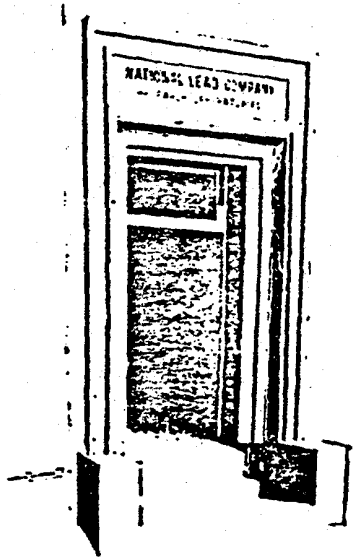
Dutch Boy

Handbook on

STABILIZERS for VINYL RESINS



NATIONAL LEAD COMPANY

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Printed in the United States of America

Third Edition

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Hendricks, J. G., Plastics Technology, [illegible]

Lead Stabilizers
- DYPHOS®
- DYTHAL®
- DS-207®
- LEADSTAR
- LECTRO "60"
- NORMASAL®
- PLUMB-O-SIL® B
- PLUMB-O-SIL® C
- TRIBASE
- TRIBASE-E

FOREWORD

During the past decade, the plastics industry has grown rapidly. That part of the industry consuming vinyl chloride polymers and copolymers has reflected this phenomenal expansion. This has been due in no small measure to the development of materials and techniques for stabilization of vinyl plastics against the harmful effects of heat and light. Such effects, if not counteracted, would promote changes in color and physical properties sufficient to prevent use of vinyl plastics in many desirable applications.

At the time of the publication of our original "DUTCH BOY HANDBOOK FOR VINYL STABILIZERS" in 1949, stabilization was still more or less an "empirical art" rather than a true chemical science. This is no longer the case, because of general improvements in the resins, plasticizers, colorants and stabilizers available to the vinyl plastic industry. These improvements in raw materials coupled with the recognized need for plastic quality commensurate to the times, better compounding, and the application of vinyl plastics only in end-usages where this type of resin is indicated, have brought about a large increase in the production and sales of vinyl resin products. In the ten year period from 1945 to 1955, there has been a four-fold increase in the production and consumption of vinyl chloride resins.

Improvement in stabilizers and stabilizer techniques has kept pace with the volume growth of the industry. We are proud to have played a part in these advancements. The first two editions of the "DUTCH BOY" Stabilizer Handbook emphasized the use of lead compounds. The present edition has been increased in scope, and includes a section on non-lead "DUTCH BOY" stabilizers for applications where lead stabilization is not indicated, such as in clear or highly translucent stocks.

General formulations are given for a wide variety of end applications including practically every type of vinyl product. This expansion of the present handbook reflects 10 years of active field and laboratory experience, and is backed by a most extensive evaluation program of accelerated indoor testing, paralleled by a thorough out-of-door weathering program.* This test program involves the evaluation of resins, plasticizers and stabilizers from all available world sources, kept current in a new and modern plastics research and development laboratory. In addition, the National Lead Company has available complete technical service laboratories, for the application of "DUTCH BOY" vinyl stabilizers and other chemicals in the plastics industry. Your inquiries to our nearest branch office are invited, and technical representatives will be glad to call and discuss individual problems in detail.

*Hendricks, J. G. and White, E. L., *Ind. Eng. Chem.*, [illegible]
Hendricks, J. G. and White, E. L., *Wire and Wire Products*, [illegible]
Hendricks, J. G., *Plastics Technology*, 1, No. [illegible]

Lead Stabilizers

- DYPHOS®
- DYTHAL®
- DS-207®
- LEADSTAR
- LECTRO "60"
- NORMASAL®
- PLUMB-O-SIL® B
- PLUMB-O-SIL® C
- TRIBASE
- TRIBASE-E

Non-Lead Stabilizers

- CALSTAR
- CLARITE A
- CLARITE B
- CS-137
- FLOMAX 25
- MALZIN
- PROVINITE A
- PROVINITE B

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...United States of America
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I. INTRODUCTION

Vinyl chloride was polymerized into resin by Regnault in 1838. However, the commercial development of this resin in the United States did not start for nearly one hundred years. Until 1939, when the industry produced 1.2 million pounds, there was no appreciable volume used. During World War II, the need sprang up for an elastomeric synthetic with good sheeting characteristics and desirable extrudability. Vinyl chloride plastics filled this need admirably, and their use in raincoats, ground cloths, packaging, insulation, tubing, metal coating, and a multitude of similar products important to the armed forces, brought about a hundred-fold growth to the industry between 1940 and 1945.

In 1947, the first genuine post-war year, a rapidly expanding consumer market utilized 150 million pounds of vinyl plastics. The year 1948 brought a further expansion to over 215 million pounds. The present rate of increase indicates an output of between 700 million and 1 billion pounds by 1960.

This rapid expansion may be attributed primarily to the versatility of the thermoplastic vinyl chloride type resins. Modification of the vinyl resins through the use of chemical plasticizers, colorants, and fillers has offered a variety of rigid, semi-rigid and flexible products.

In addition to floor coverings and unbreakable records, uses for flexible plasticized vinyl compounds have been found in belting, upholstery, shoe uppers, luggage, packaging, protective sheets, raincoats, shower curtains, umbrellas, window curtains, garment bags, electrical tapes, electrical insulation, tubing and hose and many other varied products.

The wide range of usefulness makes apparent the necessity of maintaining the original physical properties required for the particular final application. There must be no discoloration or deterioration during the heat processing cycle, shelf life and ultimate consumer use.

This involves the employment of a diversity of raw materials to fulfill specific functions. Certain plasticizers give low temperature flexibility, non-inflammability, "drape," non-migration characteristics, resistance to lacquer lift and any number of further chemical and physical properties. Colorants, fillers and lubricants have been developed which will withstand a variety of processing and service conditions. The multitude of end uses has actually intensified the search for satisfactory component raw materials with which to modify the original vinyl chloride polymer. Even the polymers themselves have been modified by molecular weight variations, and by copolymerization with other materials.

To meet these many and varied present day requirements, a line of "DUTCH BOY" vinyl stabilizers has been developed. These "DUTCH BOY" products not only protect the resins themselves against degradation, but at the same time offer no interference with the other components of a particular vinyl plastic system.

"DUTCH BOY" vinyl stabilizers are also of interest in connection with polyvinylidene chloride, a close relative of the regular vinyl chloride type resins. These stabilizers have considerably improved the light and heat resistivity of this resin.

Federal and state safety authorities have become increasingly concerned in recent years over the necessity of flameproofing protective and decorative coatings, plastics and other articles used in places of public gathering. This has accelerated the development and application of the chlorinated paraffins of 40% to 70% chlorine content now produced by a number of manufacturers. Here again, "DUTCH BOY" stabilizers and their methods of application have played an important role.

As an added example, chlorinated styrene and chlorinated polyethylene seem to have useful possibilities and may require additional materials to give them heat and light stability. National Lead Company's research chemists are constantly at work along development lines, not only with the products covered in this Handbook but with stabilizers and chemical compounds for other chlorinated materials.

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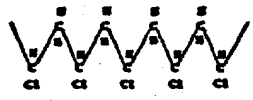
II. CHEMISTRY OF STABILIZATION

As heretofore indicated, the deleterious action of heat and light encountered during the useful life of a vinyl plastic product promotes changes in color and physical characteristics of the unstabilized vinyl composition which are sufficient to prohibit its use in many otherwise wholly desirable applications. The modes of chemical action whereby such compositions are degraded or may be stabilized must be considered in order to intelligently attack the problem of correctly formulating stable vinyl chloride resin compositions. For present purposes, it will be sufficient to define the resinous vinyl materials herein treated as polyvinyl chloride, with the understanding that this designation includes the polymer of vinyl chloride and the copolymers of vinyl chloride with a lesser proportion of some other monofunctional unsaturated compound, i.e., vinyl acetate, vinylidene chloride, ethyl maleate, ethyl fumarate, etc.

X-ray studies and chemical analysis have demonstrated the structure of polyvinyl chloride to be:



A. HEAT DEGRADATION

It is known that heating polyvinyl chloride resin at temperatures of 80° C. and upward will produce a series of color changes. This reaction gives rise to first a light yellow color, which quickly changes to dark yellow, to orange, and finally to a reddish brown which may ultimately become a charred black. The isolation of hydrogen chloride during this reaction suggests that the degraded polymer has resulted, for the most part, from removal of chlorine in combination with hydrogen from an adjacent carbon yielding the following structure:

Investigative work reported by the National Lead Company Research Laboratories has confirmed the presence of polyene structures of the type indicated above. The characteristic light absorption patterns of heat degraded polyvinyl chloride were obtained and showed multiple absorption peaks in the region above 3000 A. Such absorption curves are indicative of visible color formation. These data further demonstrated that the intensity of absorption is definitely increased by longer heat treatments. The determination of absorption peaks at higher wavelengths after longer heat treatments showed the shift of color from the yellow portion of the visible spectrum to the

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darker red bands. From this it may be seen that longer heat treatment of polyvinyl chloride resin produces additional degradation and results in the formation of more numerous and longer polyene structures within the degraded polymer. (See Figure I.)

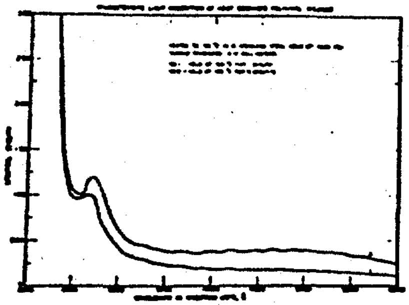

Figure I

On this basis, it may be hypothesized that the simplest form of heat degradation of polyvinyl chloride proceeds through the splitting out, at random, of a hydrogen chloride unit, following which internal excitation from this initial unsaturated position tends to promote stepwise removal of additional hydrogen chloride units down the polymer chain. The presence of the hydrogen chloride released appears to favor conjugation. The resulting overall reaction gives rise to the formation of the color bearing polyene systems.

Actually the degradation mechanism is not so clear cut, and another sort of reaction is taking place simultaneously. The light absorption characteristics of heat degraded polyvinyl chloride show a strong peak at 2730 A which is indicative of the presence of carbonyl groupings. Comparison of these data with light data on known carbonylic unsaturated compounds has shown a great deal of similarity. These carbonyl containing systems can very readily form by oxidation of unsaturated structures produced during the primary dehydrochlorination degradation reaction. The possibility of such oxidative reactions is quite likely at the temperatures and pressures involved in commercial processing practices. The action of a number of materials generally harmful to polyvinyl chloride may also be explained through the concept of an auto-catalytic oxidation mechanism. Such materials include the higher valence compounds of iron, tin, cadmium, and other metals. The oxidation products may result in carbonyl structures which definitely contribute to the intensity of apparent color. Oxidation also will promote chain scission and cross linking.

The question of whether or not hydrogen chloride itself acts as an oxidation catalyst under purely thermal conditions was recently investigated in the National Lead Laboratories.* These studies showed reasonably well that hydrogen chloride catalyzes the dehydrochlorination mechanism under strong heat conditions, but that it does not affect the oxidation reaction to a measurable extent.

In summary, it is felt that heat degradation of vinyl chloride type resins occurs through a dual mechanism of dehydrochlorination and oxidation. Under normal processing conditions, the former reaction (loss of hydrogen chloride) predominates be-

*[illegible], A., [illegible], W. L., and [illegible], F. W., Modern Plastics, 28, No. 4, [illegible] ([illegible])

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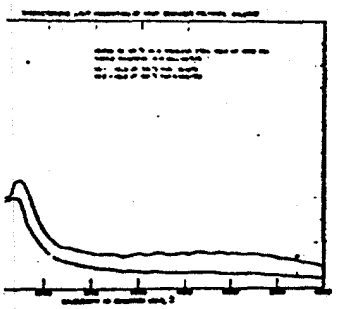

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cause of the driving force of the heat energy put into the polymer, and oxidation occurs as a secondary reaction attacking the unsaturation developed in the polymer. Under extreme catalytic conditions, the oxidation may become the primary degradation action with the ultimate result of actual combustion.

B. LIGHT DEGRADATION

Polyvinyl chloride plastics are subjected to considerable heat during processing and fabrication, and consequently some measure of polyene unsaturation may be present when the finished compound is exposed to light. Such polyene systems absorb light within the ultra-violet range. The energy resulting from this absorption will act to re-energize the polymer chain and promote both oxidative degradation and dehydrochlorination. Since ultra-violet light is an oxidation catalyst, the oxidative type of degradation is probably predominant during the light aging life of the vinyl compound. Further split-out of hydrogen chloride will proceed to a somewhat lesser degree producing additional polyene unsaturation and increasing the possibility of even more oxidation. In addition, hydrogen chloride itself definitely catalyzes oxidative attack on the double bonds under exposure to ultra-violet light.* Primary light failure of vinyl chloride type plastics will evidence itself more through embrittlement and tackiness typical of oxidation, with increased color formation as a secondary failure.

In this manner, the difference between light and heat induced degradation may be evidenced. The dual mechanism of oxidation and hydrogen chloride loss occurs in both types of degradation. The essential differences are in degree rather than type of degradation. As a result, the compound heat-stabilized against both dehydrochlorination and oxidation, will also be resistant to light and vice versa. In practice, however, good heat and light stability may not always be in parallel evidence. This deviation from theory is generally due to the interference of side reactions set up between stabilizer and plasticizer, colorant or filler. These reactions are under study and specific recommendations for various cases are made elsewhere in this manual. For this reason, there *cannot be a universal stabilizer*, no matter how well any one material may meet all the theoretical requirements for the ultimate in stabilization.

C. REQUIREMENTS OF AN IDEAL STABILIZER

From a consideration of the basic chemical reactions involved in heat and light degradation of polyvinyl chloride type resins, it is possible to postulate the requirements of an "ideal stabilizer" material, or combination of materials.

(1) *Since the hydrogen chloride released in the dehydrochlorination reaction has given evidence of promoting the auto-catalytic nature of the ultimate degradation, it is necessary to remove or chemically combine this material as effectively as possible.* Where electrical properties are required, it is essential that this chemical combination not result in an electrolytic conductor, and it is necessary to combine the hydrogen chloride into an insoluble and non-ionizable end product. Of all the metals known, only silver, mercurous mercury, and lead form insoluble chlorides. As a result, some form of reactive lead compound is the most suitable practical source of "*hydrogen chloride acceptor.*" While lead compounds are the most suitable hydrogen chloride acceptors from the standpoint of chloride insolubility, there are some instances where lead compounds are not indicated, and other metal compounds, as for example, those of barium, cadmium, tin and sodium are more desirable. There are still other applications where combinations of the above materials

and wholly organic compounds, such as epoxides, act satisfactorily as hydrogen chloride acceptors.

(2) Since dehydrochlorination results in the formation of repeating unsaturation which acts to internally excite further hydrogen chloride split-out and the creation of more intense color bodies, it is desirable to modify these polyene structures by the use of a suitable "reactive molecule." It has been suggested that materials such as esters of maleic and aconitic acid may stabilize vinyl chloride type polymers by undergoing a modified Diels-Alder reaction with the heat-produced unsaturation. Such action would act to destroy the continuity of the conjugated unsaturated color producing systems and inhibit color formation. The break-up of these polyene groupings could reduce the possibility of extended internal excitation and generally inhibit the overall dehydrochlorination degradation process. Conceivably, such compounds as, for example, alkylated tin salts, tribasic lead maleate, dibasic lead phthalate, and dibasic lead phosphite, might exhibit properties and give such a "*reactive molecule*" stabilizing effect.

(3) Recent developments have indicated the great importance of oxidation as a factor in the degradation mechanism of polyvinyl chloride type plastics. This oxidation exhibits itself in the formation of color-bearing carbonyl structures in the degraded polymer, in the promotion of scission and cross-polymerization of the resin chains, and in the destruction of the plasticizer portion of the compounded vinyl plastic. Degradation of the plasticizer promotes brittleness and loss of plasticity, and may result in formation of oxidation products which detrimentally affect the degradation characteristics of the resin system. Oxidation, as demonstrated in the previous portions of this discussion, is a definite factor in both the heat and light stability pattern of the vinyl compound. As a result, the use of a suitable *antioxidant* will often be the determining factor between good stability and excellent stability in a particular vinyl compound. The concept of using antioxidants is not new to the vinyl chemist, but there have been no entirely satisfactory antioxidants available. Most typical antioxidants are organic in nature and exhibit poor heat and light resistivity in their own right, and often, in obtaining effective antioxidant action will shift into molecular forms which are strong chromophores, exhibiting color to a greater extent than the degraded vinyl system itself. Several lead salts, e.g., normal lead salicylate (NORMASAL) and dibasic lead phosphite (DYPHOS), and a number of organic phosphites and phenols possess properties that make them ideally suited as "*antioxidants*" for vinyls.

(4) Since exposure to light most generally occurs in the ultimate use of a polyvinyl chloride type plastic, the action of ultra-violet light in catalyzing the degradation of both resin and plasticizer must be effectively resisted. It is most desirable to "*screen out the ultra-violet light*" by use of agents ranging from complete opacifiers which transmit little or no light (e.g., carbon blacks, titanium pigments) to complex organic compounds which absorb a portion of the ultra-violet band of incident light (e.g., phenyl salicylate and lead salicylate). In addition, the basic metallic soaps, such as dibasic lead stearate (DS-207), appear to inhibit the effects of ultra-violet light in a manner not as yet determined.

The "four essentials" of this postulated "ideal stabilizer system" may be briefly summarized as:

1. Hydrogen chloride acceptor
2. [illegible] dienophilic molecule
3. Antioxidant
4. Ultra-violet light screen

III. APPLICA

A. STABILIZER REACT

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acceptor — 3. Antioxidant
molecule — 4. Ultra-violet light screen

III. APPLICATION OF "DUTCH BOY" LEAD STABILIZERS

A. STABILIZER REACTIVITY

The group of "DUTCH BOY" lead stabilizers described in this section have each been *found to have specific chemical and physical properties* that make them useful, either alone or in combination, for one or more of the varied vinyl plastic applications. Since all of these materials are lead salts, they meet the basic requirement of being an "acid acceptor," and therefore contribute to the ultimate heat and light stability in vinyl compounds. Actually, litharge (PbO) would be the most efficient form of using lead as an "acid acceptor," but the nature of vinyl stabilization goes beyond mere acid acceptance, and various other chemical and physical actions must be incorporated into a desirable stabilizer compound or combination. It must be noted that litharge is not light and color stable and may be used only in certain black pigmented compounds.

Basic lead carbonate has long been an important paint pigment. Chemically, basic lead carbonate may be represented as $2PbCO_3 \cdot Pb(OH)_2$. The total PbO content is 85% but only 28-31% is in the available basic portion of the molecule. Reaction of PbO beyond this available 28-31% will evolve CO_2 and give the phenomenon of "gassing."* From this, it may be seen that in a lead stabilizer there are two considerations, reactive and safe PbO content, which are, of course, both related to the total PbO content. In the case of basic lead carbonate there is 85% total and reactive PbO, but only 28-31% safe PbO. These considerations should be kept in mind in choosing the proper stabilizer for a vinyl compound. In many cases, the total reactive basicity must be limited because of the chemical nature of the plasticizer, colorants, and fillers used. A study of the chemical compositions of "DUTCH BOY" lead stabilizers will indicate the total, reactive, and safe PbO in each of these materials.

Electrical properties are of prime importance for the many kinds of insulation and dielectric materials in which vinyl chloride resins are used. Such application is a prime example of a situation where the lead stabilizer is most necessary. The stabilization mechanism proceeds by reaction with the hydrogen chloride released during processing and aging, and must result in an insoluble, non-ionizable material. Lead is the only economical material which forms an insoluble, non-ionizable chloride. For this purpose "DUTCH BOY" TRIBASE, DYTHAL, DYPHOS, LECTRO "60", TRIBASE-E and DS-207 have been found exceptionally desirable.

B. PLASTICIZER-STABILIZER INTERACTION

A stabilizer may very satisfactorily impart good heat and light resistivity into the polymer, but in so doing, may react with the plasticizer and give rise to loss of plasticity or severe color formation or both. At the temperatures of processing used for the average vinyl application, plasticizer-stabilizer-resin interaction is almost inevitable. It is, therefore, necessary to form reaction products which are non-colored and possess desirable stabilizing effects. In some cases, it is desirable to keep stabilizer-plasticizer interaction to as low a degree as possible. Some stabilizers may be added for the purpose of directing or modifying this plasticizer- stabilizer interaction (actually stabilize the plasticizer).

*[illegible]

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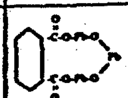
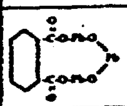
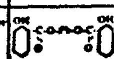
TABLE OF PROPERTIES OF "DUTCH BOY" LEAD STA[BILIZERS]

PRODUCT	DYPHOS	DYTHAL	DS-207	LEADSTAR	LECTRO "60"	NORMASAL
COMPOSITION	Dibasic Lead Phosphite	Dibasic Lead Phthalate	Dibasic Lead Stearate	Normal Lead Stearate	Lead Chlorosilicate Complex	Normal Lead Salicylate
FORMULA	$2PbO \cdot PbHPO_3 \cdot \frac{1}{2}H_2O$		$2PbO \cdot Pb(C_{17}H_{35}COO)_2$	$Pb(C_{17}H_{35}COO)_2$	Complex structure	
MOLECULAR WEIGHT	743	818	1221	774	—	481
BASIC LEAD CONTENT (% PbO) 1. Total 2. Safe 3. Reactive	90.0 60 90.0	79.8 54.6 79.8	55.3 31.5 55.3	29.5 — 29.5	47.5 36.1 36.1	46.5 — 46.5
COLOR AND FORM	fine acicular white crystals	fluffy yellow white crystalline powder	soft white powder (unctuous)	fine white powder (unctuous)	fine white powder	soft creamy white crystalline powder
NON-LEAD CONTENT	11.2%; phosphorous acid	19.5%; phthalic anhydride	46.5%; stearic acid	71.1%; stearic acid	47%; SiO_2, 3%; Cl	57.4%; salicylic acid
REFRACTIVE INDEX	2.25	1.99	1.60	1.50-1.60	2.1	1.70
SPECIFIC GRAVITY	6.94	4.6	2.02	1.40-1.42	4.0	2.36
SOLUBILITY	insoluble in all common solvents	insoluble in all common solvents	insoluble in all common solvents	insoluble in all common solvents	insoluble in all common solvents	0.3%; sol. in water; sol. in glycols, glycol ethers, sl. sol. methyl and ethyl alcohol.
RECOMMENDED APPLICATION 1. Special	Antioxidant heat and light stabilizer for vinyls, especially with paste resins	General purpose light and heat stabilizer	Stabilizer and lubricant	Lubricant and supplementary stabilizer	Economical stabilizer for vinyl electrical and calendered products	Anti-oxidant and light screening agent
2. Plasticizer Recommended*	Types I, IIC, IIIA, IV, V, VIA, IIA for electrical insulation.	Types I, IIIA, IV, IIA for electrical insulation.	Types I, IIIB & C, V, VIA	Types I, III, IV, V, VIA, Especially recommended for IIIA	Types I, IIA & B, III, IV	Type II (Special for asbestos filled flooring stocks, see page 34)
3. Suggested Formulations**	V, VIII, XII, XVI, XXII, XXVIII, XXXIII, XXXVIII, XLI	IV, XI, XXIX, XXXV	I, III, IV, V, VIII, IX, XI, XVI, XX, XXII, XXIII, XXVIII, XXXI, XXXII, XXXIII, XXXV, XXXIX	II, XII, XV, XXIX	II, III, XXIII	XIV, XV

*See page 12 or 28.
**See pages 38 to 42.

TABLE OF PROPERTIES OF "DUTCH BOY" LEAD STABILIZERS

[illegible]	DYTHAL	DS-207	LEADSTAR	LECTRO "60"	NORMASAL	PLUMB-O-SIL B	PLUMB-O-SIL C	TRIBASE	TRIBASE E
	Dibasic Lead Phthalate	Dibasic Lead Stearate	Normal Lead Stearate	Lead Chloro-silicate Complex	Normal Lead Salicylate	Coprecipitated Lead Orthosilicate and Silica Gel	Coprecipitated Lead Orthosilicate and Silica Gel	Monohydrous Tribasic Lead Sulfate	Basic Lead Silicate Sulfate
[illegible]		$2PbO{\cdot}Pb(C_{17}H_{35}COO)_2$	$Pb(C_{17}H_{35}COO)_2$	Complex structure		Complex structure	Complex structure	$3PbO{\cdot}PbSO_4{\cdot}H_2O$	Complex structure
	818	122[illegible]	774	—	481	—	—	991	—
	79.8 54.6 79.8	55.3 31.5 55.3	29.5 — 29.5	47.5 36.1 36.1	46.5 — 46.5	51 25-51 25-51	47 23-47 23-47	89 67.3 67.3	68 50.8 50.8
	fluffy yellow white crystalline powder	soft white powder (unctuous)	fine white powder (unctuous)	fine white powder	soft creamy white crystalline powder	soft white powder	soft white powder	fine white powder	fine white powder
[illegible]	19.5% phthalic anhydride	46.5% stearic acid	73.1% stearic acid	47% SiO_2, 3% Cl	57.8% salicylic acid	42.6% SiO_2	38.3% SiO_2	8.1% SO_3	21.9% SiO_2, 6.1% SO_3
	1.99	1.60	1.50-1.60	2.1	1.78	1.50-1.60	1.50	2.1	2.1
	4.6	2.02	1.40-1.42	4.0	2.36	3.3	2.96	7.1	5.55
[illegible]	insoluble in all common solvents	insoluble in all common solvents	insoluble in all common solvents	insoluble in all common solvents	0.5% sol. in water; sol. in glycols, glycol ethers, Sl. sol. methyl and ethyl alcohol.	insoluble in all common solvents	insoluble in all common solvents	insoluble in all common solvents	insoluble in all common solvents
...heat and ... for ... width	General purpose light and heat stabilizer	Stabilizer and lubricant	Lubricant and supplementary stabilizer	Economical stabilizer for vinyl electrical and calendered products	Anti-oxidant and light screening agent	Translucent polyvinyl chloride resins	Translucent polyvinyl chloride resins (Specially treated for easy dispersion)	High quality electrical vinyl compounds	Economical electrical stabilizer for vinyl chloride
IIIA, ...A, for ...	Types I, IIIA, IV, IIA for electrical insulation.	Types I, IIIB & C, V, VIA	Types I, III, IV, V, VIA, Especially recommended for IIIA	Types I, IIA & B, III, IV	Type II (Special for asbestos filled flooring stocks, see page 34)	Types I, IIA & B, III, IV	Types I, IIA & B, III, IV	Types I, IIIA, IV, IIA for electrical insulation	Types I, IIIA, IV, IIA for electrical insulation
XVI, ...II, ...II	IV, XI, XXIX, XXXV	I, III, IV, V, VIII, IX, XI, XVI, XX, XXII, XXIII, XXVIII, XXXI, XXXII, XXXIII, XXXV, XXXIX	II, XII, XV, XXIX	II, III, XXIII	XIV, XV		IX, XX, XXI, XXIII, XXVI, XXVII, XXIX	I, V, XV, XXXI, XXXV, XXXIX	I, II

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There are a great number of plasticizers, both primary and secondary, available to the vinyl compounder. For the sake of convenience, these materials have been classified into six major groups.

CLASSIFICATION OF VINYL PLASTICIZERS

TYPE I *Organic Ester Type* (Phthalates, adipates, azelates, sebacates, which do not contain ether linkages or aliphatic unsaturation)
- A. Primary* type plasticizer
- B. Primary type plasticizer of highest quality with special properties, such as low temperature flexibility or low volatility, etc.

TYPE II *Phosphate Type*
- A. Aryl phosphates
- B. Aryl-alkyl phosphates
- C. Alkyl phosphates

TYPE III *Oil Type***
- A. Organic ester epoxides
- B. Ether esters (Polyethylene glycol esters, etc.)
- C. Aliphatic unsaturated esters (Unsaturated oil derivatives)

TYPE IV *Polyester Type* (Polymerics, semi-polymerics)

TYPE V *Chlorinated Type* (Chlorinated paraffins and aromatics)

TYPE VI *Miscellaneous Type*
- A. Hydrocarbons, nitriles, amides, etc.
- B. Sulfur containing materials

C. RECOMMENDED LEAD STABILIZATION FOR VARIOUS PLASTICIZER TYPES

Organic Ester Type

The plasticizers in Type I perform best in vinyl stocks which are stabilized with highly basic lead compounds, such as "DUTCH BOY" TRIBASE, DYTHAL, and DYPHOS. There is some interaction between plasticizer and stabilizer in any system, and the action of these stabilizers in forming stable non-reactive salts with the breakdown products from this group of plasticizers is unique. Actually, the development of "DUTCH BOY" DYTHAL (dibasic lead phthalate) as a vinyl stabilizer resulted from studies of the reaction of TRIBASE with phthalate type plasticizers. TRIBASE, DYTHAL, and DYPHOS are all outstanding for heat stability, but vary individually in their light stabilizing action. TRIBASE alone gives only fair light stability for the majority of plasticizers, but it is greatly improved by the co-use of "DUTCH BOY" DS-207 (0.5% to 1.0%, based on the weight of the resin). DYTHAL provides good light stability and is a highly satisfactory all-

*A primary plasticizer [illegible]

**This classification is based on [illegible]

around stabilizer. Outdo[...]
superior to all other stabi[...]

Phosphate Type

In Type II plasticize[...]
stabilizer. Where the aryl [...]
ably cause formation of fr[...]
to either heat or light. Thi[...]
in the general case of aryl[...]
B or C, or "DUTCH BO[...]
tion of formulations with[...]
II A and II B) plasticiz[...]
the PLUMB-O-SILs and[...]
lead stabilizers with a m[...]
instances, NORMASAL [...]
products. In special cases[...]
used in electrical insulati[...]
DYPHOS, or DYTHAL[...]
used with such plasticizer[...]
primary requirements. D[...]
compounds containing lar[...]

Admittedly there ar[...]
II plasticizers where lead [...]
non-lead stabilization wit[...]
"APPLICATION OF "[...]
on page 17.

Oil Type

With the Type III A[...]
lizers, DYPHOS, DYTH[...]
vide very good heat and[...]
LEADSTAR, normal le[...]
cation is desired in comp[...]

In the case of oxidiz[...]
to have a detrimental effe[...]
ties. This is particularly [...]
pronounced "spewing"*[...]
exception to this rule. T[...]
BOY" PLUMB-O-SIL [...]
and light aging with plas[...]
spewing is inhibited, prob[...]
SIL. As a result, LECT[...]
stability for compounds i[...]
act as anti-blocking agen[...]

Though Types III [...]
type of stabilizer, it is no[...]

[illegible]

r of plasticizers, both primary and secondary, available or the sake of convenience, these materials have been ips.

ATION OF VINYL PLASTICIZERS

c Ester Type (Phthalates, adipates, azelates, sebacates, which do not contain ether linkages or aliphatic unsaturation)

mary* type plasticizer

mary type plasticizer of highest quality with special perties, such as low temperature flexibility or low volay, etc.

ate Type

l phosphates

l-alkyl phosphates

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ganic ester epoxides

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er Type (Polymerics, semi-polymerics)

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drocarbons, nitriles, amides, etc.

lur containing materials

STABILIZATION FOR VARIOUS PLASTICIZER TYPES

I perform best in vinyl stocks which are stabilized ds, such as "DUTCH BOY" TRIBASE, DYTHAL, interaction between plasticizer and stabilizer in any stabilizers in forming stable non-reactive salts with this group of plasticizers is unique. Actually, the de-Y" DYTHAL (dibasic lead phthalate) as a vinyl of the reaction of TRIBASE with phthalate type HAL, and DYPHOS are all outstanding for heat in their light stabilizing action. TRIBASE alone gives majority of plasticizers, but it is greatly improved by " DS-207 (0.5% to 1.0%, based on the weight of es good light stability and is a highly satisfactory all-

[illegible]

[illegible]

around stabilizer. Outdoor weathering tests show conclusively that DYPHOS is superior to all other stabilizers with this group of plasticizers.*

Phosphate Type

In Type II plasticizers, the nature of the organic portion governs the choice of stabilizer. Where the aryl group is cresyl, the reactive basic lead stabilizers will probably cause formation of free cresylic acid and result in discoloration under exposure to either heat or light. This acid formation with resultant poor stability seems to apply in the general case of aryl phosphates. The use of "DUTCH BOY" PLUMB-O-SIL B or C, or "DUTCH BOY" LECTRO "60" has been found desirable for stabilization of formulations with aryl phosphate and mixed aryl-alkyl phosphate (Types II A and II B) plasticizers. This is an excellent illustration of the effectiveness of the PLUMB-O-SILs and LECTRO "60" in providing the desirable properties of lead stabilizers with a minimum of the apparent reactivity of basic lead. In some instances, NORMASAL appears to inhibit formation of cresylic acid and related products. In special cases, where the Type II A plasticizers (aryl phosphates) are used in electrical insulation compounds, TRIBASE, LECTRO "60", TRIBASE-E, DYPHOS, or DYTHAL are recommended. These basic lead stabilizers should be used with such plasticizers when excellent electrical properties in a stabilizer are the primary requirements. DYPHOS imparts the best heat and light stability to vinyl compounds containing large amounts of the alkyl phosphate (Type II C) plasticizers.

Admittedly there are several types of applications involving the use of Type II plasticizers where lead stabilization is not indicated. Numerous examples of such non-lead stabilization with Type II plasticizers will be found in the section entitled "APPLICATION OF 'DUTCH BOY' NON-LEAD STABILIZERS" beginning on page 17.

Oil Type

With the Type III A plasticizers (organic ester epoxides), the basic lead stabilizers, DYPHOS, DYTHAL, TRIBASE, TRIBASE-E, and LECTRO "60" provide very good heat and light stability. It should be noted that "DUTCH BOY" LEADSTAR, normal lead stearate, is recommended rather than DS-207 when lubrication is desired in compounds containing these plasticizers.

In the case of oxidizable Types III B and III C plasticizers, basic lead appears to have a detrimental effect which is generally evidenced by poor heat aging properties. This is particularly apparent through the discoloration and occasionally more pronounced "spewing"** of the vinyl compositions. LECTRO "60" is a notable exception to this rule. The shielded reactivity of LECTRO "60" and "DUTCH BOY" PLUMB-O-SIL B and C has been found particularly outstanding in both heat and light aging with plasticizers of this general type. In addition, any tendency towards spewing is inhibited, probably by adsorption on the activated silica gel of PLUMB-O-SIL. As a result, LECTRO "60" and PLUMB-O-SIL B and C provide the best stability for compounds in which Type III B or C plasticizers predominate, and also act as anti-blocking agents to reduce any tendency toward spewing.

Though Types III B and C plasticizers are difficult at best to stabilize with any type of stabilizer, it is sometimes necessary by reason of cost or other considerations to

*[illegible]

**Spewing may be defined as migration to the surface of [illegible]

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use these materials for the good low temperature properties, hand, and drape, which they impart to vinyl products. Additional stabilization of Types III B and C plasticizers will be discussed in the "APPLICATION OF 'DUTCH BOY' NON-LEAD STABILIZERS" section.

Polyester Type

The Type IV plasticizers are widely used because of the permanence they impart to plastic compositions. Since any breakdown of the compound resulting in volatile and unstable degradation products would defeat the purpose of using polyester plasticizers, proper stabilization is especially important. The "DUTCH BOY" stabilizers, such as TRIBASE, DYTHAL, DYPHOS, TRIBASE-E and LECTRO "60" have adequate reserve basicity for long-term protection, and are especially beneficial with the polyester plasticizers. These five stabilizers are all good for heat stability, and they range from fair for TRIBASE-E and LECTRO "60" to outstanding for DYPHOS on light stability. When supplementary lubrication is required for these primary stabilizers in systems containing Type IV plasticizers, LEADSTAR is the recommended lubricant.

Chlorinated Type

The chlorinated type plasticizer (Type V) presents a special case. Chlorinated paraffins and aromatics have been particularly interesting to the vinyl compounder because of their low cost and excellent electrical and flameproofing properties. Their logical adaptation to vinyl compounding has always been seriously hindered by their well-known rapid and severe degradation characteristics. Pioneering work by the National Lead Company Research Laboratories* has shown that the advantages of using chloroparaffins can be realized through stabilization with "DUTCH BOY" DYPHOS. Effective stabilization with DYPHOS permits the use of chlorinated paraffins and aromatics in stocks which must have heat and light stability of a very high order, at a volume-cost reduction of as much as ten percent compared to other stocks of comparable quality. To properly stabilize compounds containing chlorinated hydrocarbons, it is necessary to consider that the entire resin-chlorinated hydrocarbon portion needs stabilizing. The necessity for using an additional amount of DYPHOS to compensate for the inclusion of a chlorine-containing secondary plasticizer is immediately apparent. The use of "DUTCH BOY" DS-207 was found to enhance the stabilizing action of DYPHOS appreciably.

Miscellaneous Type

The hydrocarbon, nitrile, amide, and other Type VI A plasticizers present special problems in both stabilization and compatibility with the vinyl resins. It is for this reason that they are relegated to the role of secondary plasticizers. DYPHOS is the best stabilizer for these plasticizers because its excellent heat and light stabilizing action is supplemented by its role as an anti-oxidant. These plasticizers are readily oxidizable in the presence of heat and ultra-violet light, and the acidic by-products further aggravate the stability and spew resistance of the vinyl product.

The sulfur-containing plasticizers (Type VI B) undergo a chemical interaction with the lead stabilizers to form lead sulfide. For this reason, the "DUTCH BOY" Lead Stabilizers are not recommended with these plasticizers. We refer you to page 25 for a discussion of the use of "DUTCH BOY" FLOMAX 25 and NALZIN combinations with plasticizers of this type.

*[illegible], Ind. Eng. Chem., [illegible]

Mixtures of Plasticizer

In commercial practic
one type of plasticizer is
using combinations of plast
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have plasticizers from Ty
total effect on stability is
each general plasticizer g
some cases, when the total
highly basic stabilizer is
entire plasticizer system w
BOY" non-lead stabilizers

D. LUBRICATION

For successful process
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four are all molten at proc
the temperature rises. "D
(40 F.) and maintains a c
ing history. Since DS-207 i
become molten, it does n
carried to the surface. The
lubricant mentioned.

Stearic acid is less c
in concentrations much ov
soaps, CALSTAR (calci
the hydrogen chloride rel
This reaction, of course,
primary stabilization. "DU
seen from its structure, ha
fore any stearic acid is rel
DS-207 is less prone to p
stability over these other m
reactive, and safe PbO co
with the other "DUTCH
and light resistance of the

E. STABILIZER TINTIN

The ultimate applicat
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Lead stabilizers are not
most so-called "clear" ap
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e "APPLICATION OF 'DUTCH BOY' NON-LEAD

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e any breakdown of the compound resulting in volatile
ducts would defeat the purpose of using polyester plas-
s especially important. The "DUTCH BOY" stabilizers,
AL, DYPHOS, TRIBASE-E and LECTRO "60" have
long-term protection, and are especially beneficial with
hese five stabilizers are all good for heat stability, and
TRIBASE-E and LECTRO "60" as outstanding for
When supplementary lubrication is required for these
s containing Type IV plasticizers, LEADSTAR is the

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reduction of as much as ten percent compared to other
To properly stabilize compounds containing chlorinated
to consider that the entire resin-chlorinated hydrocarbon
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e of a chlorine-containing secondary plasticizer is imme-
"DUTCH BOY" DS-207 was found to enhance the
S appreciably.

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s and compatibility with the vinyl resins. It is for this
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ultra-violet light, and the acidic by-products further
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rm lead sulfide. For this reason, the "DUTCH BOY"
mmended with these plasticizers. We refer you to page 25
"DUTCH BOY" FLOMAX 25 and NALZIN combi-
his type.

[illegible]

Mixtures of Plasticizer Types

In commercial practice, it is the exception when only one plasticizer, or even one type of plasticizer is used in the vinyl compound. There are many reasons for using combinations of plasticizers from the various groups. Among these are economy, availability, and specific properties sought. As a result, a typical film compound may have plasticizers from Types I, II, and III or IV present. In such cases, since the total effect on stability is generally additive, combinations of specific stabilizers for each general plasticizer grouping may be successfully and advantageously used. In some cases, when the total plasticizer used consists primarily of the types where a highly basic stabilizer is detrimental, it may be desirable to stabilize as though the entire plasticizer system were of this order of reactivity. For these cases, "DUTCH BOY" non lead stabilizers should be used. (See Section IV, pp. 17-25.)

D. LUBRICATION

For successful processing of a vinyl compound, it is desirable and necessary to use lubricants. Various lubricants including waxes, stearic acid, "DUTCH BOY" CALSTAR (calcium stearate), "DUTCH BOY" LEADSTAR (normal lead stearate), and "DUTCH BOY" DS-207 (dibasic lead stearate) have been used. The first four are all molten at processing temperatures and have reduced lubrication value as the temperature rises. "DUTCH BOY" DS-207 does not melt (decomposes above 400 F.) and maintains a constant solid phase lubrication over the entire heat processing history. Since DS-207 is almost entirely insoluble in most plasticizers, and does not become molten, it does not enter the plasticizer phase of the compound, and is not carried to the surface. The over-all compatibility of DS-207 is greater than any other lubricant mentioned.

Stearic acid is less compatible than either calcium stearate or lead stearate, and, in concentrations much over 0.75%, tends to spew severely to the surface. The normal soaps, CALSTAR (calcium stearate) and LEADSTAR (lead stearate), react with the hydrogen chloride released from the polymer and give some degree of stability. This reaction, of course, frees stearic acid and promotes spewing, in the absence of primary stabilization. "DUTCH BOY" DS-207, $2PbO \cdot Pb(C_{17}H_{35}COO)_2$, as may be seen from its structure, has two additional PbO groupings which must be reacted before any stearic acid is released into the vinyl compound. As a result, "DUTCH BOY" DS-207 is less prone to promote spewing and offers greatly enhanced heat and light stability over these other materials. This is another application of the concept of total, reactive, and safe PbO content. Use of DS-207 in the normal lubricant concentrations with the other "DUTCH BOY" lead stabilizers will double or even treble the heat and light resistance of the compound in many cases.

E. STABILIZER TINTING STRENGTH

The ultimate application of a vinyl compound may require complete translucency, a high degree of translucency, complete opacity, or any number of vivid or pastel colors. Lead stabilizers are not suitable for the obtaining of crystal clear transparency. For most so-called "clear" applications, a high degree of translucency, with opacity no greater than that contributed by a matted calender, is all that is required. Since, in effect, the "DUTCH BOY" lead stabilizers are actually pigments with stabilizing properties, it is well to differentiate between their relative "tinting strengths."*

*Tinting strength is related directly to the difference in refractive index of vehicle and pigments. [illegible]

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"DUTCH BOY" PLUMB-O-SIL B and C have refractive indices of 1.58 to 1.60 and will give a high degree of translucency with vinyl chloride type polymers (refractive index 1.58 to 1.60). When it is desirable to obtain strong vivid colors, the low tinting strength may be used advantageously. It is possible to obtain press-polished blacks which do not tend to show gray streaks, and vivid shades of red and other colors in this manner. "DUTCH BOY" DS-207 has a refractive index of 1.40 and does not contribute any apparent opacity when it is used in normal lubricant concentration. "DUTCH BOY" TRIBASE, DYTHAL, DYPHOS, TRIBASE-E and LECTRO "60" have refractive indices of approximately 2.0 and contribute in some degree to the white pigment value of the compound.

F. EFFECT OF SPECIFIC GRAVITY

Specific gravity is another factor which must be considered. If the vinyl compound is formulated on a "pound" basis, and is sold to the consumer on a "pound" basis, specific gravity is not of any particular importance. In most cases, however, the formulator compounds by weight but his end-product is sold on a volume basis. As a result, one stabilizer may be more expensive than another, on a pound basis, but on a pound-volume consideration may be more economical to use. On this basis, "DUTCH BOY" PLUMB-O-SIL C (specific gravity 2.96), PLUMB-O-SIL B (specific gravity 3.3) and LECTRO "60" (specific gravity 4.0) are among the most economical "DUTCH BOY" lead stabilizers which may be used in vinyls. Similarly, "DUTCH BOY" DYTHAL (specific gravity 4.6) is actually no more costly than "DUTCH BOY" TRIBASE (specific gravity 7.1), although there is a difference of cost per pound in these materials. This case is an example where quality may be obtained without sacrifice in cost considerations.

An additional advantage to be found with all the "DUTCH BOY" lead stabilizers is their non-marring characteristics. Since they are solid insoluble materials, they are not readily extracted by water, organic solvents, oils, etc., during their use and exposure. As indicated in the table of properties, basic lead salts are insoluble in all common solvents.

G. SUMMARY

In conclusion, it may be seen that several factors must be considered in choosing the correct lead stabilizer for the job. Some of the things to be considered include:

1. Degree of heat stability required.
2. Degree of light stability required.
3. Electrical properties.
4. Chemical characteristics of plasticizers used.
5. Lubrication desired.
6. Tinting strength.
7. Total, reactive, and safe basic lead content.
8. Specific gravity.

A number of specific applications will be indicated in the section on "PRACTICAL COMPOUNDING WITH 'DUTCH BOY' VINYL STABILIZERS," beginning on page 28.

IV. APPLICATIO

"DUTCH BOY" lead
for the vast majority of
industry with "DUTCH
utility and economy. In gene
for certain end-use require
ingredients. For cases whe
National Lead Company,
of non-lead stabilizers. P
stabilizers, both lead and
effectively almost any type

A. CONSIDERATIONS

There are four separa
lead stabilizers may be acc

1. Clarity

There are some plast
greater than that available
as PLUMB-O-SIL B or C.
ucts are transparent colored
types of belting, clear phon
"DUTCH BOY" non-lead
these classifications.

2. Staining

Some vinyl plastic pr
o. other sulfides where the
sulfide formation, leading
lead stabilizers are used. T
ing of the stocks. Another f
wrapping paper and cardb
resistance is required, use
Vinyl sheeting used as upho
eries and table cloths, and
where "DUTCH BOY"

It should be emphasiz
desirable properties which
very important advantages
resistant stock, and it is up
which are the most importa

3. Toxicity

Only a very small perc
non-toxic. Included in this
tubing. There are a great
toxic, are still sometimes i
as a safety measure. Examp
shank molded toys. In most
now possible, simply because
use of plasticizers which are
tion may be achieved there

'Y" PLUMB-O-SIL B and C have refractive indices of 1.58 to 1.60 h degree of translucency with vinyl chloride type polymers (refrac-.0). When it is desirable to obtain strong vivid colors, the low tinting d advantageously. It is possible to obtain press-polished blacks which gray streaks, and vivid shades of red and other colors in this manner. DS-207 has a refractive index of 1.60 and does not contribute any hen it is used in normal lubricant concentration. "DUTCH BOY" IAL, DYPHOS, TRIBASE-E and LECTRO "60" have refractive nately 2.0 and contribute in some degree to the white pigment value

PECIFIC GRAVITY

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ability required.
ability required.
rties.
eristics of plasticizers used.
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ed safe basic lead content.

ic applications will be indicated in the section on "PRACTICAL WITH 'DUTCH BOY' VINYL STABILIZERS," beginning

17

IV. APPLICATION OF "DUTCH BOY" NON-LEAD STABILIZERS

"DUTCH BOY" lead stabilizers provide the best heat and light stability available for the vast majority of vinyl plastic applications. The long experience of the vinyl industry with "DUTCH BOY" lead stabilizers has established their efficiency, versatility and economy. In general, it is necessary to utilize vinyl stabilizers, other than lead, for certain end-use requirements, or in conjunction with certain special compounding ingredients. For cases where lead stabilizers cannot be used, or are not desirable, the National Lead Company, through its Research Laboratories, has developed a new line of non-lead stabilizers. Proper application of appropriate "DUTCH BOY" vinyl stabilizers, both lead and non-lead, enables the vinyl plastics compounder to stabilize effectively almost any type of vinyl end-product he is called upon to produce.

A. CONSIDERATIONS IN CHOOSING NON-LEAD STABILIZERS

There are four separate reasons why application of the "DUTCH BOY" non-lead stabilizers may be necessary or desirable.

1. Clarity

There are some plastic end-products requiring a high degree of transparency, greater than that available through use of the highly translucent lead stabilizers, such as PLUMB-O-SIL B or C, DS-207, LEADSTAR, etc. Notable examples of such products are transparent calendered film and sheeting, extruded clear garden hose, certain types of belting, clear phonograph records, plastisols, organosols and solution coatings. "DUTCH BOY" non-lead stabilizers may be used to advantage in clear products in all these classifications.

2. Staining

Some vinyl plastic products are used in atmospheres containing hydrogen sulfide or other sulfides where the possibility exists of reaction with the stabilizers used. Lead sulfide formation, leading to highly colored reaction products, is often observed when lead stabilizers are used. The result is the formation of brown, black, or yellow staining of the stocks. Another frequent source of sulfide staining is the use of sulfite process wrapping paper and cardboard containers. In cases where a high degree of staining resistance is required, use of "DUTCH BOY" non-lead stabilizers is recommended. Vinyl sheeting used as upholstery, vinyl light gauge sheeting used for curtains, draperies and table cloths, and stain resistant vinyl flooring are a few of the end-products where "DUTCH BOY" non-lead stabilizers may be used to advantage.

It should be emphasized, however, that stain resistance is only one of a great many desirable properties which must be built into quality vinyl products. Very often, some very important advantages may be compromised in formulation of a completely stain-resistant stock, and it is up to the good judgment of individual compounders to decide which are the most important properties for a particular end-use.

3. Toxicity

Only a very small percentage of vinyl plastic products are required to be completely non-toxic. Included in this group are food packaging film, and surgical and beverage tubing. There are a great many other products which, while not required to be non-toxic, are still sometimes formulated by manufacturers without use of lead stabilizers, as a safety measure. Examples of this type are vinyl baby clothing and accessories, and plush molded toys. In most cases, complete non-toxicity in products is neither necessary nor possible, simply because the physical properties required are obtainable only through use of plasticizers which are not, in themselves, non-toxic in nature. Excellent stabilization may be achieved through the use of "DUTCH BOY" non-lead stabilizers, even

though no toxicological clearance has been obtained for these stabilizers at the present time. The compounder must balance the non-toxicity and stability requirements of the over-all vinyl compound in selecting not only the stabilizer but the other ingredients as well.

4. Interaction with Other Compounding Ingredients

As discussed in the section of this handbook dealing with "DUTCH BOY" lead stabilizers, a lead stabilizer system may be selected which will give excellent stabilization with almost all the compounding ingredients used in vinyl resins. There are, however, a few raw materials, especially plasticizers, which show up to best advantage when used in combination with "DUTCH BOY" non-lead stabilizers. Detailed information on this subject is contained in the section on "RECOMMENDED NON-LEAD STABILIZATION FOR VARIOUS PLASTICIZER TYPES."

B. "DUTCH BOY" NON-LEAD STABILIZERS

The "DUTCH BOY" non-lead stabilizers listed below are designed to fill the need for excellent stabilization in vinyl chloride products of all types. While the general recommendations concerning the best stabilizers to use in particular products are suitable for most cases, it should be borne in mind that plasticizer-stabilizer interaction, lubrication requirements, cost and other factors may affect the recommendations in each particular instance. Section VI of this handbook, "PRACTICAL COMPOUNDING WITH 'DUTCH BOY' VINYL STABILIZERS" gives many formulations for vinyl products which are representative of those that are successfully used in the industry. The formulations given in Section VI will provide an excellent starting point toward meeting specific needs for various compounds.

"DUTCH BOY" CLARITE is a barium-cadmium organic stabilizer which combines excellent heat stability with good light stability and clarity. The outstanding feature of CLARITE is its extremely high heat stability which is effective over long term conditions. It is well adapted for all types of molded and extruded products, such as belting, tubing, garden hose, profile extrusions, and injection moldings. The lubricating action of CLARITE is normally adequate for processing requirements without additional lubricants.

CLARITE is supplied as two components. CLARITE A is a white powder and CLARITE B is a clear liquid. CLARITE A should be used at a level of from 1.25% to 2%, based on the resin, depending on the particular combination of heat stability, clarity and lubricity desired. 1% of CLARITE B is customarily used with this level of CLARITE A. A special case, however, is the use of 2% of CLARITE A and 1% CALSTAR in vinyl flooring stocks. When asbestos filler is present, the requisite amount of "DUTCH BOY" NORMASAL should be added to the stock, as discussed in Section VI B.

In summary, CLARITE is recommended for extremely high heats, for extrusion and molding stocks, and in vinyl flooring compounds. In this same class of high heat, lubricating, barium-cadmium stabilizers, "DUTCH BOY" PROVINITE is preferred in stocks requiring maximum non-yellowing and superior light stability.

"DUTCH BOY" PROVINITE is a barium-cadmium organic complex supplied in a two-package system, which physically resembles CLARITE. Its stabilizing characteristics are different from CLARITE in several respects. While its heat stability is comparable, PROVINITE is readily distinguished by its stronger anti-oxidant action, its excellent light stability, and its exceptional freedom from yellowing. The strong stabilizing action of PROVINITE is shown by its usefulness at lower concentrations in the vinyl stock than conventional barium-cadmium soaps. PROVINITE has

slightly less lubricat
than CLARITE,
plasticizers.

PROVINITE
stabilizers. Althoug
lizers, PROVINIT
stocks for insulate
wire coatings.

PROVINITE
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essential. It may be
1% of PROVINIT
A and 1% of B in
clarity and less lu
staining film stock
BOY" NALZIN

Barium-cadmi
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"DUTCH BO
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always be used in
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PROVINITE A
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"DUTCH BO
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"DUTCH BOY"
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to 3% FLOMAX

rance has been obtained for these stabilizers at the present balance the non-toxicity and stability requirements of the selecting not only the stabilizer but the other ingredients

Compounding Ingredients

ion of this handbook dealing with "DUTCH BOY" lead system may be selected which will give excellent stabiliza- mpounding ingredients used in vinyl resins. There are, especially plasticizers, which show up to best advantage ith "DUTCH BOY" non-lead stabilizers. Detailed infor- ntained in the section on *"RECOMMENDED NON-* FOR VARIOUS PLASTICIZER TYPES."

EAD STABILIZERS

non-lead stabilizers listed below are designed to fill the tion in vinyl chloride products of all types. While the ncerning the best stabilizers to use in particular products should be borne in mind that plasticizer-stabilizer inter- nts, cost and other factors may affect the recommendations . Section VI of this handbook, "PRACTICAL COM- TCH BOY" VINYL STABILIZERS" gives many for- which are representative of those that are successfully used tions given in Section VI will provide an excellent starting c needs for various compounds.

ARITE is a barium-cadmium organic stabilizer which lity with good light stability and clarity. The outstanding extremely high heat stability which is effective over long lapted for all types of molded and extruded products, such ose, profile extrusions, and injection moldings. The lubri- is normally adequate for processing requirements without

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is recommended for extremely high heats, for extrusion yl flooring compounds. In this same class of high heat, stabilizers, "DUTCH BOY" PROVINITE is preferred non-yellowing and superior light stability.

VINITE is a barium-cadmium organic complex supplied ich physically resembles CLARITE. In stabilizing char- CLARITE in several respects. While its heat stability is is readily distinguished by its stronger anti-oxidant action, and its exceptional freedom from yellowing. The strong INITE is shown by its usefulness at lower concentrations conventional barium-cadmium soaps. PROVINITE has

slightly less lubricating action than CLARITE. It develops lower viscosity in plastisols than CLARITE, and is particularly recommended for use with easily oxidized plasticizers.

PROVINITE has the best electrical properties of the barium-cadmium type stabilizers. Although its electrical properties are not equal to the standard lead stabilizers, PROVINITE is highly satisfactory for clear and brightly colored jacketing stocks for instrument wires, novelty Christmas tree wire, and other low requirement wire coatings.

PROVINITE's combination of stabilizing properties is especially suitable for calendered vinyl stocks, where resistance to oxidation and sharp retention of color are *essential. It may be used at concentrations ranging from 2% of PROVINITE A and* 1% of PROVINITE B in high temperature sheeting stocks to as low as 0.75% of the A and 1% of B in thin film. The use of the lower concentrations provides even better clarity and less lubrication than the conventional level of usage. An excellent non-staining film stock may be achieved through the use of a small quantity of "DUTCH BOY" NALZIN with PROVINITE, as described below.

Barium-cadmium organic stabilizers are well established for clear and highly translucent compositions. One serious limitation of these systems is their tendency to stain in contact with sulfur or sulfur-containing materials. It has long been known that small amounts of organic zinc compounds eliminate or minimize the staining tendency of barium-cadmium stabilizers. Presumably this is due to the preferential acceptance of *the sulfur compounds by the organic zinc salt to form a soluble or light colored sulfide.*

"DUTCH BOY" NALZIN is a zinc organic complex especially developed for co-use with barium-cadmium stabilizers to eliminate sulfur staining. NALZIN should always be used in accordance with recommendations, since in large amounts, zinc compounds can readily become degradation catalysts instead of stabilizers for vinyls.

The exact level of NALZIN needed in a particular formulation depends to a large extent on the level of the barium-cadmium stabilizer, the sulfur staining resistance requirements, and the processing conditions. The optimum ratio, based on barium-cadmium content, is approximately 15% NALZIN, based on FLOMAX 25, or 25% NALZIN, based on PROVINITE A. For example, 3% FLOMAX 25 (based on the resin) should be changed to 2½% FLOMAX 25 with 0.5% NALZIN, where freedom *from sulfide staining and optimum heat stability are required. Correspondingly,* 2% PROVINITE A and 1% PROVINITE B should be changed to 1.5% PROVINITE A, 0.5% NALZIN, and 1% PROVINITE B (all on resin basis). *Under no circumstances should NALZIN be used alone without supplementary stabilization.*

"DUTCH BOY" FLOMAX 25 is a liquid barium-cadmium organic stabilizer. It is readily incorporated and imparts the highest degree of clarity of all of the "DUTCH BOY" stabilizers. FLOMAX 25 is entirely compatible with vinyls and it shows very little plating tendency. FLOMAX 25 gives vinyl film an ideal surface for heat sealing and printing, since it provides a dry and tack-free surface. It is recommended for plastisols, organosols and solution coatings because of its ready dispersibility, low viscosity, clarity and compatibility. The heat stability of FLOMAX 25 is almost on a par with the CLARITE-PROVINITE class of stabilizers for extended heat exposure at very high temperatures. It is excellent for the normal processing conditions used in calendering, extrusion and dispersion resin fusions. The light stability is remarkably good, being equal to or better than that of PROVINITE. For most vinyl stocks, FLOMAX 25 is recommended at a level of approximately 3% on the resin, subject to requirements for special heat conditions. Vinyl film is generally successfully stabilized with 2.5% FLOMAX 25 together with about 0.5% stearic acid. From 2½ to 3% FLOMAX 25 is best for dispersion and solution vinyl resin systems.

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TABLE OF PROPERTIES OF "DUTCH BOY" NON-LEAD STA[...]

PRODUCT	CALSTAR	CLARITE: CLARITE A	CLARITE: CLARITE B	CS-137	FLOMAX 20	[cut off]
COMPOSITION	Calcium Stearate	Barium-Cadmium Organic Complex		Barium-Sodium Organic Complex	Barium-Cadmium Organic Complex.	Zinc Organic [cut off]
FORMULA	$Ca(C_{17}H_{35}COO)_2$	Complex Structure		Complex Structure	Complex Structure	Complex Str[cut off]
MOLECULAR WEIGHT	607	—	—	—	—	—
COLOR AND FORM	fine white powder	soft white powder	clear straw-colored liquid	creamy white paste	Clear yellow liquid	Clear pale y[cut off]
REFRACTIVE INDEX	1.52-1.53	1.56 max.	1.49	1.48	1.48	1.4[cut off]
SPECIFIC GRAVITY	1.04-1.07	1.34	0.930	2.30	1.03	0.[cut off]
SOLUBILITY	insoluble in water and all common organic solvents	insoluble in all common solvents	miscible in mixtures of hydrocarbon solvents with ketones, esters, "Cellosolves," etc.	solids portion insoluble in all common organic solvents.	miscible in mixtures of hydrocarbon solvents with ketones, esters, "Cellosolves," etc.	miscible in [cut off] hydrocarbon [cut off] ketones, [cut off] "Cellosolve[cut off]
SPECIAL REMARKS		Supplied as a two part system. General Recommendation: 2 parts CLARITE A, 1 part CLARITE B per 100 parts of resin		Supplied as a 70% solids paste in DOP (di-2-ethylhexyl phthalate)		
RECOMMENDED APPLICATION 1. Special	Lubricant with some heat stabilizing properties for clear compounds.	Heat and light stabilizer for extruded and molded clears, and vinyl flooring.		Anti-oxidant light stabilizer for good weathering resistance	Liquid stabilizer with very high clarity and excellent plating resistance.	Supplement[cut off] for [illegible] to [illegible]
2. Plasticizer Recommended*	Types I, II, III, IV, VI	Types I, II, III, IV		Types I, II, III, IV, VI	Types I, II, III, IV, VIA; VIB with NALZIN	Types I, II, [cut off]
3. Suggested Formulations**	XIII, XIV, XXX, XXXIV	XIII, XIV, XXXIV		XL	VII, XVII, XVIII, XIX, XXI, XXV, XXVII, XXXVII, XL	X, XVIII, [cut off]

*See page 12 or 28.
**See pages 30 to 48.

TABLE OF PROPERTIES OF "DUTCH BOY" NON-LEAD STABILIZERS

CLARITE		
CLARITE A	CLARITE B	CD-532
Barium-Cadmium Organic Complex		Barium-Sodium Organic Complex
Complex Structure		Complex Structure
—	—	—
soft white powder	clear straw-colored liquid	creamy white paste
1.56 max.	1.49	1.48
1.36	0.930	2.90
insoluble in all common solvents	miscible in mixtures of hydrocarbon solvents with ketones, esters, "Cellosolves," etc.	solids portion insoluble in all common organic solvents
Supplied as a two part system *General Recommendation:* 2 parts CLARITE A 1 part CLARITE B per 100 parts of resin		Supplied as a 70% solids paste in DOP (di-2-ethylhexyl phthalate)
Heat and light stabilizer for extruded and molded sheets and vinyl flooring		Antioxidant light stabilizer for good weathering resistance
Types I, II, III, IV		Types I, II, III, IV, VI
XIII, XIV, XXXIV		XL

FLOMAX ES	NALZIN	PROVINITE	
		PROVINITE A	PROVINITE B
Barium-Cadmium Organic Complex	Zinc Organic Complex	Barium-Cadmium Organic Complex	
Complex Structure	Complex Structure	Complex Structure	
—	—	—	—
Clear yellow liquid	Clear pale yellow liquid	soft white powder	clear straw-colored liquid
1.48	1.46	1.56 max.	1.51
1.03	0.916	1.31	0.995
miscible in mixtures of hydrocarbon solvents with ketones, esters, "Cellosolves," etc.	miscible in mixtures of hydrocarbon solvents with ketones, esters, "Cellosolves," etc.	insoluble in all common solvents	miscible in mixtures of hydrocarbon solvents with ketones, esters, "Cellosolves," etc.
		Supplied as a two part system *General Recommendation:* 0.75 to 2 parts PROVINITE A 1 part PROVINITE B per 100 parts of resin	
Liquid stabilizer with very high clarity and excellent plating resistance.	Supplementary stabilizer for barium-cadmium types to resist sulfide stain.	*General purpose* clear heat and light stabilizer, for calendering, extrusion and dispersion paste applications.	
Types I, II, III, IV, VIA; VIII with NALZIN	Types I, II, III, IV, VI	Types I, II, III, IV, VIA; VIII with NALZIN	
VII, XVII, XVIII, XIX, XXI, XXV, XXVII, XXXVII, XL	X, XVIII, XXV, XL	VI, X, XXIV, XXVI, XXXVI	

"DUTCH BOY" CS-137, a barium-sodium organic complex, is an excellent anti-oxidant stabilizer for clear vinyl products. Normally, it is the first stabilizer that should be considered whenever exceptional light and outdoor weathering stability are desired. Used at normal concentrations in thin films, CS-137 will give as much as 2-3 years of outdoor stability without significant breakdown. This performance is considered outstanding for clear vinyl stocks. Used alone, CS-137 does not have the outstanding heat stability characteristic of CLARITE or PROVINITE. Hence its main use is in vinyl organosols and solution coatings over cloth or metal. It has also given very successful results in plastisol and thin calendered films requiring weathering resistance, especially with supplementary stabilizers to aid in withstanding the heat cycle. CS-137 has outstanding stain resistance. For ease in dispersion in paste resins and solutions, it is supplied as a 70% solids paste in di-2-ethylhexyl phthalate (DOP).

"DUTCH BOY" CALSTAR, calcium stearate, is a lubricant and supplementary stabilizer for clear vinyl products. It is useful in calendered products and extrusions, and also as a mold release agent for plastisols and injection molded articles. In general, it should be used with the various "DUTCH BOY" non-lead stabilizers only to the extent that additional lubrication is required over that provided by the stabilizers themselves. This will vary with processing methods and speeds, and the "practical compounding" section illustrates its use in several specific applications. In a few products, such as some clear phonograph records, CALSTAR is used as the sole stabilizer. More often, however, an additional stabilizer will prove to be a very good investment.

C. PLASTICIZER-STABILIZER INTERACTION

Effective and economical application of non-lead stabilizers is similar to the use of the lead stabilizers, in that the nature of the entire vinyl plastic system determines the best stabilizer, or combination of stabilizers, to accomplish the intended purpose. Actually, all of the compounding ingredients, including resin, plasticizers, fillers and colorants, have a bearing on proper choice of stabilizer. Of all the factors involved, however, the plasticizer system is by far the most important. Plasticizers vary considerably in their ability to withstand processing heat and attack by breakdown products of the vinyl resin. In some cases, the proper non-lead stabilizers actually inhibit breakdown of plasticizers. In other words, they stabilize the plasticizer as well as the resin, just as is the case in lead stabilization. In other instances, plasticizers in the systems are sufficiently stable to heat and light conditions so that all that is required of a good non-lead stabilizer is to do its primary job of stabilizing the resin. There are cases, however, where stabilizers do react unfavorably with plasticizers of certain types. This chemical interaction is sometimes observed as severe color formation, or as loss of plasticity, as evidenced by physical measurements, such as the hardness or modulus of the stock. The effects of stabilizer-plasticizer interaction are also made apparent by the plasticizer becoming incompatible. This is sometimes evidenced by blocking or severe spewing, or by the reaction products catalyzing the degradation of the resin.

Proper choice of "DUTCH BOY" non-lead stabilizers will give very effective stabilization in stocks containing practically all types of plasticizers. As discussed previously in the lead stabilizer section of this handbook, plasticizers may be divided into several distinct types or groups according to their chemical nature and properties. For convenience in the discussion of recommendations of "DUTCH BOY" non-lead stabilizers with various plasticizers, the plasticizer table on page 12 is reproduced here.

CLASSIF

TYPE I *Organ*
A. Pr
B. Pr
pr
til
TYPE II *Phosp*
A. Ar
B. Ar
C. Al
TYPE III *Oil Ty*
A. Or
B. Ep
C. Al
TYPE IV *Polyes*
TYPE V *Chlori*
TYPE VI *Miscel*
A. Hy
B. Su

D. RECOMMENDED NON-
TYPES

Organic Ester Type

Plasticizers of Type I p
lent performance is obtained
as CLARITE, PROVINIT
is governed chiefly by the typ
clarity requirements. For ex
CLARITE is suggested; for
would be selected; for maxim
advantages and recommenda
section.

Where outstanding weath
vinyl solution coatings contain
be used in conjunction with

Phosphate Type

As mentioned previously
factory stabilization. "DUTC
25 are exceptionally effective
plasticizers, with PROVINI
any of the barium-cadmium
small amount of epoxidized

barium-sodium organic complex, is an excellent
yl products. Normally, it is the first stabilizer that
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NTERACTION

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according to their chemical nature and properties.
f recommendations of "DUTCH BOY" non-lead
, the plasticizer table on page 12 is reproduced here.

CLASSIFICATION OF VINYL PLASTICIZERS

TYPE I *Organic Ester Type* (Phthalates, adipates, azelates, sebacates, which do not contain ether linkages or aliphatic unsaturation)
- A. Primary* type plasticizer
- B. Primary type plasticizer of highest quality with special properties such as low temperature flexibility or low volatility, etc.

TYPE II *Phosphate Type*
- A. Aryl phosphates
- B. Aryl-alkyl phosphates
- C. Alkyl phosphates

TYPE III *Oil Type***
- A. Organic ester epoxides
- B. Ether esters (Polyethylene glycol esters, etc.)
- C. Aliphatic unsaturated esters (Unsaturated oil derivatives)

TYPE IV *Polyester Type* (Polymerics, semi-polymerics)

TYPE V *Chlorinated Type* (Chlorinated paraffins and aromatics)

TYPE VI *Miscellaneous Type*
- A. Hydrocarbons, nitriles, amides, etc.
- B. Sulfur containing materials

D. RECOMMENDED NON-LEAD STABILIZATION FOR VARIOUS PLASTICIZER TYPES

Organic Ester Type

Plasticizers of Type I present relatively few problems in stabilizer choice. Excellent performance is obtained by the use of the barium-cadmium organic stabilizers such as CLARITE, PROVINITE, and FLOMAX 25. The choice among these stabilizers is governed chiefly by the type of products being manufactured and their stability and clarity requirements. For example, for maximum heat stability PROVINITE or CLARITE is suggested; for maximum light stability PROVINITE or FLOMAX 25 would be selected; for maximum clarity FLOMAX 25 is recommended. The specific advantages and recommendations for these stabilizers were outlined earlier in this section.

Where outstanding weathering resistance is desired in films, organosol coatings and vinyl solution coatings containing Type I plasticizers, "DUTCH BOY" CS-137 should be used in conjunction with PROVINITE or FLOMAX 25.

Phosphate Type

As mentioned previously, the Type II plasticizers often present a problem in satisfactory stabilization. "DUTCH BOY" PROVINITE, CLARITE, and FLOMAX 25 are exceptionally effective in promoting high heat and light stability in Type II plasticizers, with PROVINITE the best of this group by a small margin. Whenever any of the barium-cadmium stabilizers are employed with phosphate plasticizers, a small amount of epoxidized plasticizer (Type III A) adds to heat stability.

*A primary plasticizer may be classified as a plasticizer which of itself will produce the required degree of flexibility in a vinyl plastic [illegible]

**This classification is based on the consideration that both the aliphatic carbon to carbon unsaturated bond and the ether linkage are [illegible]

7-57-56

The use of CS 137 with Type II plasticizers gives only fair heat and light stability. Where it is desired to get very good weathering resistance in stocks containing 20% or more of Type II plasticizers, the co-use of CS-137 and PROVINITE is recommended.

Oil Type

The plasticizers of Type III fall naturally into three distinct groups. Stabilization of Type III A (organic ester epoxides) is a somewhat different problem from the other two groups, III B and III C. In many cases, use of small amounts of Type III A plasticizers (less than 10% of the vinyl resin content) actually improves the stabilizing properties of barium-cadmium stabilizers. This tendency is of greater importance in copolymer resins than in homopolymer resins, and is especially useful in vinyl chloride resins of lower molecular weight. Their advantage is also greater in heat stability than in stability toward light and outdoor weathering. "DUTCH BOY" PROVINITE, CLARITE, and FLOMAX 25 are especially recommended with plasticizers of Type III A.

Type III B (ether ester) and Type III C (unsaturated ester) plasticizers respond to very similar stabilizing techniques. "DUTCH BOY" CS-137 imparts a high degree of light resistance to Type III B and III C plasticizers, and provides excellent stabilization against outdoor weathering. "DUTCH BOY" PROVINITE serves as an excellent primary stabilizer in conjunction with CS-137 in calendered stocks containing Type III B and III C plasticizers. "DUTCH BOY" CLARITE performs similarly in extruded and highly loaded semi-rigid applications. In some products where absolute clarity is not essential, many compounders prefer to use PLUMB-O-SIL B or C along with a supplementary clear stabilizer such as CS-137, or a tin stabilizer, to enhance the light stability. These systems have proved to be very versatile and practical, especially when high amounts of Type III B and III C plasticizers are used, and when plasticizer migration is troublesome.

Polyester Type

The stabilization of vinyl stocks containing Type IV plasticizers parallels to some extent the stabilization techniques used with Type I (monomeric ester) plasticizers. The major differences are due to the necessity to combat oxidation and cross-linking, usually observed in vinyl products as a tendency on the part of the plasticizer to sweat or spew, or in the case of light exposure, to develop spot degradation or embrittlement. "DUTCH BOY" PROVINITE and FLOMAX 25 provide excellent heat and light stability with Type IV plasticizers, with PROVINITE being the stronger of the two. Some excellent results have been obtained using "DUTCH BOY" CS-137 in stocks for outdoor use that contain appreciable quantities of polyester plasticizers. This is due to the antioxidant characteristics of CS-137.

Chlorinated Type

The Type V plasticizers (chlorinated paraffins and aromatics) as mentioned on page 14, present a special stabilization problem where "DUTCH BOY" DYPHOS, used in combination with "DUTCH BOY" DS-207, gives a degree of stabilization far above that of other systems tested. While the various non-lead stabilizers help Type V plasticizers to a minor extent, the non-lead stabilizers are not generally recommended with chlorinated type plasticizers.

Miscellaneous Type

The limitations of the Type VI A plasticizers (the hydrocarbons, nitriles, amides, etc.) with respect to compatibility and stability during exposure to heat and light call for special stabilization. As discussed on page 14, DYPHOS is the best all-around stabilizer for compounds containing these plasticizers. However, if clarity is essential,

a combination of CS-137 and
CS-137 and the excellent light
to "stabilize" both the vinyl re

A combination of "DU
recommended for stabilizing
(sulfur-containing materials).
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plasticizers. CS-137 is also re
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FLOMAX 25 in those vinyl
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CALSTAR is very efficient.

Mixtures of Plasticizer Ty

It should be remembered
several plasticizers, often of
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E. LUBRICATING PROPE

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F. OTHER CONSIDERATI

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...Type III fall naturally into three distinct groups. Stabilization ...ester epoxides) is a somewhat different problem from the other ...II C. In many cases, use of small amounts of Type III A plas... of the vinyl resin content) actually improves the stabilizing ...linum stabilizers. This tendency is of greater importance in ...in homopolymer resins, and is especially useful in vinyl ...molecular weight. Their advantage is also greater in heat ...ty toward light and outdoor weathering. "DUTCH BOY" ...TE, and FLOMAX 25 are especially recommended with ...A.

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...ers (chlorinated paraffins and aromatics) as mentioned on ...stabilization problem where "DUTCH BOY" DYPHOS, ...DUTCH BOY" DS-207, gives a degree of stabilization for ...treated. While the various non-lead stabilizers help Type V ...ers, the non-lead stabilizers are not generally recommended ...icizers.

...Type VI A plasticizers (the hydrocarbons, nitriles, amides, ...sibility and stability during exposure to heat and light call... As discussed on page 14, DYPHOS is the best all-around ...taining these plasticizers. However, if clarity is essential,

a combination of CS-137 and FLOMAX 25 is suggested. The anti-oxidizing action of CS-137 and the excellent light stability of this stabilizer combination will greatly help to "stabilize" both the vinyl resin and Type VI A plasticizers.

A combination of "DUTCH BOY" NALZIN and FLOMAX 25 is especially recommended for stabilizing vinyl compounds containing Type VI B plasticizers (sulfur-containing materials). In addition to its very good all-around stabilizing action, this combination does not cause undesirable sulfide staining in the presence of these plasticizers. CS-137 is also resistant to sulfide staining, as well as being an excellent light stabilizer. It is recommended as a secondary stabilizer with PROVINITE or FLOMAX 25 in those vinyl compounds which must have extreme resistance to outdoor weathering and ultra-violet light. When added lubrication is desired for easier processing or better mold release in compounds containing the Type VI B plasticizers, CALSTAR is very efficient.

Mixtures of Plasticizer Types

It should be remembered that the usual practice in vinyl compounding is to use several plasticizers, often of several types or groups, to get the specific properties desired in various products. The contribution of each plasticizer as far as stabilization techniques are concerned is generally additive. Thus, the stabilizer system used for a mixture of plasticizers will be made up of proportional amounts of the stabilizer that would be used if each plasticizer were considered alone. Very often, where a formulation contains a large amount of a plasticizer other than Type I, which tends to be reactive or difficult to stabilize, it is necessary to select a stabilizer system as if the entire plasticizer content were of this order of reactivity. In this respect, use of "DUTCH BOY" non-lead stabilizers is similar to lead stabilization. The section on "Practical Compounding" gives many helpful stabilizer suggestions for specific cases.

E. LUBRICATING PROPERTIES

Two of the "DUTCH BOY" barium-cadmium stabilizers, CLARITE and PROVINITE, possess sufficient lubricating properties of themselves, so that supplementary lubrication is not normally required for most applications. FLOMAX 25 has no lubricity. Among the non-lead stabilizers, "DUTCH BOY" CALSTAR is the best overall lubricant. The lubricating properties of CALSTAR are superior to those of the barium-cadmium compounds. On the other hand, the heat stability protection afforded by CALSTAR is definitely inferior to that of the other "DUTCH BOY" non-lead stabilizers.

F. OTHER CONSIDERATIONS

"DUTCH BOY" non-lead stabilizers are not suitable for primary insulation. The unique requirement of high volume resistivity makes complete absence of soluble or ionizable compounds in electrical formulations desirable. Lead stabilizers are considered mandatory for this application. For secondary insulation or jacketing stocks, however, "DUTCH BOY" PROVINITE can be used when special effects are required, such as in clear, highly colored insulation overlays.

V. INCORPORATION OF VINYL STABILIZERS

Although the necessity for the incorporation of stabilizers into vinyl products is well recognized, it is not as generally realized that the proper dispersion or incorporation of stabilizer is required for the promotion of maximum ultimate stability.

The degree of stability obtained in any one system will depend upon the amount and type of stabilizer used. Nevertheless, without proper dispersion of such stabilizer, degradation of any vinyl product will occur more rapidly, resulting in loss in flexibility, change in color and other physical changes. Extreme cases of poor dispersion of the various incorporated materials are usually indicated by visible spots or specks in the finished product. This phenomenon, of course, is seldom encountered in any commercially acceptable product, but even without the appearance of spotting, the required degree of stabilizer dispersion still may be unsatisfactory.

Due to the random nature of vinyl degradation, change in color often occurs in localized areas on the surface and at the edges where more severe exposure conditions are encountered. Such failure, which may be attributed in part to "localized stabilizer exhaustion," shows the necessity of having sufficient stabilizer evenly dispersed throughout the plastic compound to inhibit such localized degradation to the maximum degree. It may be easily shown that the degree of dispersion of the stabilizer will markedly affect the ultimate stability of the vinyl compound. Comparison of the stability of two compounds, one having excellent distribution of the stabilizer, and the other having poor distribution, will show that a multi-fold increase in ultimate stability will be the result of more effective mixing.

There are a number of processing techniques used in the industry to obtain proper stabilizer dispersion. Although the compound which is to be further processed by calendering, extruding, injection molding, or compression molding, may be mixed and fused in one step on a two-roll mill or Banbury mixer, more satisfactory dispersion is obtained by using a two-step process which includes premixing and fluxing. Premixing may be accomplished by thoroughly blending all the dry ingredients such as resin, stabilizer, filler and pigments, in dough mixers, ribbon blenders, pony mixers or tumbling blenders. The dry mix is then carefully wetted with plasticizer by stepwise incorporation. This premix may then be fused in the usual processing equipment.

Barium-cadmium stabilizers such as "DUTCH BOY" CLARITE and PROVINITE are each supplied as two-component systems; CLARITE A and PROVINITE A are dry powders, while CLARITE B and PROVINITE B are liquids. These stabilizers can be best incorporated by adding the dry powder to the other dry ingredients such as resin, filler and pigments in the premixing operation. The liquid portion of the stabilizer is added along with the plasticizer during the wetting of the dry mix. "DUTCH BOY" FLOMAX 25 and NALZIN are entirely liquid, and consequently provide maximum dispersion ease. They are easily blended with the plasticizer.

Additional method
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"DUTCH BOY" PLU
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rsion ease. They are easily blended with the plasticizer.

Additional methods have been utilized to obtain shorter pre-mixing and fusing cycles. They shorten the time in which the plastics compound will be subjected to high temperatures and insure more complete wetting of stabilizer and resin by the plasticizer. Notable among these is the use of stabilizers specially treated for ease of dispersion. "DUTCH BOY" PLUMB-O-SIL C, TRIBASE-E and LECTRO "60" are outstanding materials of this type, and they wet and disperse very easily in plastic mixes. They will be found very useful in all applications where stabilizer dispersion is a problem.

The technique of masterbatching has been very successfully employed in obtaining the degree of dispersion necessary for better ultimate stability. Not only does masterbatching insure this necessary dispersion, but it also allows easier handling and results in a more uniform product. *The dispersion of stabilizer in plasticizer to form a stabilizer paste* is a very obvious method of masterbatching. In this method, the stabilizer is dispersed in plasticizer by grinding on a three-roll paint mill, in a colloid mill, or in a ball mill. The dispersion of stabilizer in resin has also been successfully employed and may be utilized in *masterbatch chip form,* or may be made into a *solvated semi-paste.*

Other methods of processing vinyls, such as coating, dipping and casting, which utilize organosols, plastisols and emulsion dispersions, have also successfully utilized pre-dispersed stabilizers. Actually, masterbatches may cut the required grinding time needed for the total organosol or plastisol.

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VI. PRACTICAL COMPOUNDING WITH "DUTCH BOY" VINYL STABILIZERS

The foregoing material has been of a general nature. An attempt has been made to indicate how specific physical and chemical properties of the "DUTCH BOY" vinyl stabilizers might be most efficiently and effectively utilized. The information that follows is of a more specific nature and illustrates the application of the "DUTCH BOY" vinyl stabilizer in a number of practical end uses in the vinyl plastics field. The compounds suggested are by no means the only ones that would possess the properties sought for a particular use. In many instances, other similarly modified compositions may offer advantages in quality, cost and manufacturing ease over the ones suggested herein. There is no intention to recommend one available component raw material over another in any particular application. The entire purpose is to illustrate correct general techniques in utilizing "DUTCH BOY" vinyl stabilizers.

In the formulations given, various component raw materials will be indicated by generic classes rather than by brand or chemical names. In all cases the resin described may be either a polymer of vinyl chloride, or a copolymer of vinyl chloride with any of the numerous monofunctional unsaturated materials in use today. Colorants will be omitted from these formulations altogether, although they do constitute a definite factor in the stabilization characteristics of the vinyl compound. Fillers will be indicated as "filler," with the choice of the numerous materials available left to the discretion of the compounder.

Plasticizer will be indicated by symbols from the plasticizer classification table shown on pages 12 and 23.

The stabilizer will be specifically indicated from the "DUTCH BOY" series. In cases where some other commercially available stabilizer would be helpful in conjunction with "DUTCH BOY" vinyl stabilizers, these will merely be indicated as "supplementary stabilizer."

A. EXTRUSION COMPOUNDS

There are two general methods of preparing extrusion compounds for the actual extrusion operation itself. These are dry blender pre-mixing and hot fluxing. The dry mixing is carried out by adding the various dry compounds, i.e., resin, stabilizer, colorant and filler, to a blender where thorough mixing produces fair relative dispersion. The plasticizer is heated and sprayed into the powder mix with continuous agitation. The semi-swollen plastic premix may then be directly extruded. Although the heat involved in this mixing operation is fairly low and the stabilizer is a less important factor at this point, the higher temperatures required for fluxing and extrusion of a dry mixed compound make a stabilizer of ultimate great importance for this process. Extrusion compounds of this sort are sometimes handled by two extruders in series. The first extruder acts to flux and complete the mixing of the vinyl compound, while the second extruder yields the finished product. Temperatures involved range from 320° to 375° F. for cycles up to forty-five minutes.

Hot fluxed compounds may be prepared by adding a well pre-blended stock to a Banbury mixer at temperatures of 300° to 400° F. for cycles of four to eight minutes. The Banbury compound is then transferred to a hot two-roll plastic warm-up mill where it is slabbed off for pelletizing. These pellets are used cold to feed the extruder. Another technique is to use the hot compound from the two-roll plastic mill and actually hot-stripfeed the extruder. Tempe
minutes are encountered durin
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The entire fluxing and mi
plastics mill. Cycles up to forty
tered under such conditions. T
may range up to 375° F., but g
compounds.

Electrical Compounds

Two broad classes of co
insulation for wire coating, an
protection of primary insulate
conductor to provide electrical
insulation resistance, and the m
long-term exposure to heat an
fillers are incorporated to increa
fifteen percent by weight are us
lower the heat stability. A high
wire from cutting through the

In primary insulation "D
"60" and DYTHAL have
stabilizing action and electrica
is not generally required.

"DUTCH BOY" TRIBA
89%, of which 67% is reactive
electrical characteristics with a
any danger of color instability.
electrical stabilizer for primary

"DUTCH BOY" TRIB
containing 68% total PbO, of w
electrical properties of the sa
possess the reserve heat stabili
carbonate and other similar pig
(5.5) makes this material an
compounds.

"DUTCH BOY" LECTR
excellent electrical properties a
LECTRO "60" has outstandin
ties on long-term water immers
as TW wire where good lon
LECTRO "60" can be used
polymerics, phosphates and u
gravity (4.0) makes LECTRO
for primary insulation.

"DUTCH BOY" DYTH
is safe reactive PbO, compares
and is particularly useful in h

PRACTICAL COMPOUNDING WITH "DUTCH BOY" VINYL STABILIZERS

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MPOUNDS

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stripfeed the extruder. Temperatures of 300° to 350° F. for periods of ten to thirty minutes are encountered during such operations. Hot-stripfeed stock may stay on the warm-up mill for a longer period, but is compensated by a shorter cycle in the extruder.

The entire fluxing and mixing may be carried out directly on a large two-roll hot plastics mill. Cycles up to forty minutes at temperatures of 300° to 360° F. are encountered under such conditions. Temperatures in the extruder for hot mixed compounds may range up to 375° F., but generally for shorter periods than required for dry mixed compounds.

Electrical Compounds

Two broad classes of compounds are employed in the electrical field, primary insulation for wire coating, and jacketing or secondary insulation for the mechanical protection of primary insulated wires. Primary insulation, applied directly over the conductor to provide electrical protection for the system, must necessarily have a high insulation resistance, and the maintenance of flexibility and electrical properties during long-term exposure to heat and moisture is of paramount importance. Selected clay fillers are incorporated to increase insulation resistance, but amounts higher than ten to fifteen percent by weight are usually avoided so as not to impair physical properties and lower the heat stability. A high resistance to deformation is desirable in preventing the wire from cutting through the insulation during handling and installation.

In primary insulation "DUTCH BOY" TRIBASE, TRIBASE-E, LECTRO "60" and DYTHAL have been found exceptionally desirable, since their heat stabilizing action and electrical properties are outstanding, and unusual light stability is not generally required.

"DUTCH BOY" TRIBASE ($3PbO \cdot PbSO_4 \cdot H_2O$) has a total PbO content of 89%, of which 67% is reactive and safe. This high basic lead content affords excellent electrical characteristics with most of the commonly used electrical plasticizers without any danger of color instability, gassing, or moisture pick-up. TRIBASE is the quality electrical stabilizer for primary insulation.

"DUTCH BOY" TRIBASE-E is a specially prepared basic lead silicate sulfate containing 66% total PbO, of which 50.8% is safe and reactive PbO. It gives excellent electrical properties of the same order of magnitude as TRIBASE, but it does not possess the reserve heat stability of TRIBASE, although it is superior to basic lead carbonate and other similar pigment materials. The low specific gravity of TRIBASE-E (5.5) makes this material an economical, general stabilizer for primary insulation compounds.

"DUTCH BOY" LECTRO "60" is a lead chlorosilicate complex which possesses excellent electrical properties and good heat stability combined with ready dispersability. LECTRO "60" has outstanding moisture resistance and retention of electrical properties on long-term water immersion. It is particularly recommended for applications, such as TW wire where good long term water immersion characteristics are essential. LECTRO "60" can be used with a wide range of plasticizers including certain polymerics, phosphates and unsaturated or other esters. In addition, its low specific gravity (4.0) makes LECTRO "60" the most economical "DUTCH BOY" stabilizer for primary insulation.

"DUTCH BOY" DYTHAL, with a total PbO content of 79.8% of which 54.8% is safe reactive PbO, compares favorably with TRIBASE in stabilizing vinyl insulation, and is particularly useful in high-temperature appliance wire formulations. In fact,

DYTHAL is the best available stabilizer for coping with the high extrusion temperatures employed and the rigorous heat history encountered in the subsequent use of 90° C. to 105° C. appliance wire insulation. This appears to be due to the unusually low reactivity of DYTHAL with plasticizers under strong heat conditions as compared to the other highly basic lead stabilizers.

"DUTCH BOY" DS-207 provides an effective boost in stabilizing action for all electrical stocks as a supplement to the primary stabilizer. It provides lubrication without incompatibility, and improves electrical properties during prolonged water immersion conditions.

Secondary insulating or jacketing stocks are compounded with somewhat less emphasis on maximum insulation resistance, since mechanical protection is their primary function. Jacketing stocks are usually applied in thicker wall sections than primary stocks, and for this reason they must be more flexible. Other prime requisites are toughness, abrasion resistance, and flame resistance. The stabilization requirements differ somewhat due to the greater exposure to light and oxidative attack. The heat stabilizing action and electrical properties of TRIBASE, TRIBASE-E and LECTRO "60" are nicely supplemented with a small addition of DS-207, giving a good general-purpose heat and light resistance suitable for jacketing. Where actual outdoor service will be encountered, the use of "DUTCH BOY" DYPHOS and DS-207 is almost mandatory in vinyl electrical stocks of all non-black types.

"DUTCH BOY" PLUMB-O-SIL B and C, low sodium content, complex precipitates of lead orthosilicate and silica gel have good electrical characteristics in vinyl chloride polymers. While they have somewhat less heat stability reserve than the more basic stabilizers, their low tinting strength, prevention of spewing, and low reactivity towards plasticizers and colorants are unique for a number of special electrical applications. Christmas tree wiring, ornamental fixture and appliance cords, and aircraft wire, where special color effects and translucency are desirable, can be compounded to best advantage with PLUMB-O-SIL B or PLUMB-O-SIL C. The good electrical characteristics of these PLUMB-O-SILs, combined with their low specific gravities (3.3 and 2.9% respectively), make these materials economical stabilizers which can be used in vinyl electrical applications.

"DUTCH BOY" PROVINITE possesses outstanding heat stability and good light stability. It is particularly well suited for use in jacketing stocks where clarity or bright colors are desired and where the greater insulation resistance of lead stabilizers is not required.

Special stabilizer consideration should be given whenever the chlorinated paraffin or aromatic plasticizers are used for their excellent electrical properties in vinyl insulation. The choice of DYPHOS is mandatory in such compounds to stabilize both the vinyl resin and plasticizer, as discussed on page 14.

FORMULA I

Standard General Purpose Insulation (Primary or Jacket)

Resin	100
Type I A Plasticizer	50
Filler	10-20
TRIBASE or TRIBASE-E	7
DS-207	0-1

FORMULA II

Low-Co

Resin	
Type I A Plasti	
Type I A Plasti	
Type III A Pla	
Type V Plastici	
Type VI A Pla	
Filler	
TRIBASE-E or	
LEADSTAR	

FORMULA III

TW

Resin	
Type I A Plasti	
Type IV Plastic	
Filler	
LECTRO "60"	
DS-207	

FORMULA IV

High Temperatu

Resin	
Type I B Plasti	
Type IV Plastic	
Filler	
DYTHAL	
DS-207	

FORMULA V

Resin	
Type I A Plasti	
Type I B Plasti	
Filler	
TRIBASE or E	
DS-207	

*Specially recommended for outdoor

able stabilizer for coping with the high extrusion tempera-
neous heat history encountered in the subsequent use of
rire insulation. This appears to be due to the unusually low
th plasticizers under strong heat conditions as compared
d stabilizers.

07 provides an effective boost in stabilizing action for all
ement to the primary stabilizer. It provides lubrication
d improves electrical properties during prolonged water

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ation resistance, since mechanical protection is their pri-
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MB-O-SIL B and C, low sodium content, complex pre-
and silica gel have good electrical characteristics in vinyl
y have somewhat less heat stability reserve than the more
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nds are unique for a number of special electrical applica-
ornamental fixture and appliance cords, and aircraft wire,
d translucency are desirable, can be compounded to best
SIL B or PLUMB-O-SIL C. The good electrical charac-
SILs, combined with their low specific gravities (3.3 and
e materials economical stabilizers which can be used in

NITE possesses outstanding heat stability and good light
ined for use in jacketing stocks where clarity or bright
e greater insulation resistance of lead stabilizers is not

ion should be given whenever the chlorinated paraffin
d for their excellent electrical properties in vinyl insu-
is mandatory in such compounds to stabilize both the
cussed on page 14.

l Purpose Insulation (Primary or Jacket)

	100
cizer	50
	10-20
TRIBASE-E	7
	0-1

FORMULA II

Low-Cost General Purpose Insulation

Resin	100
Type I A Plasticizer	27
Type I A Plasticizer (low cost)	15
Type III A Plasticizer	8
Type V Plasticizer	5
Type VI A Plasticizer	5
Filler	25
TRIBASE-E or LECTRO "60"	7
LEADSTAR	1

FORMULA III

TW Type Insulation (60° C.)

Resin	100
Type I A Plasticizer	40
Type IV Plasticizer	7-12
Filler	10-15
LECTRO "60"	7
DS-207	0-1

FORMULA IV

High Temperature Appliance Type Insulation (105° C.)

Resin	100
Type I B Plasticizer	15
Type IV Plasticizer	45
Filler	10-20
DYTHAL	7
DS-207	0-1

FORMULA V

Low Temperature Jacketing

Resin	100
Type I A Plasticizer	40
Type I B Plasticizer	20
Filler	0-10
TRIBASE or DYPHOS*	6
DS-207	0-1

*Especially recommended for outdoor exposure.

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FORMULA VI

Clear Jarketing for Special Purposes

Resin	100
Type I A Plasticizer	25
Type II A Plasticizer	25
Type III A Plasticizer	5
PROVINITE A	2
PROVINITE B	1

FORMULA VII

Resin	
Type I A Pla	
Type I A Pla	
Type III A P	
Type III B P	
FLOMAX 25	
Stearic Acid	

FORMULA VIII

Resin	
Type I A Pla	
Type I A Pla	
Type III B P	
Filler	
DYPHOS	
DS-207	

FORMULA IX

Translucent or

Resin	
Type I A Pla	
Type II B Pl	
Type III B P	
PLUMB-O-SI	
DS-207	

FORMULA X

Resin	
Type I A Pla	
Type I B Pla	
Type II B Pl	
Type III A P	
PROVINITE	
PROVINITE	
KALZIN	

Non-Electrical Extrusion Compounds

Extrusion compounds are used in a variety of specialized non-electrical applications such as garden hose, clothesline, welting, gasketing, etc. The *type of stabilization* required is dictated by such end-use requirements as heat and light stability, clarity and cost. The following formulations may be modified for specialized uses by varying filler and plasticizer contents to obtain the desired physical properties and processing characteristics. Where stiffer stocks are formulated with lower plasticizer amounts, the extrusion heat history becomes more severe, and higher proportions of stabilizer must be used for adequate protection. The inclusion of a flame polishing operation will constitute an additional high heat cycle and require additional stabilization.

"DUTCH BOY" TRIBASE and TRIBASE-E are recommended for general purpose opaque extrusions. The high basic lead content of these stabilizers contributes a high order of heat stability. When particularly severe conditions are encountered, such as high extrusion temperatures, "DUTCH BOY" DYTHAL is the logical choice. DYTHAL also contributes good all-purpose light stability. "DUTCH BOY" DYPHOS is the outstanding stabilizer for applications such as opaque garden hose and spline, where protection against the deleterious effects of ultra-violet light on outdoor exposure is essential.

"DUTCH BOY" PLUMB-O-SIL B and C are used in applications requiring translucency or bright colors. In addition to their low tinting strength, their low specific gravities recommend them for low cost applications.

"DUTCH BOY" CLARITE has proven to be particularly well suited for clear profile extrusions, such as gasketing, welting, spline, etc.

Where maximum clarity and non-yellowing are desired "DUTCH BOY" FLOMAX 25 should be used. Its good heat and light stability, combined with exceptional ease of incorporation recommend it especially for clear garden hose.

For extrusion stocks which will be resistant to sulfide staining, a combination of either FLOMAX 25 or CLARITE, with KALZIN, is recommended.

"DUTCH BOY" DS-207, dibasic lead stearate, increases the stability of an extrusion compound while providing lubrication without incompatibility. LEADSTAR, normal lead stearate, is suggested when greater lubricity is desired in extruding highly filled compounds. "DUTCH BOY" CALSTAR provides effective lubrication with "DUTCH BOY" non-lead stabilizers.

...lear Jacketing for Special Purposes

...	100
...lasticizer	25
...Plasticizer	25
...Plasticizer	5
...TE A	2
...TE B	1

...n Compounds

...are used in a variety of specialized non-electrical applica... ...clothesline, welting, gasketing, etc. The type of stabilization ...h end-use requirements as heat and light stability, clarity and ...ations may be modified for specialized uses by varying filler ...to obtain the desired physical properties and processing ...er stocks are formulated with lower plasticizer amounts, the ...omes more severe, and higher proportions of stabilizer must ...section. The inclusion of a flame polishing operation will ...gh heat cycle and require additional stabilization.

...IBASE and TRIBASE-E are recommended for general ... The high basic lead content of these stabilizers contributes ...ility. When particularly severe conditions are encountered, ...peratures, "DUTCH BOY" DYTHAL is the logical choice. ...good all-purpose light stability. "DUTCH BOY" DYPHOS ...er for applications such as opaque garden hose and spline, ...e deleterious effects of ultra-violet light on outdoor exposure

...MB-O-SIL B and C are used in applications requiring ... In addition to their low tinting strength, their low specific ...for low cost applications.

...ARITE has proven to be particularly well suited for clear ...gasketing, welting, spline, etc.

...y and non-yellowing are desired "DUTCH BOY" FLO... ...a good heat and light stability, combined with exceptional ...mend it especially for clear garden hose.

...hich will be resistant to sulfide staining, a combination of ...LARITE, with NALZIN, is recommended.

...-207, dibasic lead stearate, increases the stability of an extru... ...oviding lubrication without incompatibility. LEADSTAR, ...ggested when greater lubricity is desired in extruding highly ...CH BOY" CALSTAR provides effective lubrication with ...d stabilizers.

FORMULA VII

Clear Garden Hose

Resin	100
Type I A Plasticizer	25
Type I A Plasticizer (low cost)	15
Type III A Plasticizer	5
Type III B Plasticizer	10
FLOMAX 25	2.5
Stearic Acid	0.5

FORMULA VIII

Opaque Garden Hose

Resin	100
Type I A Plasticizer	25
Type I A Plasticizer (low cost)	15
Type III B Plasticizer	20
Filler	20-40
DYPHOS	4
DS-207	0.5-1

FORMULA IX

Translucent or Brightly Colored Belting (Flame Resistant)

Resin	100
Type I A Plasticizer	25
Type II B Plasticizer	15
Type III B Plasticizer	15
PLUMB-O-SIL C	4
DS-207	0.5-1

FORMULA X

Clear Non-Staining Welting

Resin	100
Type I A Plasticizer	20
Type I B Plasticizer	10
Type II B Plasticizer	15
Type III A Plasticizer	5
PROVINITE A	1
PROVINITE B	1
NALZIN	0.25

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FORMULA XII

Refrigerator Gasketing

Resin	100
Type I A Plasticizer	30
Type I B Plasticizer	15
Type IV Plasticizer	15
Filler	5-10
DYTHAL	5
DS-207	0.5-1

FORMULA XII

Spline or Other Channel Extrusions

Resin	100
Type I A Plasticizer	25
Type I A Plasticizer (low cost)	15
Type IV Plasticizer	15
Filler	10
DYPHOS	5
LEADSTAR	1

B. HIGHLY FILLED SEMI-RIGID COMPOUNDS FOR FLOOR TILE, TABLE TOPS AND COVE MOLDING

This special class of vinyl products includes floor tile, table tops, and cove molding. The high filler content calls for careful compounding and processing techniques. Proper fusing in the processing step and dimensional stability in the finished product require that larger amounts of stabilizers be employed in these compounds. FORMULA XIII shows a typical standard semi-rigid stock which does not contain asbestos. CLARITE A, used alone, supplies excellent heat stability in compounds of this type. It processes smoothly, and its good clarity allows maximum freedom in vivid color choices. Best results are obtained by using a small amount of CALSTAR with the CLARITE A, as shown in the illustration.

Asbestos is commonly used as a filler in semi-rigid compounds because of its excellent contribution to dimensional stability and wearing characteristics, but it poses a distinct stabilization problem. Discoloration due to iron and other impurities in the asbestos is prevented by the use of "DUTCH BOY" NORMASAL. The amount of NORMASAL required is 5% of the amount of asbestos present. The color stabilizing action of NORMASAL with asbestos fillers is specific, and it is not duplicated by any other commercial stabilizer.

"DUTCH BOY" C
NORMASAL for standa
illustrated in FORMULA
necessary for these system
formulation.

In heavy duty applica
exist, the more basic stabili
E, and LECTRO "60" are
desired, as has been dire
NORMASAL and TRIB

FORMULA XIII

Re
Resin .....
Type I A P
Type "I A
Filler .....
CLARITE
CALSTAR

FORMULA XIV

Resin .....
Type I A P
Type III A
Asbestos Fi
Filler .....
TITANOX
NORMASA
CLARITE
CALSTAR

FORMULA XV

Resin (speci
vinyl
Type I A P
Type I B P
Type V Pla
Asbestos Fi
Filler .....
TITANOX
NORMASA
TRIBASE
LEADSTA

Refrigerator Gasketing

....	100
'lasticizer..............................	30
'lasticizer..............................	15
asticizer..............................	15
....	5-10
....	5
....	0.5-1

line or Other Channel Extrusions

....	100
lasticizer..............................	25
lasticizer (low cost)................	15
asticizer..............................	15
....	10
....	5
R	1

I-RIGID COMPOUNDS FOR FLOOR TILE, TABLE TOPS G

yl products includes floor tile, table tops, and cove molding, or careful compounding and processing techniques. Proper and dimensional stability in the finished product require zers be employed in these compounds. FORMULA XIII i-rigid stock which does not contain asbestos. CLARITE llent heat stability in compounds of this type. It processes y allows maximum freedom in vivid color choices. Best a small amount of CALSTAR with the CLARITE A, as

ed as a filler in semi-rigid compounds because of its excellent stability and wearing characteristics, but it poses a distinct oloration due to iron and other impurities in the asbestos is UTCH BOY" NORMASAL. The amount of NORMA- amount of asbestos present. The color stabilizing action of n fillers is specific, and it is not duplicated by any other

"DUTCH BOY" CLARITE A is highly recommended in conjunction with NORMASAL for standard asbestos-filled stocks. Application of this principle is illustrated in FORMULA XIV. CLARITE provides the additional heat stability necessary for these systems, particularly when Type II plasticizers are used in the formulation.

In heavy duty applications, where more stringent requirements for heat stability exist, the more basic stabilizers such as TRIBASE, DYTHAL, DYPHOS, TRIBASE-E, and LECTRO "60" are used, the selection depending on the heat and light stability desired, as has been discussed previously. FORMULA XV illustrates the use of NORMASAL and TRIBASE for primary heat stability of an asbestos-filled stock.

FORMULA XIII

Standard Semi-Rigid (Non-Asbestos)

Resin	100
Type I A Plasticizer	35
Type III A Plasticizer	5
Filler	200
CLARITE A	2
CALSTAR	1

FORMULA XIV

Standard Asbestos Semi-Rigid

Resin	100
Type I A Plasticizer	60
Type III A Plasticizer	10
Asbestos Filler	140
Filler	130
TITANOX RA-50	25
NORMASAL	7
CLARITE A	2
CALSTAR	1

FORMULA XV

Heavy Duty Asbestos Semi-Rigid

Resin (special low molecular weight vinyl copolymer)	100
Type I A Plasticizer	20
Type I B Plasticizer	5
Type V Plasticizer	10
Asbestos Filler	100
Filler	250
TITANOX RA-50	10
NORMASAL	6
TRIBASE	2
LEADSTAR	1

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C. RIGID COMPOUNDS

The development of special high molecular weight vinyl resins by the resin manufacturers has made it possible to extrude and calender rigid compositions. Products such as pipe and fittings, signs and advertising displays, and panels for construction of buildings, office partitions, breezeways, etc., are attractive and serviceable when made from rigid vinyls.

Stabilization is a problem because processing temperatures range from 350° F. to 390° F. The best development of physical properties and maximum impact strength is obtained with a mixture of 2% DYPHOS and 2% DS-207, as illustrated in the formula below. In a number of industrial applications, the use of larger proportions of TRIBASE or DYTHAL in combination with DS-207 has also proven valuable.

FORMULA XVI

Rigid Formulation for Extrusion, Molding or Calendering*

Resin**	100
Type I A Plasticizer	0-10***
DYPHOS	2
DS-207	2

D. CALENDERED COMPOUNDS

Calendered stocks for supported and unsupported film and flexible sheeting are produced by first thoroughly preblending the component ingredients in a dough mixer, ribbon blender, etc. The preblend is then fluxed in a Banbury mixer for periods of four to eight minutes at temperatures of 320° to 350° F. The Banbury stock is transferred to mixing and warm-up two-roll plastic mills where either hot strips or hot rolled slabs are fed to the calender. Stocks are maintained at 320° to 350° F. on the open mill for periods of ten to twenty-five minutes. The entire fluxing and mixing cycle may be carried out in one operation on a hot two-roll plastic mill at temperatures of 320° to 350° F. for fifteen to thirty minute periods. Many processors prefer to put the plastic stock through a screen before the final warm-up mill operation. The time in these strainers will range from five to ten minutes, and high heats to 380° F. may be built up. Calendering is carried out on three- or four-roll stack calenders or on the Z-type four-roll calender. Calenders are operated at temperatures of 320° to 340° F., but plastic working banks between the rolls will average ten to twenty degrees higher in temperature than the rolls themselves due to frictional heat build-up. A three-roll calender will not give as extended heat exposure as the four-roll type. The four-roll Z-calenders run the stock through at greater speed than the four-roll vertical stack calender, and the heat exposure cycle is accordingly reduced. However, the working banks of the Z-calender are only exposed to a 90° air surface and tend to hold in more heat than on the vertical calender, which should equalize the heat history between these types of equipment to some degree. The reworking of trim, either by direct hot addition to the feed banks, or by addition of a fixed percentage to the original virgin batch, will act to multiply this heat history.

Compounding practice for calendered stocks varies according to processing conditions in use, and the type of film or sheeting being produced. The following formulations are indicative of the variety of components that make up stocks which must meet many

*If flexibility [illegible] inherent to this formulation is desired, up to 10 parts of Type I B plasticizer, based on the resin, may be added.

**[illegible] high molecular weight polyvinyl chloride resin.

***Up to 10 parts of [illegible] plasticizer [illegible] been found [illegible] for easier processing.

requirements. Proper s
previously outlined, using
processing and reworking

For outstanding clar
FLOMAX 25 is the firs
tributed by FLOMAX 2
with a wide range of pla
enables the compounder
MAX 25 is entirely liqu
to disperse. FLOMAX 2
is often a valuable aid in

"DUTCH BOY" P
and other high quality ap
combination of heat and
above that of FLOMAX
equal to FLOMAX 25. F
yellowing. Of itself, PR
stocks. When formulati
determine whether any a

Where complete free
NALZIN may be comb
mended amounts of NAL
of non-staining stocks are

"DUTCH BOY" P
stabilizers in the entire
plasticizers and colorant
PLUMB-O-SIL C to p
extremely helpful. The a
tinting strength, plasticize
attractive for both translu
in most types of sheeting
same properties are desir

For opaque film,
stabilizers are outstandin
ing greater reserve heat
especially suited for hea
temperature calendering
also provide strong heat
ticularly recommended f

Careful control of c
stabilizing action and u
The lubricating action
advantage in conjunction
ciable quantities of organ
BOY" LEADSTAR is p

·ecial high molecular weight vinyl resins by the resin manu-
·ible to extrude and calender rigid compositions. Products
·ys and advertising displays, and panels for construction of
breezeways, etc., are attractive and serviceable when made

·lem because processing temperatures range from 350° F. to
·ent of physical properties and maximum impact strength is
2% DYPHOS and 2% DS-207, as illustrated in the formula
·ustrial applications, the use of larger proportions of TRI-
·ombination with DS-207 has also proven valuable.

·tion for Extrusion, Molding or Calendering*

....	100
·lasticizer........................	0-10***
....	2
....	2

·OUNDS

·upported and unsupported film and flexible sheeting are
·y preblending the component ingredients in a dough mixer,
·blend is then fluxed in a Banbury mixer for periods of four
·tures of 320° to 350° F. The Banbury stock is transferred to
·ill plastic mills where either hot strips or hot rolled slabs
·cks are maintained at 320° to 350° F. on the open mill for
minutes. The entire fluxing and mixing cycle may be carried
· two-roll plastic mill at temperatures of 320° to 350° F. for
·ods. Many processors prefer to put the plastic stock through
·m-up mill operation. The time in these strainers will range
·ed high heats to 380° F. may be built up. Calendering is
·roll stack calenders or on the Z-type four-roll calender.
·peratures of 320° to 360° F., but plastic working banks
·en to twenty degrees higher in temperature than the rolls
·eat build-up. A three-roll calender will not give as
· four-roll type. The four-roll Z-calenders run the stock
·e four-roll vertical stack calender, and the heat exposure
However, the working banks of the Z-calender are only
·d tend to hold in more heat than on the vertical calender,
· history between these types of equipment to some degree.
· by direct hot additions to the feed banks, or by addition
·ginal virgin batch, will act to multiply this heat history.
· calendered stocks varies according to processing condi-
·m or sheeting being produced. The following formulations
·of components that make up stocks which must meet many

requirements. *Proper stabilization follows the general principles which have been previously outlined*, using the more basic stabilizers where maximum heat stability for processing and reworking is needed.

For outstanding clarity and resistance to yellowing and plate out, "DUTCH BOY" FLOMAX 25 is the first choice for film or sheeting. The heat and light stability contributed by FLOMAX 25 is of a high order. FLOMAX 25 can be successfully used with a wide range of plasticizers, including the more sensitive types, and consequently enables the compounder to formulate with the widest possible latitude. Since FLOMAX 25 is entirely liquid, it is also the easiest of all the "DUTCH BOY" stabilizers to disperse. FLOMAX 25 has no lubricating properties. A small amount of stearic acid is often a valuable aid in processing.

"DUTCH BOY" PROVINITE is recommended for the heavier type of sheeting and other high quality applications, where a clear stabilizer is required with an excellent combination of heat and light stability. The heat stability of PROVINITE is slightly above that of FLOMAX 25, while PROVINITE's light stabilizing action is nearly equal to FLOMAX 25. *PROVINITE combines high clarity with good resistance to* yellowing. Of itself, PROVINITE has a definite lubricating action in vinyl plastic stocks. When formulations are based on PROVINITE, the individual case will determine whether any additional lubricants will be required.

Where complete freedom from sulfide staining is mandatory, "DUTCH BOY" NALZIN may be combined with either FLOMAX 25 or PROVINITE. Recommended amounts of NALZIN are discussed in detail on page 19, and several examples of non-staining stocks are shown in the formulations below.

"DUTCH BOY" PLUMB-O-SIL's are among the most versatile and popular stabilizers in the entire field of calendered vinyl products. If sensitive and reactive plasticizers and colorants are present, the ability of both PLUMB-O-SIL B and *PLUMB-O-SIL C to provide excellent stability with a minimum of reactivity* is extremely helpful. The additional properties of PLUMB-O-SIL B or C, such as low tinting strength, plasticizer spew absorption, and low volume cost, make them especially attractive for both translucent and opaque film. They are widely used and recommended in most types of sheeting such as whites, blacks, pastels, and vivid colors, where the same properties are desired.

For opaque film, and white pastel sheeting, the "DUTCH BOY" basic lead stabilizers are outstanding. DYTHAL and DYPHOS are used for products requiring greater reserve heat stability combined with excellent light stability. They are especially suited for heavier sheeting, where strong stabilization is needed for high-temperature calendering and reworking cycles. TRIBASE and LECTRO "60" will also provide strong heat stability. LECTRO "60" and the PLUMB-O-SILs are particularly recommended for economy in opaque film and sheeting applications.

Careful control of calendering conditions is greatly improved through the heat stabilizing action and uniform non-melting character of "DUTCH BOY" DS-207. The lubricating action of DS-207 in opaque and translucent stocks is employed to advantage in conjunction with any of the "DUTCH BOY" stabilizers. When appreciable quantities of organic ester epoxide plasticizers are present, the use of "DUTCH BOY" LEADSTAR is preferred as the lubricant.

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Film (Two to Ten Mils Thick)

Special characteristics to be kept in mind include flame resistance, heat sealing and printability.

CLEAR FILM

FORMULA XVII

High Quality Clear*

Resin	100
Type I A Plasticizer	20
Type I B Plasticizer	15
Type III A Plasticizer	5
Type IV Plasticizer	10
FLOMAX 25	2.5
Stearic Acid	0.5

FORMULA XVIII

High Quality Clear Non-Staining

Resin	100
Type I A Plasticizer	20
Type I B Plasticizer	15
Type III A Plasticizer	5
Type IV Plasticizer	10
FLOMAX 25	2.5
NALZIN	0.5
Stearic Acid	0.5

FORMULA XIX

Low Cost Clear

Resin	100
Type I A Plasticizer	18
Type I A Plasticizer (low cost)	17
Type II A Plasticizer	10
Type III A Plasticizer	5
FLOMAX 25	2.5
Stearic Acid	0.5

*This formulation is not flame retardant. The most common method of imparting flame retardancy to vinyl compounds is through substitution of some type of plasticizer for an equivalent amount of the other plasticizers.

Useful for standard froze

FORMULA XX

High Qua

Resin .....
Type I A Plas
Type I B Plas
Type II B Pla
Type IV Plasti
PLUMB-O-SI
DS-207 .....
Supplementary

FORMULA XXI

Resin .....
Type I A Plast
Type I A Plast
Type II A Pla
Type III A Pl
PLUMB-O-SIL
FLOMAX 25

These stocks may be made
II or Type V plasticizer, or b

FORMULA XXII

Resin .....
Type I A Plast
Type I B Plasti
Type IV Plastici
DYPHOS ....
DS-207 .....

FORMULA XXIII

Resin .....
Type I A Plastic
Type I A Plastic
Type II A Plast
Type III C Plas
Filler .....
PLUMB-O-SIL
LECTRO "66".
DS-207 .....

*This stock is especially recommended for w

...ks)

...be kept in mind include flame resistance, heat sealing

CLEAR FILM

...High Quality Clear*

.....	100
...cizer.....	20
...cizer.....	15
...sticizer.....	5
...izer	10
.....	2.5
.....	0.5

...Quality Clear Non-Staining

.....	100
...cizer.....	20
...cizer.....	15
...sticizer.....	5
...izer	10
.....	2.5
.....	0.5
.....	0.5

Low Cost Clear

.....100	
...er.....	18
...er (low cost).....	17
...cizer.....	10
...sticizer.....	5
.....	2.5
.....	0.5

...more common method of imparting flame resistance to clear vinyl compounds ...product but an equivalent amount of the other plasticizers.

TRANSLUCENT FILM

Useful for standard frosted finish or vivid blacks and colors.

FORMULA XX

High Quality Translucent (Flame Resistant)

Resin	100
Type I A Plasticizer	20
Type I B Plasticizer	15
Type II B Plasticizer	10
Type IV Plasticizer	5
PLUMB-O-SIL C	2-3
DS-277	0.25-1
Supplementary Stabilizer	0.5-1

FORMULA XXI

Low Cost Translucent

Resin	100
Type I A Plasticizer	18
Type I A Plasticizer (low cost)	17
Type II A Plasticizer	10
Type III A Plasticizer	5
PLUMB-O-SIL C	3
FLOMAX 25	1

OPAQUE FILM

These stocks may be made flame resistant either by including 8 to 10 parts of Type II or Type V plasticizer, or by the use of 3-5% antimony oxide, based on the resin.

FORMULA XXII

High Quality Opaque*

Resin	100
Type I A Plasticizer	25
Type I B Plasticizer	15
Type IV Plasticizer	10
DYPHOS	5
DS-207	0.5-1

FORMULA XXIII

Low Cost Opaque

Resin	100
Type I A Plasticizer	15
Type I A Plasticizer (low cost)	20
Type II A Plasticizer	10
Type III C Plasticizer	10
Filler	10-20
PLUMB-O-SIL C	3
LECTRO "60"	2
DS-207	1

*White cloth is especially recommended for outdoor weathering applications.

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Flexible Sheeting (Twelve to Twenty-two Mils Thick)

Special problems involved include heat sealing, printability, and need for embossing and press polishing.

FORMULA XXIV

High Quality Clear (Flame Resistant)

Resin	100
Type I A Plasticizer	18
Type I B Plasticizer	15
Type II B Plasticizer	10
Type III A Plasticizer	5
Type IV Plasticizer	10
PROVINITE A	2
PROVINITE B	1

FORMULA XXV

High Quality Clear Non-Staining

Resin	100
Type I A Plasticizer	20
Type I B Plasticizer	15
Type III A Plasticizer	8
Type IV Plasticizer	15
FLOMAX 25	3
NALZIN	0.5

FORMULA XXVI

High Quality Base for Blacks and Vivid Colors (Flame Resistant)

Resin	100
Type I A Plasticizer	15
Type I B Plasticizer	10
Type II B Plasticizer	10
Type III A Plasticizer	5
Type III B Plasticizer	8
Type IV Plasticizer	10
PLUMB-O-SIL C	3
PROVINITE A	2
PROVINITE B	1

FORMULA XXVII

Low Cost Base for Blacks and Vivid Colors (Flame Resistant)

Resin	100
Type I A Plasticizer	20
Type II B Plasticizer	13
Type III A Plasticizer	10
Type III B Plasticizer	10
Type V Plasticizer	5
PLUMB-O-SIL C	3
FLOMAX 25	2

FORMULA XXVIII

High Q

Resin ......
Type I A Pla
Type I B Pla
Type II B Pla
Type IV Plas
DYPHOS ..
DS-207 .....

FORMULA XXIX

Low

Resin ......
Type I A Pla
Type I A Pla
Type III A P
Type III C P
Type V Plastic
Filler ......
PLUMB-O-SI
DYTHAL ..
LEADSTAR

E. MOLDING COMPOUND

Compression Molding

Molding of vinyl chlori
molded unbreakable vinyl re
molecular weight copolymer
reduce "tag"** characteristic
poor wear resistance and red
in vinyl records containing fil
fidelity of reproduction in late
manufacturers. When transp
CALSTAR is the logical ch

The compounds may be
preblend the ingredients tho
before any fluxing operations
minute cycle at temperatures o
of the preblend compound. T
uum extruder (plasticator
two-roll calender. The additi
averaging five to ten degrees h
sections by a rotary marker a
web may be broken into indiv
entire fluxing and mixing op
minute cycle at 270° to 310°
to the two-roll calender as bef
stock from the mill, and to cu
by hand into biscuits.

[illegible]

17

...o Twenty-two Mils Thick)
...nclude heat sealing, printability, and need for cushon-

...ality Clear (Flame Resistant)

....	100
...izer..........................	18
...izer..........................	15
...cizer..........................	10
...icizer..........................	5
...zer..........................	10
....	2
....	1

Quality Clear Non-Staining

....	100
...izer..........................	20
...izer..........................	15
...icizer..........................	8
...zer..........................	15
....	3
....	0.5

Base for Blacks and Vivid Colors
(Flame Resistant)

....	100
...zer..........................	15
...zer..........................	10
...izer..........................	10
...izer..........................	5
...izer..........................	8
...r..........................	10
....	3
....	2
....	1

...e for Blacks and Vivid Colors
(Flame Resistant)

....	100
...zer..........................	20
...izer..........................	15
...cizer..........................	10
...icizer..........................	10
...r..........................	5
....	3
....	2

FORMULA XXVIII

*High Quality Base for Whites and Pastels**
(Flame Resistant)

Resin	100
Type I A Plasticizer	23
Type I B Plasticizer	15
Type II B Plasticizer	10
Type IV Plasticizer	10
DYPHOS	5
DS-207	0.5-1

FORMULA XXIX

Low Cost Base for Whites and Pastels

Resin	100
Type I A Plasticizer	10
Type I A Plasticizer (low cost)	20
Type III A Plasticizer	10
Type III C Plasticizer	15
Type V Plasticizer	5
Filler	10-40
PLUMB-O-SIL C	4
DYTHAL	2
LEADSTAR	0.5-1

E. MOLDING COMPOUNDS

Compression Molding

Molding of vinyl chloride resins has been primarily in the field of compression molded unbreakable vinyl records. These vinyl compounds are based on the lower molecular weight copolymer resins and are used with very little plasticizer, if any, to reduce "sag"** characteristics. Any tendency to such "buttery" qualities will promote poor wear resistance and reduce high fidelity. The use of "DUTCH BOY" DS-207, in vinyl records containing fillers, has been found to promote the maximum degree of fidelity of reproduction in lateral phonograph records thus far measured by independent manufacturers. When transparent rigid recordings are desired, "DUTCH BOY" CALSTAR is the logical choice for a lubricant-stabilizer.

The compounds may be mixed by several procedures. In general, it is desirable to preblend the ingredients thoroughly in a ribbon blender, tumbler, or dough mixer before any fluxing operations are carried out. Use of a Banbury mixer in a four to eight minute cycle at temperatures of 275° to 300° F. will give satisfactory mixing and fluxing of the preblend compound. The Banbury mixed stock is then directly transferred to a worm extruder (plasticator type), where the resultant extruded web is fed into a two-roll calender. The additional cycle may take four to ten minutes at temperatures averaging five to ten degrees higher than in the Banbury. The stock is scored into biscuit sections by a rotary marker as it leaves the calender. After a cooling cycle, the marked web may be broken into individual biscuits. A less elaborate scheme is to carry out the entire fluxing and mixing operation on a hot two-roll plastic mill in a ten to twenty minute cycle at 270° to 310° F. The hot stock is taken from the mill in slabs and fed to the two-roll calender as before. An additional alternate procedure is to pelletize the stock from the mill, and to extrude a sufficiently wide web which may be marked or cut by hand into biscuits.

*[illegible]
**[illegible]

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The cold biscuits are placed on hot steam tables before the actual record pressing is made. The temperatures of these tables range from 260° to 300° F. In unusual cases an occasional biscuit may be left on them for several hours. Normally this preheat cycle will last from ten to thirty minutes, depending on the efficiency of the press operator. The actual pressing of the preheated biscuits is carried out in a chrome or nickel faced copper record-stamper mold in a fifteen to thirty second press cycle at temperatures of 300° to 350° F. Some manufacturers by-pass the use of biscuits and granulate a Banbury and mill mixed compound into molding powder. The molding powder is preheated, weighed out and molded in a forty-five to sixty second cycle at 300° to 350° F. The relatively short heat history in the molding operation is intensified by the pressure used.

VINYL RECORD FORMULATIONS

FORMULA XXX

Transparent Record Formulation*

Resin (low molecular weight vinyl chloride copolymers)	97.5-97.0
Carnauba Wax or substitute	0.5-1.0
Dye	0.5
CALSTAR	1.5

FORMULA XXXI

Low Filler Content Records**

Resin (low molecular weight vinyl chloride copolymers)	74
Type III B Plasticizer	4
Filler	16
Carnauba Wax or substitute	1
Carbon Black	2
TRIBASE	2
DS-207	1

FORMULA XXXII

Low Cost Record Formulation***

Resin (low molecular weight vinyl chloride copolymers)	38
Type VI A Plasticizer****	5
Type I A Plasticizer (solid)	1.5
Type III B Plasticizer	1
Filler	52.5
Carnauba Wax or substitute	0.5
DS-207	1.5

[illegible]

FORMULA XXXIII

Altern

Resin (low m

chlori

70% Chlorina

Filler ......

Carnauba Wa

Carbon Black

DS-207 ....

DYPHOS ...

Injection Molding

Injection molding of fle

successful in the automotive

the expansion of vinyl resins.

of satisfactory stabilizers. T

molding. Small pellets of fl

slabbed off a hot two-roll p

Banbury mixer or hot plast

Injection molding temperatu

fifteen to thirty thousand p

For clear injection mold

heat stability and clarity.

opaque compounds during

greatest heat protection of

For best lubricating and

bination with the basic le

CLARITE or the other "D

lubricant for clear molded

An alternate injection

plastisols using formulation

plastisols may be injection

those described above, but

thorough fluxing and full

FORMULA XXXIV

Clea

Resin ......

Type I A P

Type II B

Type III A

Type IV Pl

CLARITE

CLARITE

CALSTAR

[illegible]

placed on hot steam tables before the actual record pressing is
:f these tables range from 260° to 300° F. In unusual cases an
left on them for several hours. Normally this preheat cycle
y minutes, depending on the efficiency of the press operator.
: preheated biscuits is carried out in a chrome or nickel faced
ld in a fifteen to thirty second press cycle at temperatures of
ufacturers by-pass the use of biscuits and granulate a Banbury
d into molding powder. The molding powder is preheated,
in a forty-five to sixty second cycle at 300° to 350° F. The
y in the molding operation is intensified by the pressure used.

…YL RECORD FORMULATIONS

Transparent Record Formulation*

… molecular weight vinyl	
…oride copolymers)	97.5-97.0
…Wax or substitute	0.5-1.0
…	0.5
…	1.5

I

Low Filler Content Records**

… molecular weight vinyl	
…oride copolymers)	74
…B Plasticizer	4
…	16
…Wax or substitute	1
…ck	2
…	2
…	1

…w Cost Record Formulation***

…olecular weight vinyl	
…de copolymers)	38
…lasticizer****	5
…sticizer (solid)	1.5
…Plasticizer	1
…	52.5
…ax or substitute	0.5
…	1.5

[illegible]

FORMULA XXXIII

Alternate Low Cost Record Formulation*

Resin (low molecular weight vinyl chloride copolymers)	30
70% Chlorinated Paraffin	15
Filler	51
Carnauba Wax or substitute	0.5
Carbon Black	1
DS-207	1.5
DYPHOS	1

Injection Molding

Injection molding of flexible parts from plasticized vinyl chloride resins has been successful in the automotive equipment field. It is one of the promising outlets for the expansion of vinyl resins. This development has been contingent upon the availability of satisfactory stabilizers. Two major techniques are currently utilized for injection molding. Small pellets of fused material may be prepared by granulating compounds slabbed off a hot two-roll plastic mill. The original fusing is carried out by using a Banbury mixer or hot plastic mill in the time and heat cycles described previously. Injection molding temperatures of 300° to 360° F., over short time cycles, at pressures of fifteen to thirty thousand pounds per square inch are required.

For clear injection molding formulations, CLARITE is recommended for its high heat stability and clarity. DYTHAL or TRIBASE should be used for stabilizing opaque compounds during the vigorous heat cycle. These two stabilizers offer the greatest heat protection of the basic lead materials.

For best lubricating and mold release properties, DS-207 should be used in combination with the basic lead stabilizers. If additional lubricity is required with CLARITE or the other "DUTCH BOY" non-lead stabilizers, CALSTAR is the best lubricant for clear molded products.

An alternate injection molding procedure can be based on the injection molding of plastisols using formulations that will be discussed in the following section. The plastisols may be injection molded at the same temperatures and at lower pressures than those described above, but will require considerably longer time cycles to obtain thorough fusing and full development of physical properties.

FORMULA XXXIV

Clear Injection Molding Formulation**

Resin	100
Type I A Plasticizer	25
Type II B Plasticizer	15
Type III A Plasticizer	8
Type IV Plasticizer	12
CLARITE A	3
CLARITE B	1.5
CALSTAR	1

[illegible]

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FORMULA XXXV

Opaque Injection Molding Formulation

Resin	100
Type I A Plasticizer	30
Type II B Plasticizer	15
Type IV Plasticizer	15
Filler	10-20
DYTHAL or TRIBASE	7
DS-207	2

F. PLASTISOLS AND ORGANOSOLS

The development of polyvinyl chloride type resins of particle size, shape and nature which permit formation of a workable plasticizer-resin paste has led to new product developments in a number of fields. Mixing the usual calendering resin in the ratio of about two parts resin to one part plasticizer yields a dry dough which cannot be easily spread or molded under low pressure. The "paste resin," on the other hand, is not solvated by the common plasticizers at room temperature. Syrupy pastes are formed even by simple mixing, although mechanical grinding may be helpful. These resin-plasticizer pastes are referred to as plastisols. Use of a volatile non-solvating diluent or thinner acts to reduce the viscosity of these pastes and promotes greater ease of handling in the final application. These diluent-plasticizer-resin systems are referred to as organosols.

Since these paste resins can be formulated in two different ways, namely the plastisol and organosol systems, a wide variety of products of varying hardness is possible in the field of "slush" molding, and spread and dip coating. Films may be cast in one application in thicknesses of four to twenty mils with plastisols. Thinner films are more satisfactorily formed from organosol systems. Coating of fabrics and papers may also be carried out from either plastisols or organosols depending on the thickness and hardness required for the final coating. Cast films and coating compounds must be heat-treated to promote the fusion of the plasticizer-resin systems and drive off any volatile solvents. Temperatures of 325° to 375° F. for one-half to five minutes are required. The longer times and higher temperatures are required for thicker films.

Low pressure "slush" molding may be carried out by pouring plastisols into molds and then fusing by application of heat with relatively low applied pressure on the stock in the mold. There is practically no shrinkage in the mold due to the absence of a chemical reaction or the loss of volatiles. Temperatures of 350° to 390° F. for periods of one to five minutes are required to "cure" or flux the vinyl compounds. High frequency electronic equipment has recently been developed for fluxing thick sections.

Many variations in compounding of plastisols and organosols are called for by the diversified end-uses they meet in practice, and stabilization requirements fluctuate accordingly. Several general principles apply. The dispersion resins are less stable than the calendering and extrusion types, particularly with regard to light stability. There is usually a higher ratio of plasticizer to the resin than in the conventional vinyl resin stocks, so that plasticizer stability and reactivity are of utmost importance in proper stabilization. The removal of air and moisture in order to prevent gassing in the finished product is essential, and the choice of a stabilizer and other ingredients must exclude any materials which tend to absorb and retain appreciable amounts of moisture.

"DUTCH BOY" F
It is especially useful fo
tures, with excellent re
stability, and maintains
conditions. In all dispers
NITE A and B, based o
PROVINITE A can be

"DUTCH BOY" F
number of desirable prop
compare very favorably
for the highest degree of c
increase in plastisol visc
on adhesion, and does no
useful in plastisols becau

Where maximum
NALZIN should be use
with the directions given

"DUTCH BOY" C
tional light stabilization
solution coatings, either a
recommended for applica

"DUTCH BOY" D
sol systems. It imparts ou
among all stabilizers in its
that they compare favora

"DUTCH BOY" T
mended for use in opa
protection during the seve

"DUTCH BOY" D
confers excellent heat a
stabilizer in the field of "
tion plus mold release.

"DUTCH BOY" P
and plastisols. It combine
and low reactivity with pl
PLUMB-O-SIL C has
plasticized compounds,
stability cure should be exe
high a viscosity in the fin

The control of flow
"DUTCH BOY" BENT
advantage in this type of
treated through the high

Jection Molding Formulation

	100
ier	30
izer	15
	15
	10-20
BASE	7
	2

YSOLS

chloride type resins of particle size, shape and nature table plasticizer-resin paste has led to new product . Mixing the usual calendering resin in the ratio of lasticizer yields a dry dough which cannot be easily sure. The "paste resin," on the other hand, is not es at room temperature. Syrupy pastes are formed mechanical grinding may be helpful. These resin-plastisols. Use of a volatile non-solvating diluent or f these pastes and promotes greater ease of handling iluent-plasticizer-resin systems are referred to as

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"DUTCH BOY" PROVINITE is highly recommended for clear plastisols. It is especially useful for its performance under high processing and service temperatures, with excellent retention of clarity. PROVINITE contributes excellent light stability, and maintains the color and clarity of the stock under outdoor weathering conditions. In all dispersion resin applications, the usual level is 1% each of PROVINITE A and B, based on the resin. For special high heat conditions, the amount of PROVINITE A can be increased to meet compounding requirements.

"DUTCH BOY" FLOMAX 25 is a clear liquid stabilizer which combines a number of desirable properties in dispersion resin systems. Its heat and light stabilities compare very favorably with those of PROVINITE. It is especially recommended for the highest degree of clarity. FLOMAX 25 disperses readily and develops minimum increase in plastisol viscosity on aging. It has no lubricating action, no adverse effect on adhesion, and does not plate out on mold surfaces. FLOMAX 25 is particularly useful in plastisols because its low surface tension promotes rapid and easy deaeration.

Where maximum resistance to sulfide staining is required, "DUTCH BOY" NAL-ZIN should be used with either FLOMAX 25 or PROVINITE in accordance with the directions given on page 19.

"DUTCH BOY" CS-137 is useful in plastisols for fabric coatings where additional light stabilization is desired. It is especially suited for organosols and vinyl solution coatings, either alone or as a supplementary stabilizer. CS-137 is particularly recommended for applications in which freedom from sulfide staining is desirable.

"DUTCH BOY" DYPHOS is an outstanding stabilizer for plastisol and organosol systems. It imparts unequalled heat stability for the fusing cycles, and it is unique among all stabilizers in its ability to stabilize dispersion resins against light, to the extent that they compare favorably with the calendering and extrusion resins.

"DUTCH BOY" TRIBASE is an excellent heat stabilizer which is highly recommended for use in opaque slush molding plastisols. TRIBASE offers maximum protection during the severe heat history encountered in the molding operation.

"DUTCH BOY" DS-207 performs a special task in dispersion resin systems. It confers excellent heat stability, and its lubricating action makes it the most useful stabilizer in the field of "slush" molding, due to its two-fold performance of stabilization plus mold release.

"DUTCH BOY" PLUMB-O-SIL C is a very effective stabilizer for organosols and plastisols. It combines the advantages of low tinting strength for translucent stocks and low reactivity with plasticizers and colorants, with good heat stability and economy. PLUMB-O-SIL C has a useful ability to adsorb migratory components in highly plasticized compounds, resulting in an attractive dry surface. Due to its adsorptive ability care should be exercised when formulating with PLUMB-O-SIL C to avoid too high a viscosity in the finished system.

The control of flow properties in plastisols is readily achieved by the use of "DUTCH BOY" BENTONE 38 as a thickening agent. BENTONE 38 is of special advantage in this type of application, because its control of sag or penetration is maintained through the high temperature fusion cycle.

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FORMULA XXXVI

Clear High Quality Plastisol

Resin (dispersion type)	100
Type I A Plasticizer	40
Type I B Plasticizer	15
Type III A Plasticizer	10
PROVINITE A	1
PROVINITE B	1

FORMULA XXXVII

Clear Slush Molding Plastisol

Resin (dispersion type)	100
Type I A Plasticizer	40
Type I B Plasticizer	25
Type III A Plasticizer	10
Type VI A Plasticizer	10
FLOMAX 25	3

FORMULA XXXVIII

High Quality Opaque Plastisol*

Resin (dispersion type)	100
Type I A Plasticizer	30
Type I A Plasticizer (low cost)	10
Type I B Plasticizer	15
Type III A Plasticizer	10
DYPHOS	5

FORMULA XXXIX

Opaque Slush Molding Plastisol

Resin	100
Type I A Plasticizer	35
Type I A Plasticizer (low cost)	15
Type I B Plasticizer	25
Type VI A Plasticizer	10
TRIBASE	5
DS-207	1

*This mix is especially recommended for outdoor weathering applications.

XXXVI

Clear High Quality Plastisol

(dispersion type)	100
I A Plasticizer	40
I B Plasticizer	15
III A Plasticizer	10
VINITE A	1
VINITE B	1

XXXVII

Clear Slush Molding Plastisol

(dispersion type)	100
I A Plasticizer	40
I B Plasticizer	25
II A Plasticizer	10
VI A Plasticizer	10
IAX 25	3

XXXVIII

High Quality Opaque Plastisol*

dispersion type)	100
A Plasticizer	30
A Plasticizer (low cost)	10
Plasticizer	15
A Plasticizer	10
[illegible]	5

IX

Opaque Slush Molding Plastisol

[illegible]	100
Plasticizer	35
A Plasticizer (low cost)	15
B Plasticizer	25
I A Plasticizer	10
IE	5
[illegible]	1

[illegible] for coating applications.

FORMULA XL

High Quality Clear Non-Staining Organosol

Resin (dispersion type)	100
Type I A Plasticizer	20
Type III A Plasticizer	10
Type IV Plasticizer	5
Methyl Isobutyl Ketone	33*
Xylene	43*
Naphthenic Thinner	89*
FLOMAX 25	2
CS-137	1
NALZIN	0.3

FORMULA XLI

Low Cost Organosol

Resin (dispersion type)	100
Type I A Plasticizer	25
Type I A Plasticizer (low cost)	10
Type III A Plasticizer	5
Filler	15**
Xylene	98***
Naphthenic Thinner	42***
DYPHOS	5

C. MISCELLANEOUS COMPOUNDS

The vinyl resins are so versatile in their properties and compounding possibilities that many specialized applications are being developed which cannot be treated separately here. In the coating field particularly, many special compositions and resin combinations are in everyday use. For these applications, the "DUTCH BOY" vinyl stabilizers follow the general rules of application demonstrated in the fields discussed previously.

When little or no Type II A plasticizer is used, DYTHAL and DYPHOS appear to be most satisfactory for printing inks containing the usual low molecular weight vinyl resins. The prime requisites of these inks are good light stability and adhesion. Both DYTHAL and DYPHOS contribute outstanding light resistance to vinyl printing inks. FLOMAX 25 is recommended for vinyl printing inks which must be resistant to sulfide staining.

The high heat resistance, retention of flexibility and gloss, and light stability requirements of baked vinyl resin finishes can satisfactorily be obtained by use of "DUTCH BOY" DYTHAL or "DUTCH BOY" DYPHOS. Formulation of these systems follows the suggestions made in the sections on organosols.

The successful use of "DUTCH BOY" DYPHOS in vinyl stocks containing chloroparaffins, to which we have previously referred,**** has been extended to paint systems containing chloroparaffins and chlorinated rubber. Recent work has shown that "DUTCH BOY" DYPHOS not only improves color retention and service life of such systems, but it greatly decreases the yellowing tendencies which have been characteristic of them.

We suggest the investigation of "DUTCH BOY" stabilizers for any organic products containing halogens which may be exposed to heat, light or weathering.

*This is approximately [illegible] solids content. [illegible] "DUTCH BOY" [illegible]

**[illegible] "DUTCH BOY" [illegible]

***This is approximately [illegible] solids content. [illegible] "DUTCH BOY" [illegible]

****See Page [illegible].

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VII. CONCLUSION

The foregoing pages have indicated the general usefulness of the various "DUTCH BOY" Stabilizers. The wide variety of applications and specific problems, however, which the vinyl compounder encounters are beyond the scope of any manual. The National Lead Company Research Laboratories and Technical Service Department are steadily working to increase the over-all knowledge of the chlorinated resin fields. As additional information becomes available and new products are developed, factual data will be promptly issued to the industry.

Representatives of the Technical Service Department are available at all times to discuss individual problems in confidence and indicate the best methods for using "DUTCH BOY" chemicals based upon research laboratory data.

The reader is cordially invited to write or call the nearest Branch Office of the National Lead Company and will receive prompt attention in getting all the information and technical assistance available.

NATIONAL LEAD COMPANY, 111 Broadway, New York 6, N. Y.

ATLANTA, GEORGIA
400 Bishop Street, N.W.

BOSTON 6, MASSACHUSETTS
NATIONAL LEAD CO. of Massachusetts
800 Albany Street

CHICAGO 80, ILLINOIS
900 West 18th Street

CINCINNATI 3, OHIO
659 Freeman Avenue

CLEVELAND 13, OHIO
1776 Columbus Road

DALLAS 2, TEXAS
900 Tennessee Street

DEPEW, NEW YORK
3261 Walden Avenue

DETROIT 11, MICHIGAN
3501 Griffin Street

LOS ANGELES 23, CALIFORNIA
3113 East 26th Street

PHILADELPHIA 25, PENNSYLVANIA
2801 East Cumberland Street

PITTSBURGH 12, PENNSYLVANIA
1526 River Avenue

ST. LOUIS 1, MISSOURI
722 Chestnut Street

SAN FRANCISCO 10, CALIFORNIA
2240 20th Street

SEATTLE 4, WASHINGTON
1120 West Spokane Street

CANADIAN TITANIUM PIGMENTS LIMITED
630 Dorchester West
Montreal, Quebec, Canada

CANADIAN TITANIUM PIGMENTS LIMITED
Terminal Warehouse
Foot of York Street
Toronto, Ontario, Canada

VII. CONCLUSION

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·) COMPANY, 111 Broadway, New York 6, N. Y.

DETROIT 11, MICHIGAN
2581 Griffin Street

·SETTS
·of Massachusetts

LOS ANGELES 23, CALIFORNIA
3113 East 26th Street

PHILADELPHIA 25, PENNSYLVANIA
2647 East Cumberland Street

PITTSBURGH 12, PENNSYLVANIA
1326 River Avenue

ST. LOUIS 1, MISSOURI
722 Chestnut Street

SAN FRANCISCO 10, CALIFORNIA
2240 24th Street

SEATTLE 4, WASHINGTON
1128 West Spokane Street

·Limited

Canadian [illegible] Limited
Terminal Warehouse
Foot of York Street
Toronto, Ontario, Canada

Note

The recommendations made in this booklet are based on our research and the research of others, and are believed to be accurate. No guarantee of their accuracy is made, however, and the products discussed are sold without warranty, express or implied, and upon condition that purchasers shall make their own tests to determine the suitability of such products for their particular purposes. Likewise, statements concerning the possible use of these products are not intended as recommendations to use these products in infringement of any patent.

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