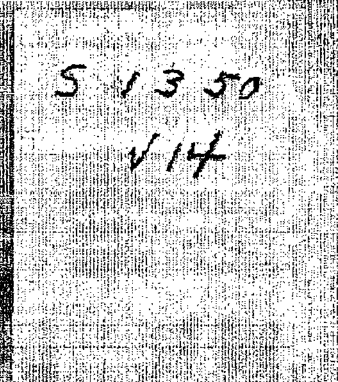
"TI-SIL" Improving Durability
41 Months, Delaware
South Vertical



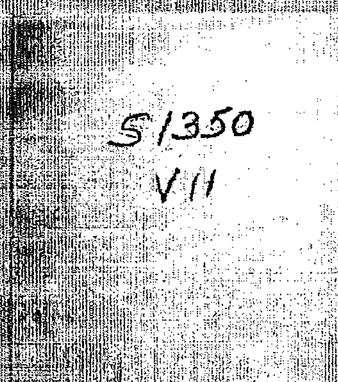
60/30/10—BCWL/ZnO/magnesium silicate—control paint



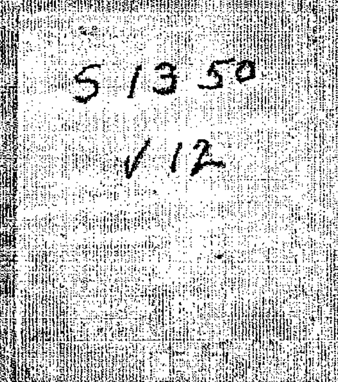
40/40/20—"TI-BAR"/cofumed 35% leaded ZnO/magnesium silicate



"TI-SIL" replacing "TI-BAR" in S-1350—13



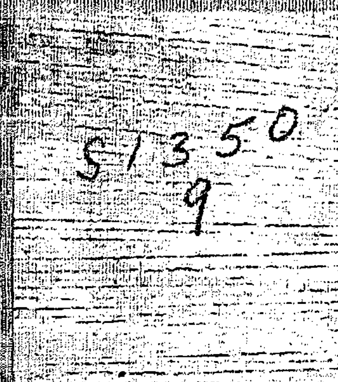
40/42/18—"TI-BAR"/cofumed 35% leaded ZnO/BCWL



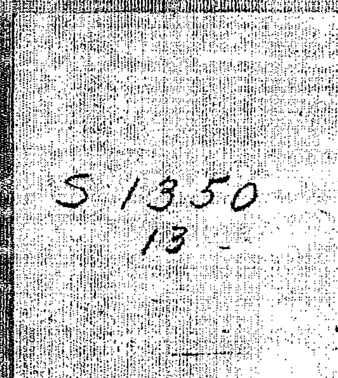
"TI-SIL" replacing "TI-BAR" in S-1350—11

2A

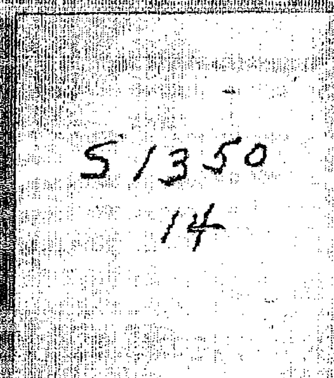
"TI-SIL" Improving Durability—
41 Months, Delaware,
45° South



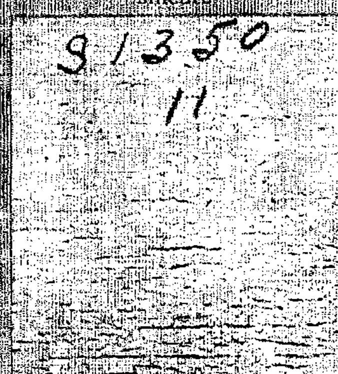
50/30/10—BCWL/ZnO/ magnesium silicate —control paint



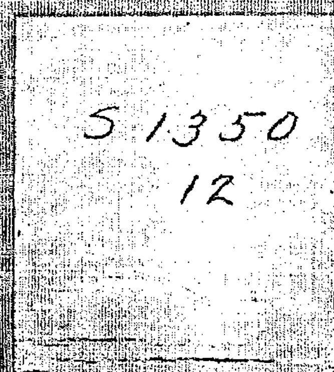
40/40/20—"TI-BAR"/cofumed 35% leaded ZnO/magnesium silicate



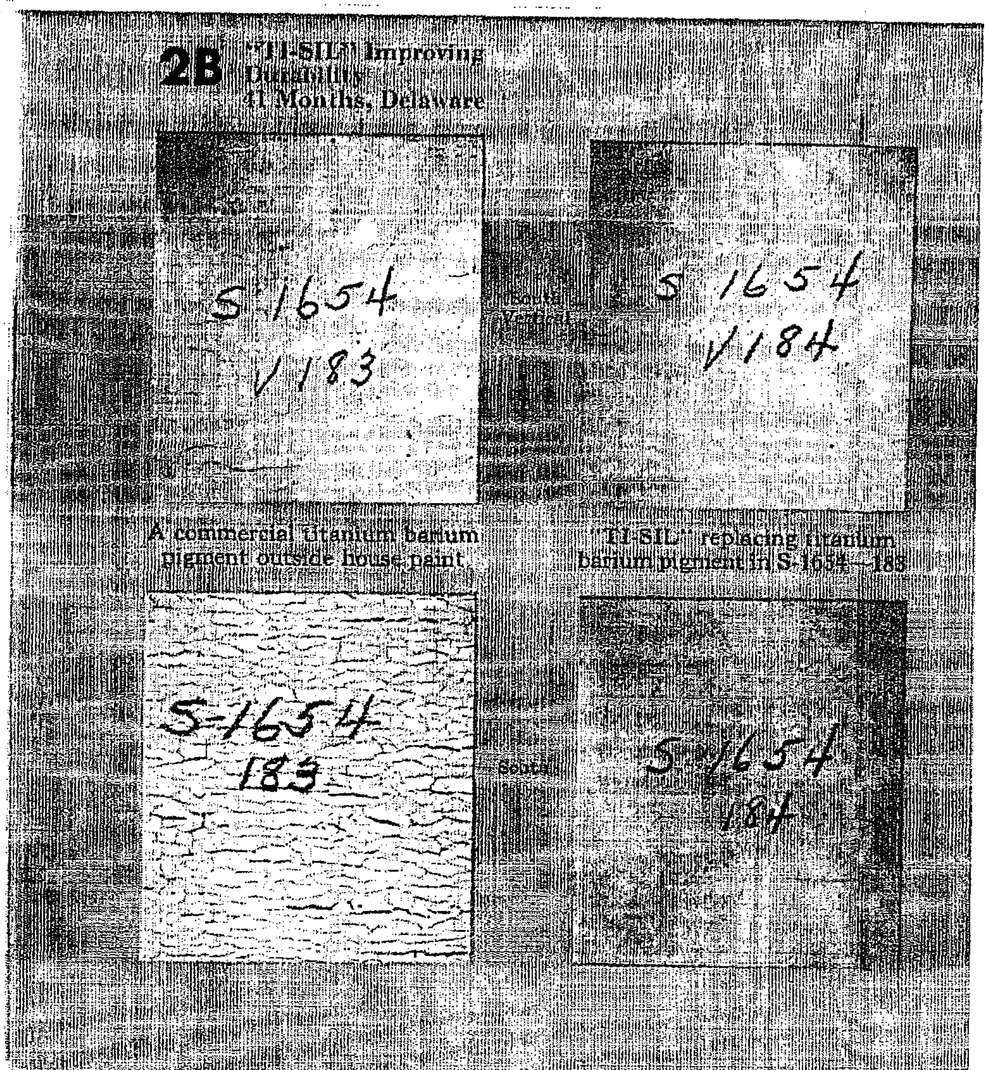
"TI-SIL" replacing "TI-BAR" in S-1350—13



40/42/18—"TI-BAR"/cofumed 35% leaded ZnO/BCWL



"TI-SIL" replacing "TI-BAR" in S-1350—11



in durability. Conversely, replacement of a titanium barium pigment, or a titanium calcium pigment, by "Ti-Sil" in an exterior paint produces an improvement in durability. It is generally true that the poorer the durability yielded by the original formula, the greater will be the durability improvement obtained by the substitution of "Ti-Sil." See Illustrations Nos. 2, 2A, and 2B.

TINTED PAINTS

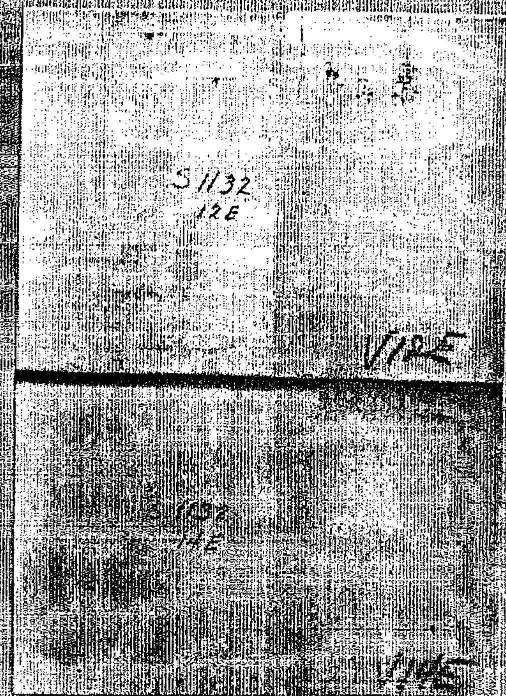
Tinted exterior paints prepared from extended titanium pigments show excellent durability characteristics, coupled with poor resistance to fading in tints. This difficulty can be overcome by the use of "TI-TINT" tinted titanium dioxide or by the use of the new "TI-PURE" O titanium dioxide pigment which is discussed later in this booklet.

Properly constructed "TI-TINT" paints exhibit excellent application properties, marked cleanliness, reduced chalking, and superior durability, with definitely reduced fading tendencies. "TI-TINT" paints exhibit a mild degree of chalking, which enhances their self-cleaning characteristics, but the chalk which is liberated is colored instead of white, which definitely reduces fading tendencies. See Illustrations Nos. 3, 3A, 3B, and 3C. A "TI-TINT" formula which offers exceptional value carries a pigmentation of 18.3/42.7/39—"TI-TINT"/cofumed 35% leaded zinc oxide/magnesium silicate. This formula in working form appears as follows:

	1 Gallon	100 Gallons
"TI-TINT"	1.51 lbs.	151 lbs.
"TOMAHAWK" Cofumed 35% Leaded Zinc Oxide	3.52 "	352 "
Magnesium Silicate	3.22 "	322 "
Raw Linseed Oil	4.36 "	56.4 gals.
Kettle Bodied Linseed Oil (Body "Q")	.38 "	4.8 "
Drier "P"	.25 "	2.8 "
Mineral Spirits	.68 "	10.4 "
Total	13.92 lbs.	

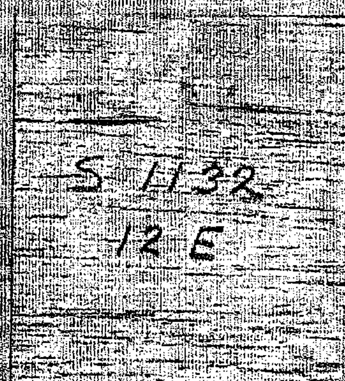
"TI-TINT" is available in three shades—light gray, dark gray, and light buff. Frequently, paints of standard tint can be produced from these "TI-TINTS" without the use of additional color. In case additional tinting is necessary, it may be mentioned that the "TI-TINT" paints can be tinted to a darker shade without sacrifice of tint retention, but tinting such paints to

3 Non-Fading of "TI-TINT"

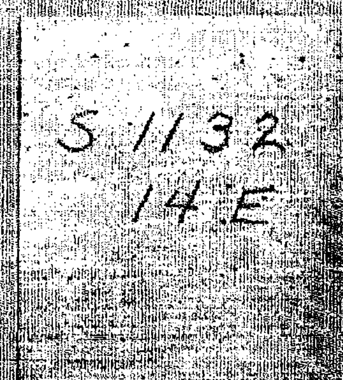


Unwashed Washed
41 Months Delaware South Vertical

39 Months Delaware 45° South

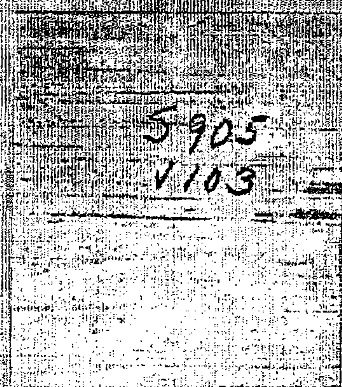


12E—50/35/15-BCWL/ZnO/ magnesium silicate



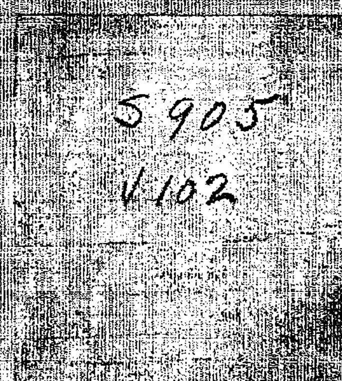
14E—15/30/55—"TI-TINT" cofumed 35% leaded ZnO/ magnesium silicate a lighter shade by the use of additional white pigment results in a proportionate decrease in fade resistance.

In the preparation of "TI-TINT" paints, it is possible to vary the ratio of prime pigment to extender over fairly wide limits, with corresponding variations in hiding power and cost, but with little, if any, variation in durability characteristics, if the pigment volume is held constant and the leaded zinc oxide content is held at about 40 to 45%.

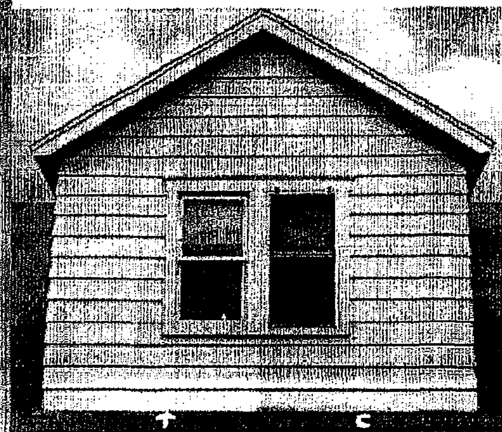


20/40/40—TiO_2/cofumed 35% leaded ZnO/magnesium silicate

3A Non-Fading of "TI-TINT" 50 Months Delaware South Vertical



"TI-TINT" replacing TiO_2 in S-905—103

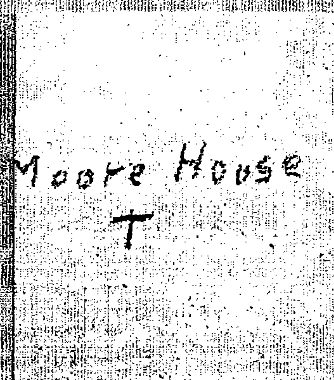


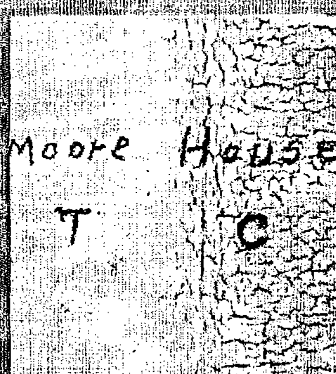
3B

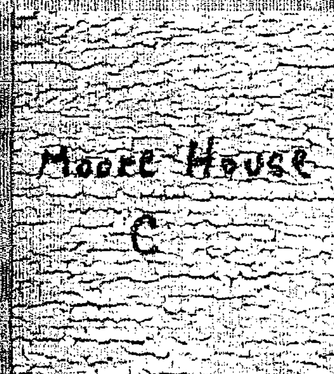
House Test
Wilmington, Delaware.
48 Months South Vertical

T—25/25/50—TI-TINT/
refined 35% leaded
ZnO/barytes

C—30/35/35—BCWL/ZnO/
magnesium silicate

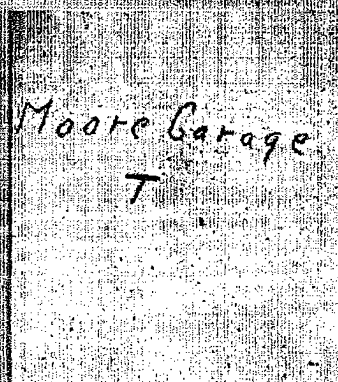






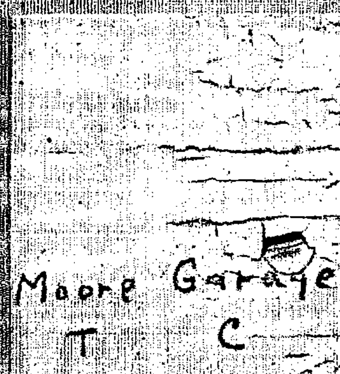
3C

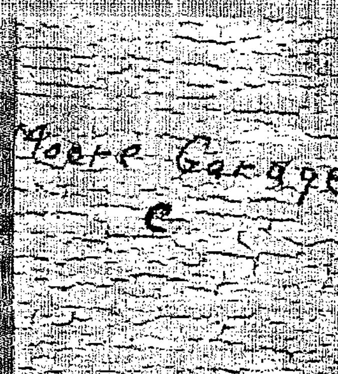
Garage Test
Wilmington, Del.
48 Months
South Vertical



T—25/25/50—"TI-TINT"/
cofumed 35% leaded
ZnO/barytes

C—50/35/15—BCWL/ZnO/
magnesium silicate
South Vertical





"PONOLITH" PAINTS

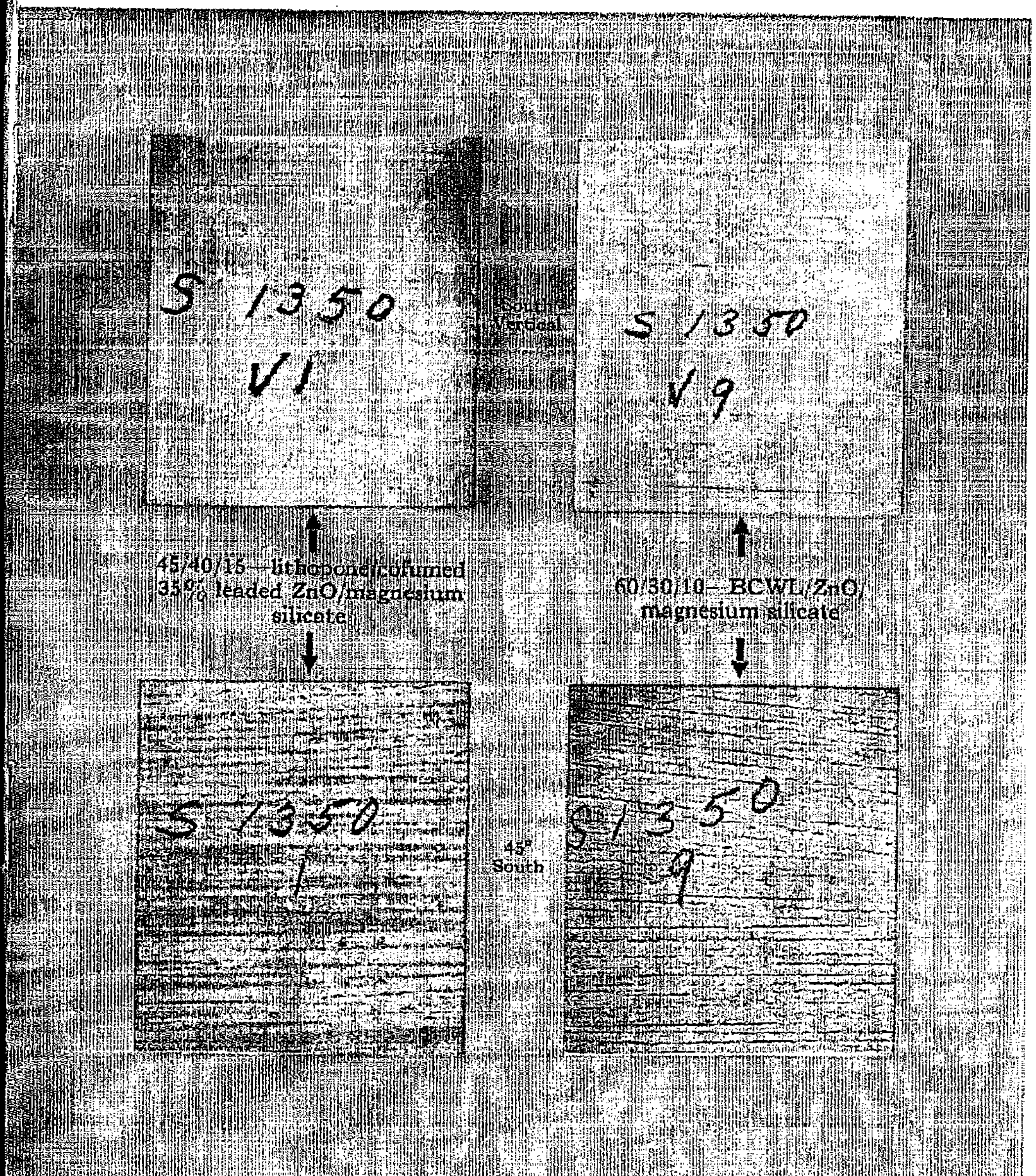
Compromise exterior paints, *i.e.*, house paints intended for use either as whites or tints, are frequently in demand. The use of such compromise formulas involves the necessity of sacrificing some of the superior durability characteristics of paints intended solely for whites or exclusively for tints and accepting also some decrease in tint retention, as compared with formulas intended for tinted paints exclusively. A compromise paint of this type, which shows perhaps a minimum loss in desirable paint characteristics, is one which is generally designated as Modified Formula K. It is a lithopone type exterior paint, in which the pigment combination is 45/40/15-lithopone/cofumed 35% leaded zinc oxide/magnesium silicate. See Illustrations Nos. 4 and 4A.

The working formula for this paint is as follows:

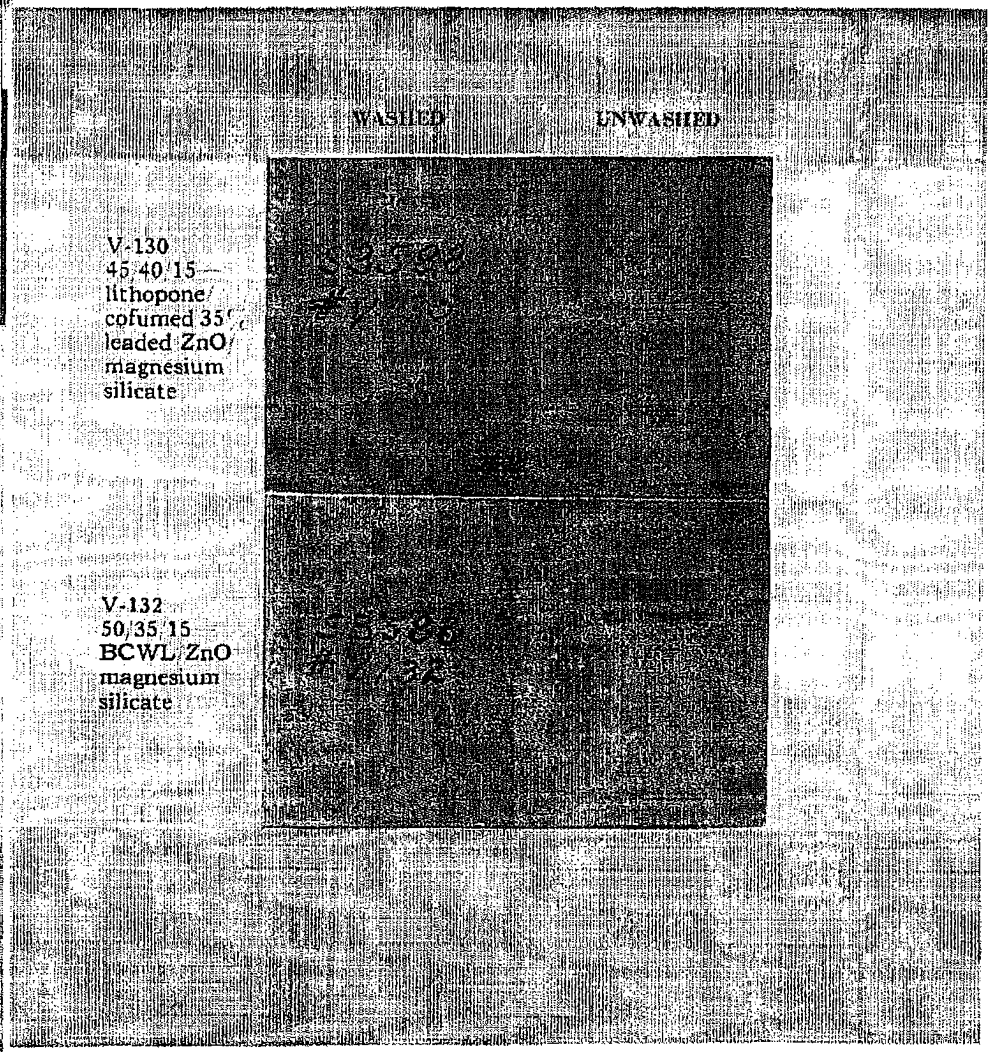
	1 Gallon	100 Gallons
"PONOLITH" Lithopone	4.09 lbs.	409 lbs.
"TOMAHAWK" Cofumed 35% Leaded Zinc Oxide	3.64 "	364 "
Magnesium Silicate	1.36 "	136 "
Alkali Refined Linseed Oil	4.20 "	54.2 gals.
Kettle Bodied Linseed Oil (Body "Q")	.37 "	4.7 "
Drier "P"	.24 "	2.7 "
Mineral Spirits	.90 "	13.8 "
Total	14.80 lbs.	

Modified Formula K is a revision of the well-known and widely accepted Formula K, produced by slightly increasing the lithopone content and decreasing the leaded zinc oxide. The original Formula K carried a pigment combination of 40/45/15—lithopone/cofumed 35% leaded zinc oxide/magnesium silicate. This revision of Formula K produces a paint with a slightly greater chalking tendency, but with improved durability and little, if any loss of tint retention.

4 Durability of Modified Formula K vs. Lead-Zinc 41 Months Delaware



4A Tint Retention of Modified Formula K vs. Lead-Zinc 8 Months Delaware South Vertical



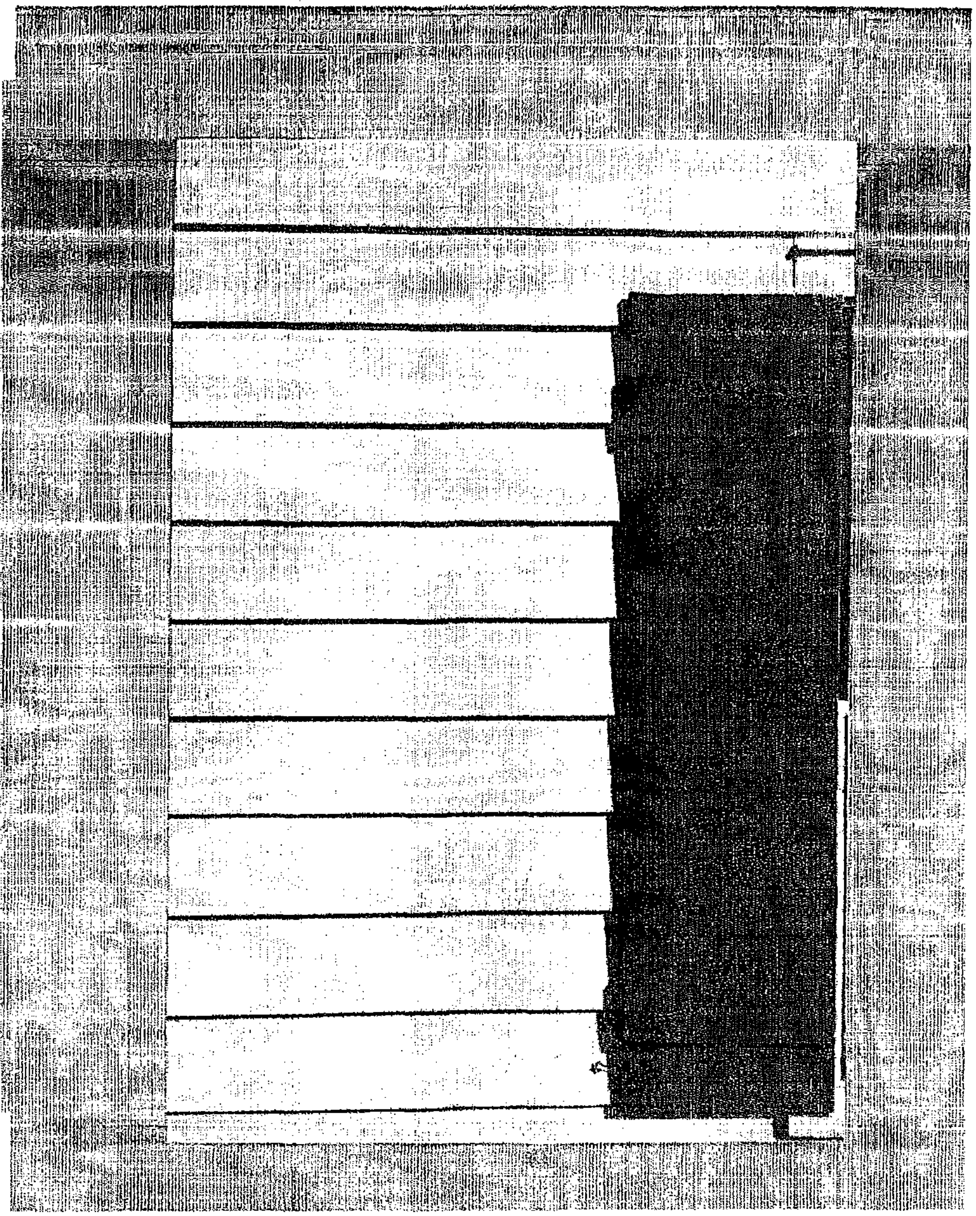
"TI-PURE" O PAINTS

Recently, a new pigment has been placed on the market and designated as "TI-PURE" O. It is essentially pure titanium dioxide, especially processed to give improved tint retention upon exterior exposure in colored finishes, accompanied by the well-known and superior durability which characterizes titanium dioxide. This pigment has exceptional merit in exterior paints, providing as it does the durability and high hiding of titanium dioxide without its tendency to fade in tinted paints.

"TI-PURE" O is a white pigment with a slightly yellow undertone. It is considerably more chalk resistant than normal titanium dioxide and is even more chalk resistant than "TI-TINT." It provides the paint manufacturer with an opportunity of producing a single base paint for whites and a full line of tints. "TI-PURE" O offers markedly superior properties for tints, though it is recognized that in whites it does not yield quite the clear brilliant outstanding white of ordinary titanium dioxide. "TI-PURE" O can be used throughout a wide range of percentages in exterior paint formulas, which gives considerable leeway in meeting hiding power and cost requirements. In preparing "TI-PURE" O exterior paints, sufficient cofumed 35% leaded zinc oxide should be incorporated to inhibit mildew. 40 to 45% of cofumed 35% leaded zinc oxide has given adequate protection. Likewise, sufficient extender should be used to give the paint a normal pigment volume. Under these conditions, paints will be produced which are fully equal to lead-in-oil paints in color, but with better durability, cleanliness, and tint retention than lead-in-oil or lead-zinc paints. See Illustrations Nos. 5, 5A, and 5B.

In order to make these suggestions more specific, it can be said that such pigment combinations as 12/44/44 or 18.3/42.7/39—"TI-PURE" O/cofumed 35% leaded zinc oxide/magnesium silicate can be used with excellent satisfaction. To illustrate the incorporation of these suggestions in practical working formulas, two specific instances are given on page 28.

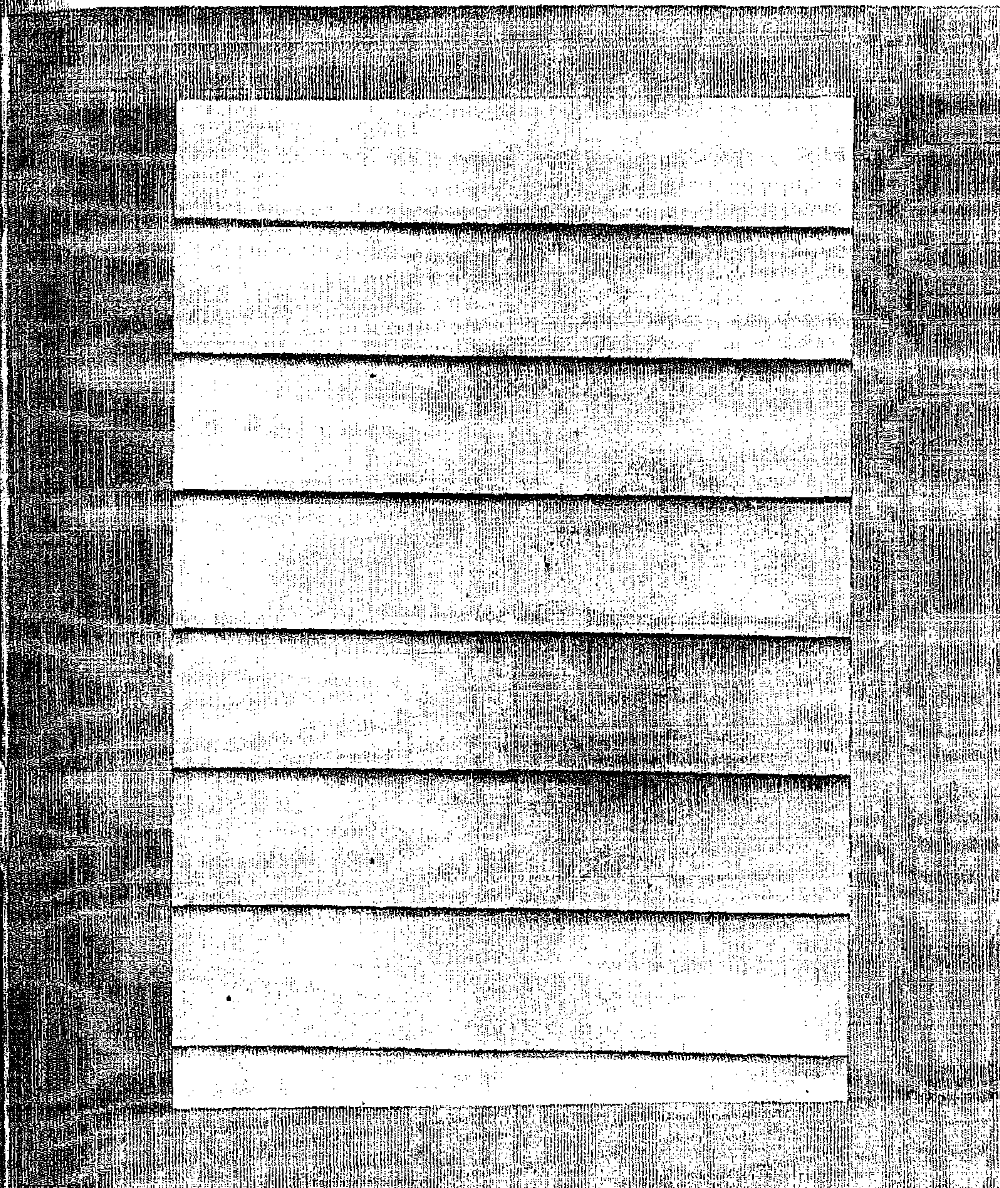
5 Color of "TI-PURE" O vs. "TI-SIL" White Paints
House Test, Kaolin, Penna.
13 Months South Vertical



37.3/45.0/17.7—"TI-SIL"/ cofumed 35% leaded ZnO/ magnesium silicate

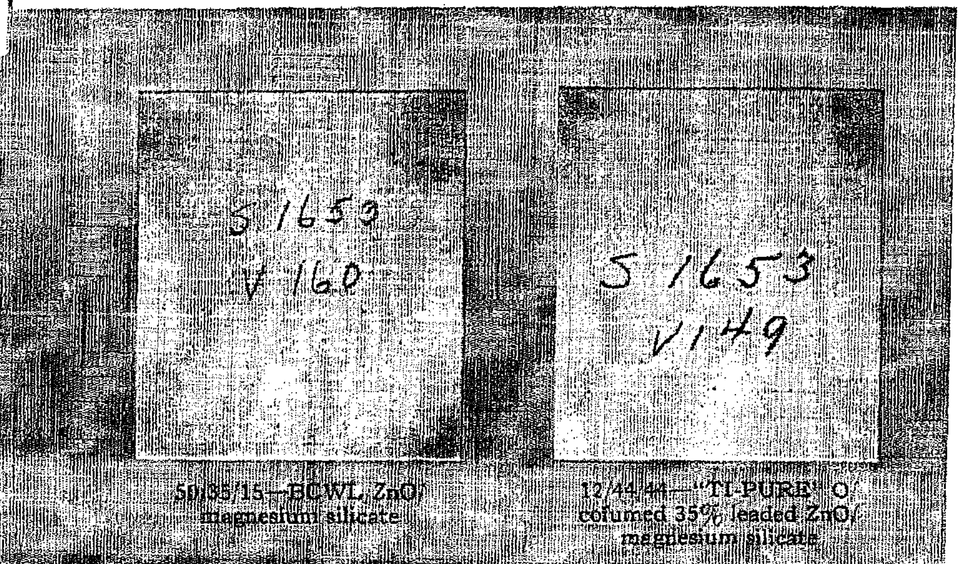
TiO_2 in "TI-SIL" replaced with "TI-PURE" O

5A Fading of "TI-PURE" O vs. Lead-in-Oil Buff Paints. House Test, Wilmington, Delaware. 15 Months North Vertical



Upper Four: Lead-in-Oil   Lower Four: 12/44/44—"TI-PURE" O/ cofumed 35% leaded ZnO/ magnesium silicate

5B "TI-PURE" O vs. Lead-Zinc-Inert
26 Months Delaware South Vertical



50/35/15—BCWL ZnO/ magnesium silicate

12/44/44—"TI-PURE" O/ cofumed 35% leaded ZnO/ magnesium silicate

FOR NORMAL HIDING	1 Gallon	100 Gallons
"TI-PURE" O	1.01 lbs.	101 lbs.
"TOMAHAWK" Cofumed 35% Leaded Zinc Oxide	3.72 "	372 "
Magnesium Silicate	3.72 "	372 "
Alkali Refined Linseed Oil	4.48 "	57.8 gals.
Kettle Bodied Linseed Oil (Body "Q")	.39 "	4.9 "
Drier "P"	.26 "	2.9 "
Mineral Spirits	.54 "	8.3 "
	14.12 lbs.	

FOR HIGH HIDING	1 Gallon	100 Gallons
"TI-PURE" O	1.56 lbs.	156 lbs.
"TOMAHAWK" Cofumed 35% Leaded Zinc Oxide	3.65 "	365 "
Magnesium Silicate	3.34 "	334 "
Alkali Refined Linseed Oil	4.45 "	57.4 gals.
Kettle Bodied Linseed Oil (Body "Q")	.39 "	4.9 "
Drier "P"	.26 "	2.9 "
Mineral Spirits	.57 "	8.8 "
	14.22 lbs.	

DRIERS

Driers are undoubtedly important constituents of outside paints, since they affect both working properties and durability. The Drier "P" specified in the formulas shown herein is regarded as offering definite advantages, particularly in achieving a type of consistency which gives good brushing properties to the paint, and at the same time good durability. It produces a slight false body and a slightly thicker consistency than is normally produced by naphthenate driers. Drier "P" is a lead-manganese linoleate type, carrying a ratio of about 30 parts of lead to 1 part of manganese. It is generally used in sufficient quantity to give 0.6% lead as metal and 0.02% of manganese as metal, calculated on the non-volatile vehicle in the paint. The finished drier has the following composition:

Lead	13.29%
Manganese	0.43%
Linseed Oil	64.04%
Mineral Spirits	22.24%
	100.00%

The making directions for Drier "P" are as follows:

Litharge		147.00 lbs.
Manganese Borate		22.00 "
Alkali Refined Linseed Oil	84 gals.	653.52 "
Mineral Spirits	35 gals.	229.25 "
Total Pounds		1051.77 lbs.
Estimated Loss		31.77 "
Yield 115 gals.		1020.00 "

Gallon weight: 8.84 lbs.-8.77 lbs.
Body required: V-X (Gardner-Holdt)

Procedure:

Mix litharge and manganese borate thoroughly, dry. Stir this mixture into 6 to 9 gallons of alkali refined oil in a change-can mixer or its equivalent.

Using a Monel metal, copper, or equivalent kettle (preferably not iron), heat the remainder of the oil (78 to 75 gallons) to 360° F. Add the slurried driers with vigorous stirring as the temperature of the oil rises to 445° F. All of the driers should be in by the time the batch reaches 445° F., and the drier addition should not take over 15 minutes. Hold at 445° F. for 30 minutes after all the metals are added. Cool to 300° F. and thin. In the above formula a loss of 31.77 lbs. is estimated. This may be high in some varnish plants. It is suggested, therefore, that the first addition of thinner be 30 gallons of mineral spirits and that further thinner be added, if needed, to control the drier within the viscosity and gallon weight figures specified.

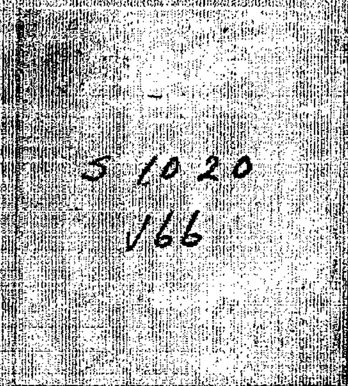
In connection with the effect of driers on exterior paint characteristics, it may be of interest to tabulate certain conclusions which are based on test fence data.

1. Litharge in exterior paints tends to induce checking and cracking failure and to retard erosion. See Illustration No. 6.

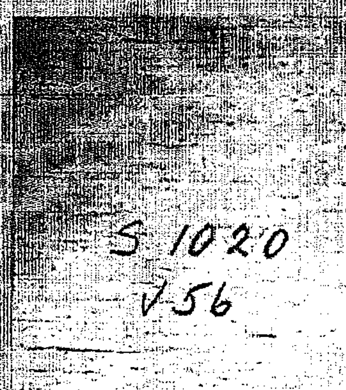
2. Cobalt and litharge used together as driers in exterior paints tend to decrease durability. See Illustration No. 7. There is also some evidence that cobalt increases fading.

3. Naphthenate type driers substituted for Drier "P" at equal metal content, yield essentially equal durability. These driers are generally interchangeable, but the naphthenate driers usually impart less false body to paints and therefore require less thinner for proper brushing consistency than the linoleate type driers. As a result, paints containing the naphthenate driers have more pull under the brush, better leveling, and better gloss than paints containing the linoleate driers. These differences, however, are only slight.

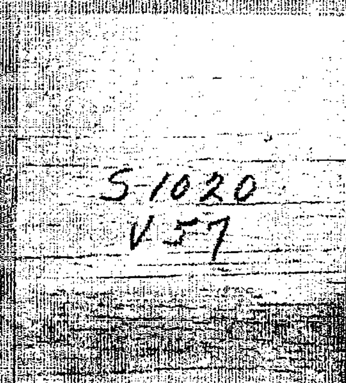
6
Litharge Inducing Cracking
42 Months
Delaware South Vertical



40/45/7.5/7.5—lithopone/cofumed 35% leaded ZnO/magnesium silicate/silica

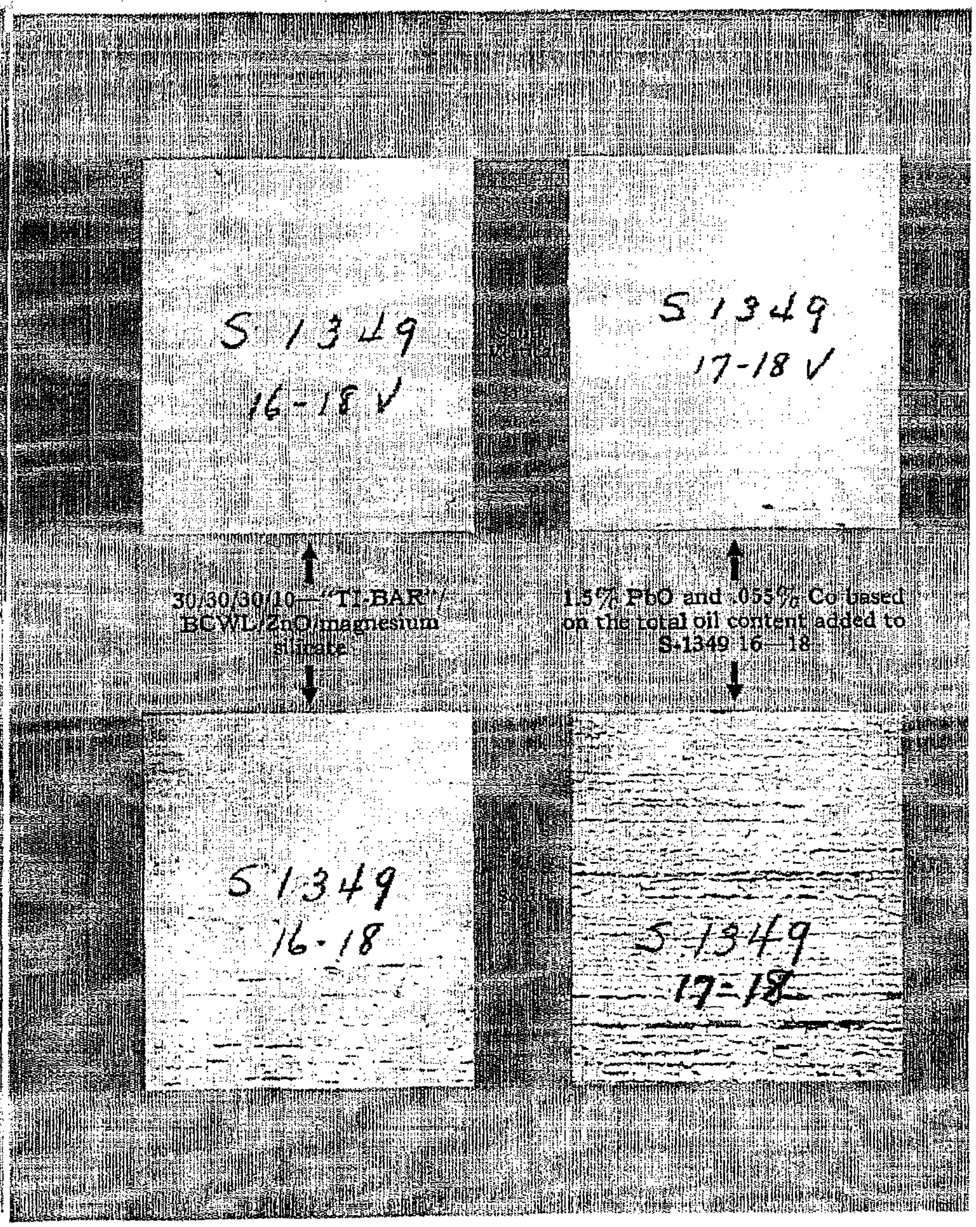


2.5% litharge added to S-1020-66 replacing an equal volume of leaded zinc



5% litharge added to S-1020-66

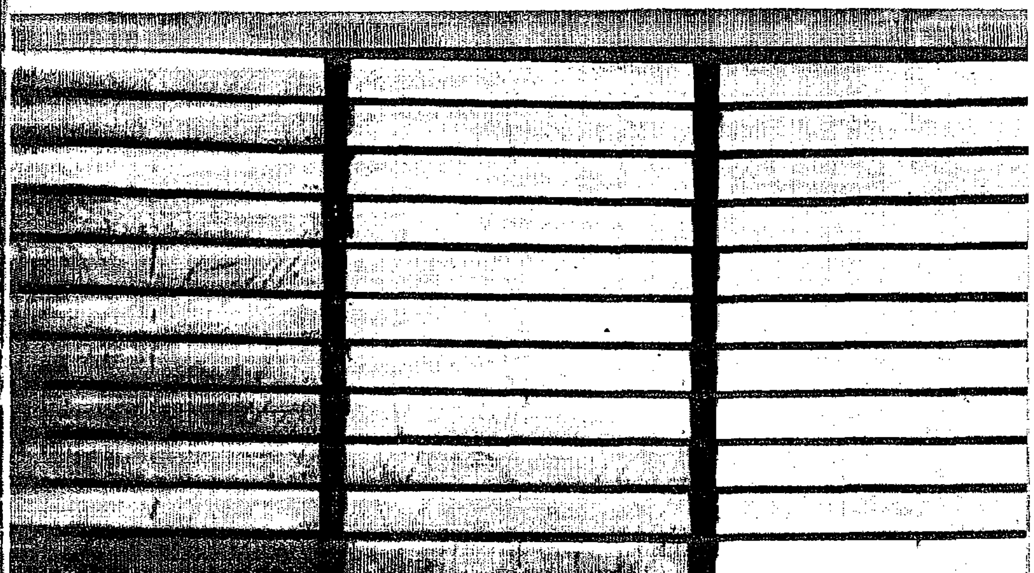
7 Cobalt and Litharge Inducing Cracking 29 Months Delaware



SELECTION OF ZINC OXIDES

Zinc oxides are essential to the composition of good exterior house paints, if good durability results and satisfactory appearance are desired. If zinc oxide is omitted, the paints have little if any resistance to mildew and exhibit excessive dirt collection, with resulting poor general appearance. See Illustrations Nos. 8, 8A, and 8B. If, however, sufficient pure zinc oxide is added to zinc sulfide or titanium type paints to prevent excessive chalking and erosion, premature checking and cracking may result. These difficulties can be surmounted by the use of cofumed leaded zinc oxide. It is possible to add this pigment in sufficient quantity to control chalking and erosion, without producing objectionable checking and cracking.

8 **Dirt Collection of a Zincless Pigmentation in Various Fortified Vehicles 16 Months Delaware South Vertical**

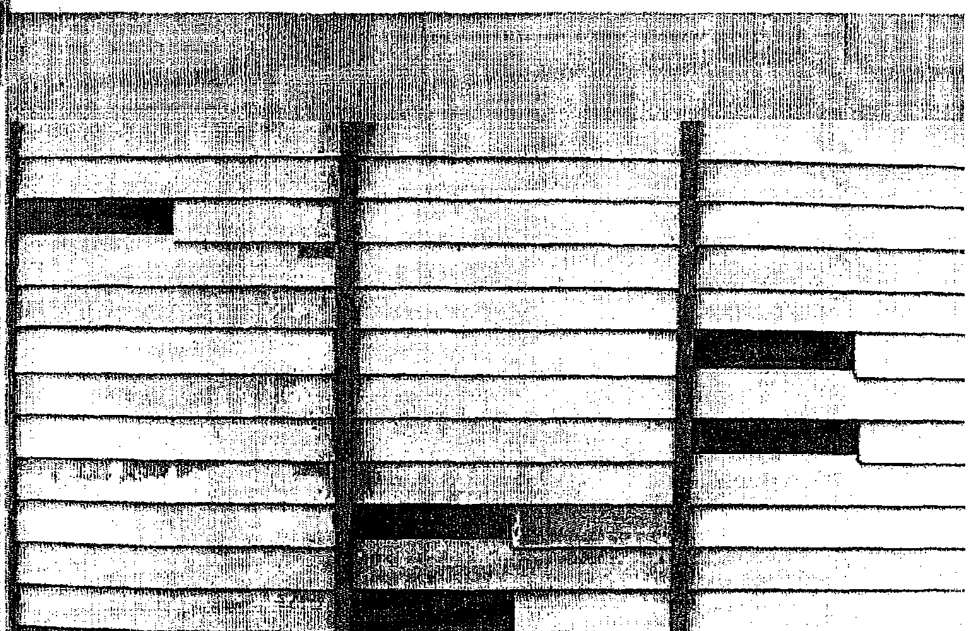


The first bay and the bottom four panels in the second bay are 40/40/20—titanium barium pigment/BCWL/magnesium silicate in various fortified vehicles and in linseed oil, showing bad dirt collection. The remainder of the panels, except the top three at the upper right, are 40/40/20—titanium barium pigment/cofumed 35% leaded ZnO/magnesium silicate in the same fortified vehicles, showing a clean white appearance.

It is desirable, however, to use *cofumed* leaded zinc oxide and not simply blends of pure zinc oxide and basic lead sulfate, since such blends show little advantage over pure zinc oxide. The advantages of cofumed leaded zinc oxide over mechanical mixtures of zinc oxide and white lead are indicated by Illustrations Nos. 9 and 9A.

There are several new types of pure zinc oxide now available on the market, which appear to be of interest from a durability standpoint, and are therefore being subjected to various durability tests. These pigments have been on exposure for about three years, but as yet the durability information available is insufficient to fully determine their value in exterior house paints.

8A **Dirt Collection of a Zincless Pigmentation in Various Fortified Vehicles 32 Months Delaware South Vertical**



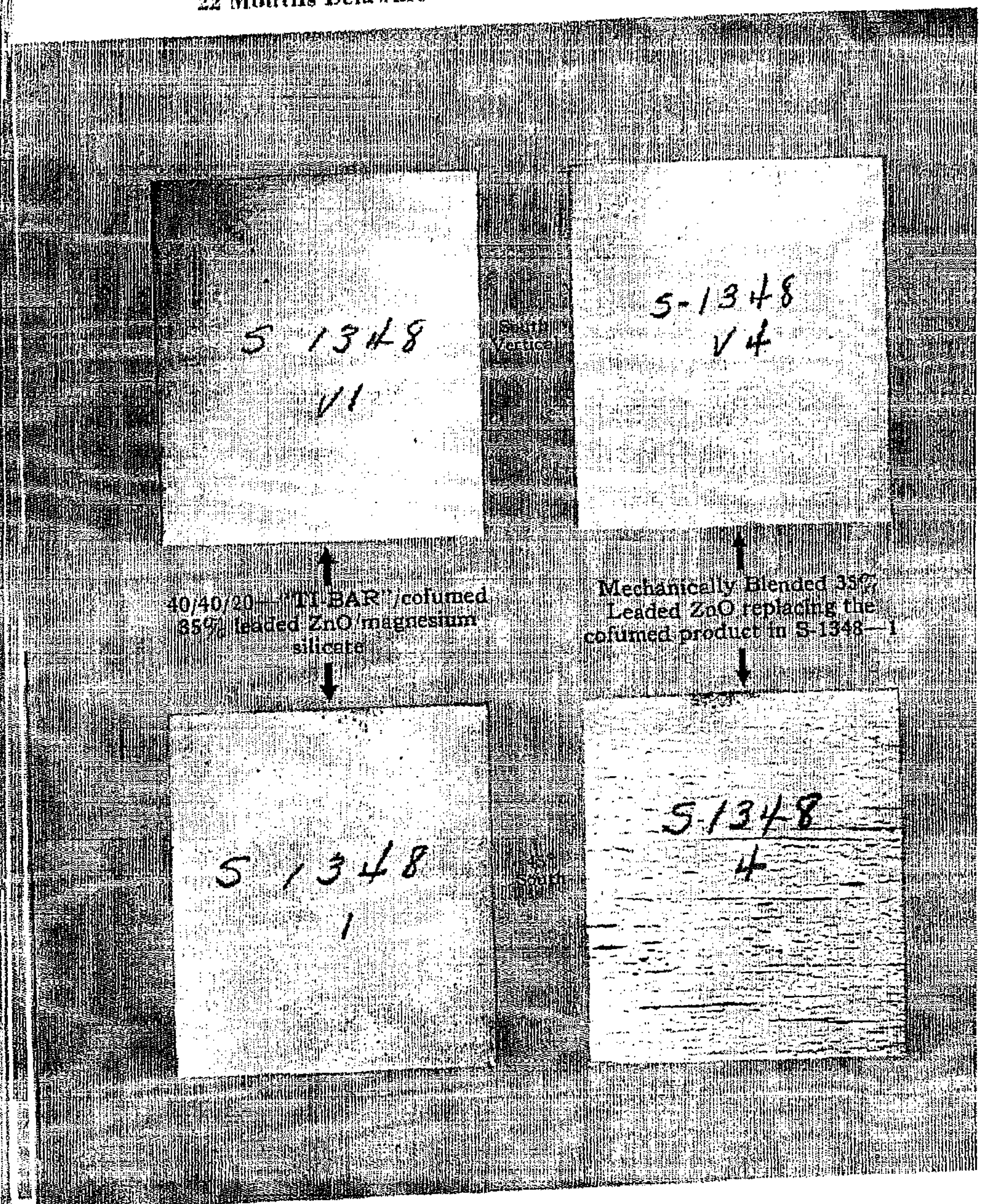
The first bay and the bottom four panels in the second bay are 40/40/20—titanium barium pigment/BCWL/magnesium silicate in various fortified vehicles and in linseed oil, showing bad dirt collection and mildew. The remainder of the panels, except the top four at the upper right, are 40/40/20—titanium barium pigment/cofumed 35% leaded ZnO/magnesium silicate in the same fortified vehicles, showing a clean white appearance.

8B Mildew with Zincless Pigmentation in Various Fortified Vehicles 20 Months Delaware South Vertical

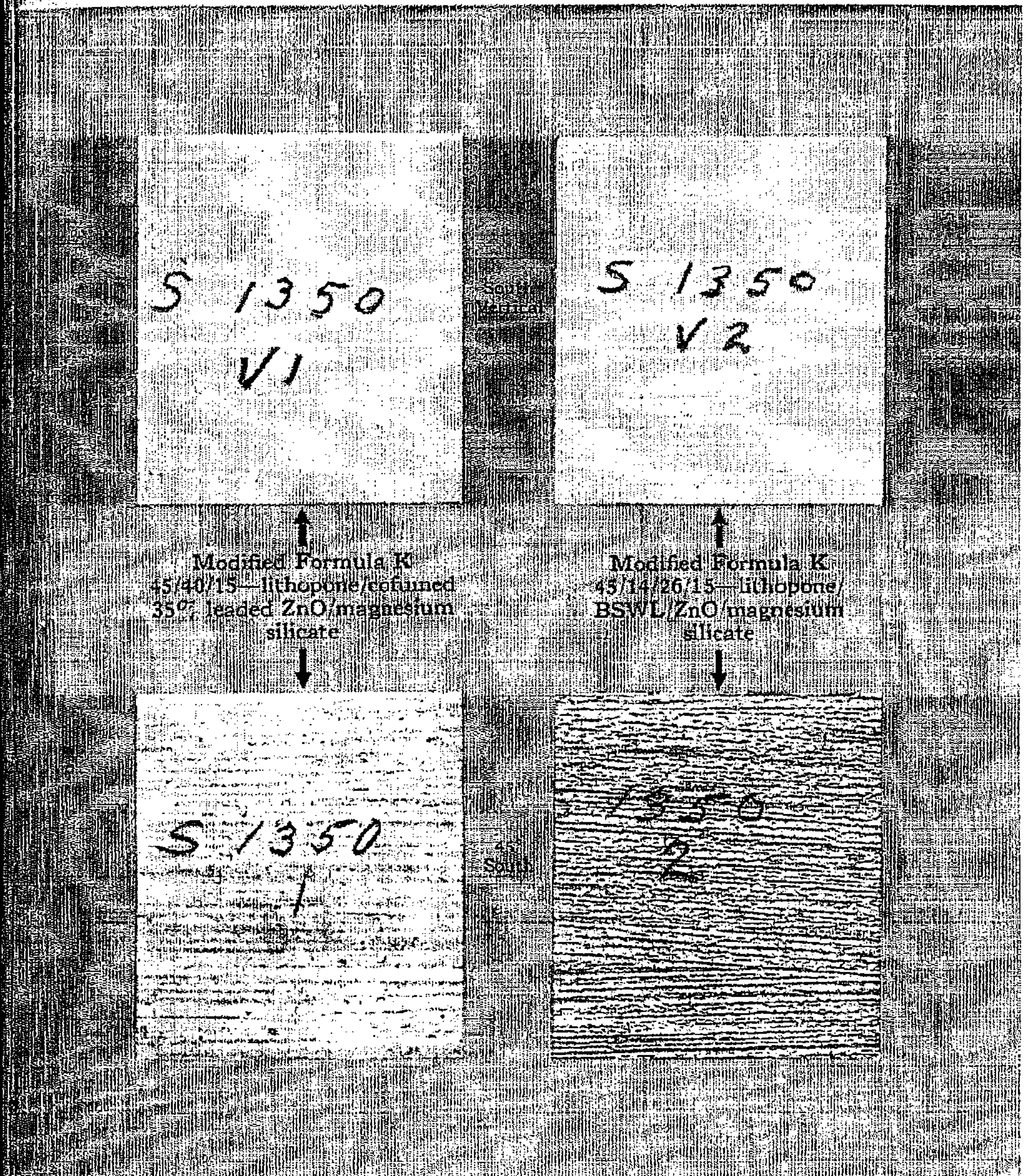
40/40/20—titanium barium pigment/BOWL/magnesium silicate

37.3/45/17.7—"TI-SIL"/cofumed 35% leaded ZnO/magnesium silicate

9 **Cofumed vs. Mechanically Blended Leaded ZnO 22 Months Delaware**



9A Cofumed vs. Mechanically Blended Leaded ZnO
32 Months Delaware



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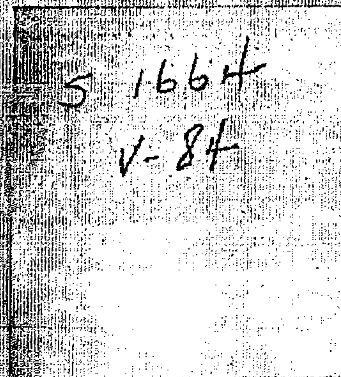
SELECTION OF EXTENDERS

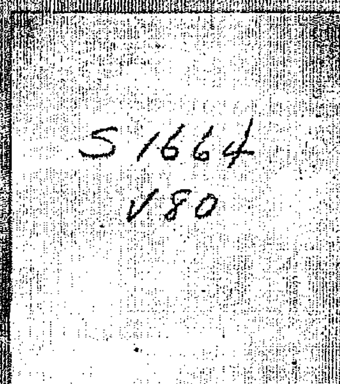
Extenders are an important constituent of exterior paints from the standpoint of durability, quite apart from cost considerations. The use of silicates of various particle sizes and shapes is believed to contribute to improvements in durability. The more effective types from this standpoint are those with fibrous and flake-like structures, among which may be mentioned mica, talc, magnesium silicate, and diatomaceous silica. These extenders are outstanding and easily surpass such extenders as barytes, whiting, china clay, calcium sulfate, and ground silica. In making selections of extenders, however, such factors as availability, color, fineness, cost, and can stability, as well as paint application and film properties, must be considered, along with the durability advantages to be obtained. Actual evaluations made in this manner indicate that selected types of magnesium silicate possess outstanding all-around merit. See Illustrations Nos. 10, 10A, and 10B. The magnesium silicate used in "TI-SIL" is especially selected to meet these requirements.

10 Durability of Extenders
20 Months
Delaware South Vertical

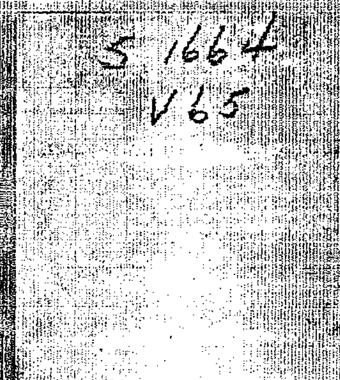
Formula K:
40/45/15—lithopone/cofumed 35% leaded ZnO/magnesium silicate. Extender replacements made at equal volume.



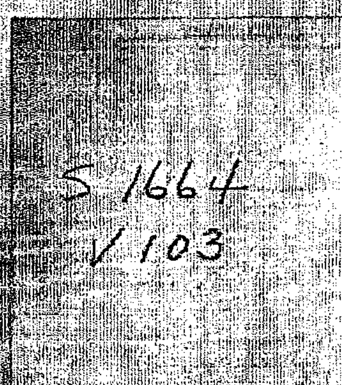
Mica



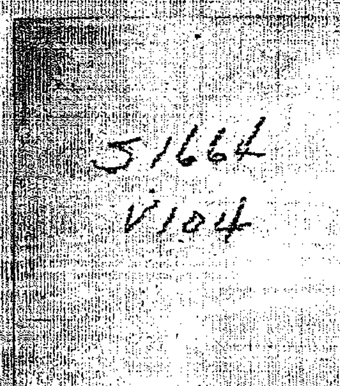
Talc



Magnesium Silicate



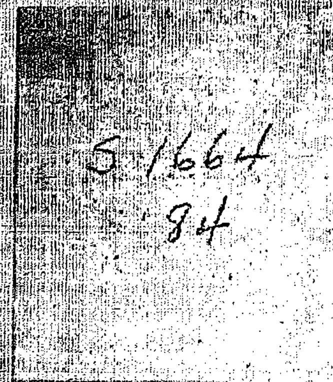
Barytes



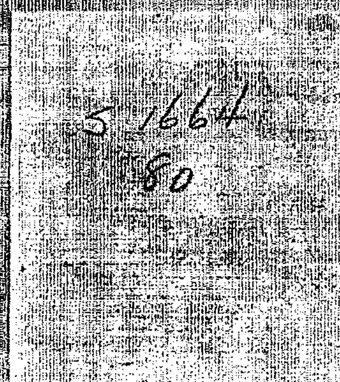
Silica

10A Durability of Extenders
20 Months
Delaware 45° South

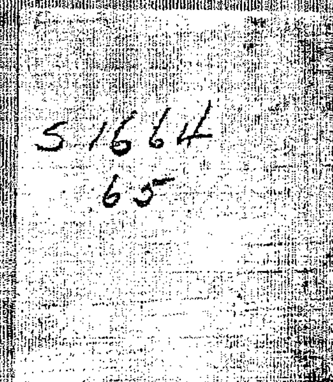
Formula K
40/45/15—lithopone/cofumed 35% leaded ZnO/magnesium silicate. Extender replacements made at equal volume.



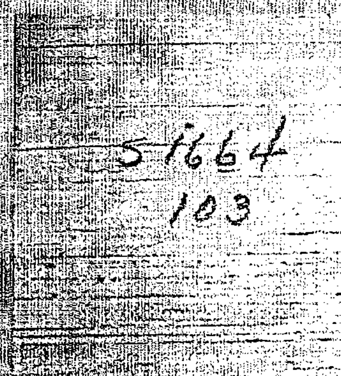
Mica



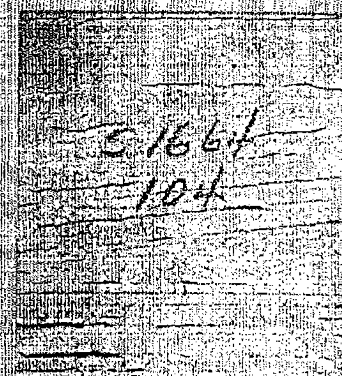
Talc



Magnesium Silicate



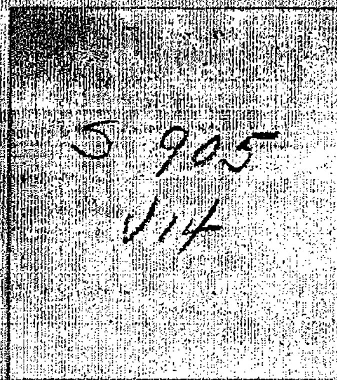
Barytes



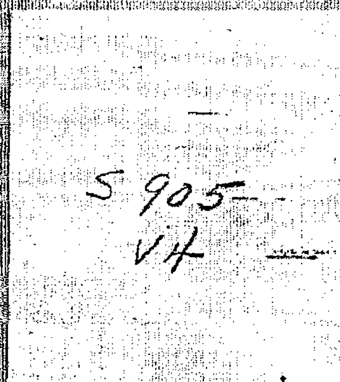
Silica

10B Durability of Extenders 56 Months Delaware South Vertical

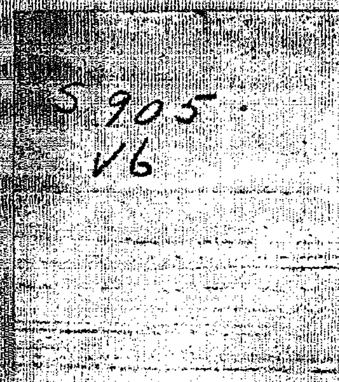
25/25/50—TiO_2/cofumed 35% leaded ZnO/magnesium silicate. Extender replacements made at equal volume.



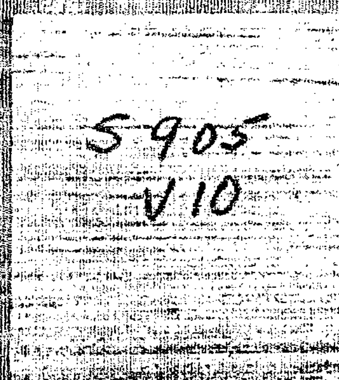
Mica



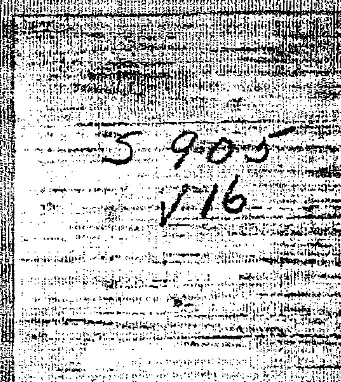
Talc



Magnesium Silicate



Barytes



Silica

MOISTURE FAILURE

Moisture failure of exterior house paints is a subject which deserves serious consideration until such a time as a satisfactory solution is available for the difficulties commonly encountered. That it is no small problem is indicated by such excellent papers on the subject as:

"Causes of Paint Failure on Sidewalls," by Hartwig, published in 1929.

"Paint Failures in Oklahoma City," by Gardner, published in 1938.

"Moisture Peeling of House Paints—Effect of Certain Structural Details," by Iliff and Davis, published in 1939.

It seems beyond question that construction defects as well as humidification and insulation without sufficient ventilation or supplementary means of protecting exterior walls from moisture are extremely important factors in causing paint failures. It is generally admitted that no unbroken paint film will withstand moisture reaching it through the wood. It is granted that paint films differ in their ability to withstand moisture, and it is believed that real progress will be made in the development of paint films which will breathe sufficiently to transmit moisture reaching them, and also allow the entrapped air and water vapor to escape from the undersurface of the paint film.

There are also other factors affecting the durability of paint films, to which adequate answers will ultimately be obtained. Such factors are adhesion, penetration, film toughness, etc., but to date no completely satisfactory solutions are available. These problems are receiving active consideration, involving extensive exposure studies, under conditions of controlled temperature and humidity, in the hope that a solution of these problems will provide a definite contribution to the technology of paints and will be of material assistance to the paint manufacturing industry, by pointing out the way to decreased paint failures even under adverse conditions.

The formulations and results given above, while based on our experience, are not guaranteed.

KREBS