Dr. I. Gubelmann)
Dr. H. A. Lubs (1)
Dr. E. K. Bolton (1)
Dr. Wm. Kirk (1)
Mr. J. S. Groves
for I.C.I. (3)
for C.I.L. (1)
J. L. Files (2)

E. I. DuPont de Nemours & Company

Jackson Laboratory

June 18, 1942

Phthalocyanines of Metals other than Copper

JLR-59-5, No. 1 Serial Number 18074

E. I. DuPont de Nemours & Company

Jackson Laboratory

Miscellaneous Dyes Division

O. Stallmann

Progress Report

June 18, 1942

Phthalocyanines of Metals other than Copper

Group Leader - S. R. Detrick

Work Done By - P. F. Gross Work Started - 10-17-41

Reported By - P. F. Gross Completed - 4-30-42

J. M. TINKER, W. S. CALCOTT,

ASST. DIRECTOR DIRECTOR

Phthalocyanines of other Metals than Copper
(Project Number 2240)

P. F. Gross

JLR-59-5, No. 1 Serial Number 18074
Code: 653.101

Object of the Investigation:

To evaluate metal phthalocyanines other than copper as pigments in lacquers, paints, printing inks, particularly with respect to bronzing and flocculation in the vehicle.

Period Covered by the Report:

October 17, 1941 to April 30, 1942.

Historical Background:

Copper phthalocyanine is a blue pigment of outstanding brilliance and fastness which has found a considerable market in recent years. A number of other metal phthalocyanines have been described briefly in the literature and a few of these have been prepared in small amounts in Jackson Laboratory, but none of them has been evaluated thoroughly in all the various uses for which copper phthalocyanine is sold. It was hoped that such a thorough evaluation of the phthalocyanines of commercially available metals might lead to the discovery of pigments of unusual shades or properties. In particular it was hoped that a phthalocyanine pigment might be found which was superior to copper phthalocyanine with respect to stability in paint systems.

Conclusions:

On the basis of tests completed to date, none of the various metallic phthalocyanines tested so far is of sales interest. Several of the metal phthalocyanines prepared by us showed improvement over CPC with respect to settling, mill-base viscosity and bronzing, but their shades were not sufficiently bright to interest the Fabrics and Finishes Division.

A large sample of lead phthalocyanine has, however, been requested by the Technical Laboratory for more thorough evaluation.

Summary:

Aluminum Phthalocyanine (AlPC), prepared by the reaction between phthalonitrile and $AlCl_3$, and finished by the salt-milling method (Ref. JLR-59-1, No. 41), was found to be very

green and weak compared with "Monastral" Fast Blue B (CPC) both in linseed oil ink and in nitro-cellulose lacquer. In the latter medium the AlPC was superior to CPC in settling and in mill-base viscosity, slightly superior in bronzing, but after outdoor exposure the masstone panels exhibited an undesirable roughening of the surface.

Nickel Phthalocyanine (NiPC) was prepared by the urea process and purified by crystallization from hot 90% H_2SO_4. It was found to be greener and duller than CPC but of equal or better tinctorial strength. NiPC was no better than CPC with respect to bronzing in nitro-cellulose lacquer. Salt-milled NiPC was superior to CPC to settling in nitro-cellulose lacquer but acid pasted NiPC was approximately equal to CPC in this respect.

Lead Phthalocyanine (PbPC) was prepared by the reaction of phthalonitrile either with litharge or with lead metal. It was finished by the salt-milling method since PbPC can not be acid-pasted without decomposition. It is a green pigment considerably yellower in shade than "Monastral" Fast Green G (Chloro-CPC). It is remarkably unstable in linseed oil, an ordinary zinc-oxide-reduction drawdown undergoing practically complete fading in less than 24 hours. In nitro-cellulose lacquer PbPC was found to be yellower and much duller in shade, superior in settling and in bronzing, compared with "Monastral" Fast Green G. In glyptal resin paint systems the bronzing was also superior to that of "Monastral" Fast Green G.

Chromium Phthalocyanine containing from 2 to 3 atoms of chlorine in the molecule was prepared from chromium chloride ($CrCl_3$) and phthalonitrile and finished both by the salt-milling method and by acid pasting. It is greener, weaker and much duller than CPC but superior to CPC with respect to settling and bronzing in nitro-cellulose lacquer. It was superior to CPC with respect to mill base viscosity when ground in glyptal resins.

Dichloro-Tin-Phthalocyanine was prepared by the reaction between stannous chloride and phthalonitrile. It was finished by the salt-milling method. In nitro-cellulose lacquer the shade was a blue-green, very much bluer and weaker than Chloro-CPC. It was superior to the latter in viscosity and in settling. Resistance to outdoor exposure is still being tested.

Cobalt Phthalocyanine was best prepared by the urea-phthalic anhydride kerosene reaction using $CoCl_2.6H_2O$. It was finished both by the salt-milling method and by acid pasting. In linseed oil inks the shade was redder than CPC but greener than "Monastral" Fast Blue 2RP and duller than either. Like lead phthalocyanine, Cobalt PC in linseed oil reduction with zinc oxide bleaches badly within 24 hours. In nitro-cellulose lacquer the product is jet, redder, duller, slightly weaker and superior in viscosity and settling as compared with CPC. In glyptal resins, it is jet, red, very dull, similar in strength and superior in mill-base viscosity as compared with CPC.

The green pigment prepared by the urea-kerosene process using 3,6-dichloro-phthalic anhydride and zinc chloride was acid pasted and tested in linseed oil inks. It was found to be very, very jet, bluer, very much duller, weaker and inferior in light fastness compared with Chloro CPC. Analysis showed this pigment had only about half the amount of zinc calculated for zinc-octa-chloro-phthalocyanine.

Samples of NiPC and CoPC were sulphonated and tested for dyeing paper in the beater. Neither showed any advantage over sulpho-CPC.

The preparation of the following phthalocyanines has been started, but to date none of them yet have been obtained sufficiently pure to be submitted for test: MgPC, CaPC, ZnPC, BaPC, MnPC, FePC. Work on these products will be reported at a later date.

Patent Situation:

All of the metallic phthalocyanines described herein have been disclosed in the prior art, principally in I.C.I. patents. None of them therefore is patentable as a new product.

No novel method of preparation of phthalocyanines has been developed during this investigation.

The process of finishing pigments by the salt-milling method is the subject of a DuPont patent application, OR-1431. See also Patent Report AN-1697.

If the salt-milling method, or some other finishing method, is found to give, in usable pigment form, a phthalocyanine, such as for instance lead phthalocyanine, which heretofore has been disclosed only as a crude on account of its instability to acid pasting, then such pigment form of the phthalocyanine probably would be patentable. The filing of a patent application covering the finishing of such (unstable)

metal phthalocyanines by the salt-milling method is under consideration at the present time.

Plans for Future Work:

The investigation will be continued along the same lines followed so far until the phthalocyanines of all metals of reasonable cost and availability have either been prepared in a pure state and tested for printing ink and paints, or else have been shown to be impracticable to obtain in a state of purity.

Further, any of the phthalocyanines which show promising properties will be converted to their sulfo- and chloro-derivatives and tested.

Experimental:

Preparation and Finishing of Aluminum Phthalocyanine
JLNB 3666-58, -148, -170; 3818-94, -174)

The most convenient method for preparing this pigment in the laboratory was to charge into an iron graining bowl 512 g. phthalonitrile, 500 g. anhydrous Na_2SO_4 and 147 g. $AlCl_3$ anhydrous. This mixture then was heated to 230°-250° and held for 10 hours, then cooled with agitation. The finely ground crude was extracted with hot dilute hydrochloric acid, filtered and washed free from soluble iron with dilute HCl, then washed with water until acid-free and dried. Yield 86%. This crude was of good purity as shown by the following analytical results:

	% Found	% Calculated for $C_{32}H_{14.55}Cl_{1.45}N_8AlOH$
Aluminum	4.55	4.45
Iron	0.072	0.00
Nitrogen	18.00	18.47
Chlorine	8.48	8.48

This crude was finished by milling in a three-gallon ball mill with 6.5 parts of salt, extracting and drying.

Evaluation:

(a) in ink: very weak and very dull vs. "Monastral" Fast Blue G (Metal Free PC).

(b) in nitrocellulose lacquer (Parlin formula) (T.L. Memo. 1743). Very jet, very green, weak and superior in settling vs. "Monastral" Fast Blue B. Also the aluminum PC showed extreme alcohol bleed.

(c) (TL Memo. 291) Very green, weak and superior in settling vs. Monochloro-CPC (3620-72)

The AlPC showed very good resistance to settling, remaining in suspension for more than 7 days. The mill base viscosity was somewhat better vs. "Monastral" Fast Blue B.

After 4 months outdoor exposure, the AlPC showed slightly less bronzing than Blue Bor than Monochloro CPC. The surface of the masstone panel was markedly rough, however.

(d) in glyptal resin - tests not yet completed.

Conclusion: On the basis of tests now completed, AlPC appears not to be of sales interest by reason of its weakness and dullness and its tendency to roughen the paint film upon outdoor exposure.

Preparation and Finishing of Nickel Phthalocyanine
JLNB 3395-143, 3666-108, -156, -160, 3737-74

The crude was prepared from 1200 g. phthalic anhydride, 1800 g. urea, 30 g. boric acid, 2.4 g. ammonium molybdate, and 492 g. $NiCl_2.H_2O$ in 3.9 liters of Deo Base by the usual urea-kerosene procedure. (Ref. JLR-59-1-UK, No. 1) The crude was filtered from the Deo Base, dried, extracted with dilute hydrochloric acid, then with dilute caustic filtered, washed and dried. Yield of extracted crude was 74.5% of theory.

The crude was purified by crystallization from hot 90% H_2SO_4. (Ref: JLR-59-1-UK, No. 4) One part of crude was slurried in 14 parts of 90% H_2SO_4 at 95 to 100° until dissolved. The solution was cooled rapidly to 5° to 10° and held for 1/2 hour. The crystals of nickel PC sulphate, (needles chiefly between 0.05 and 0.1 mm. in length) were filtered and washed with cold 90% H_2SO_4, then slurried in water, filtered, washed acid-free and dried. Yield 0.75 parts purified color per part of crude.

The crystallized color was finished by (a) acid-pasting in 98% H_2SO_4 drowning at high turbulence and converting to a soft powder by the usual toluene + TEA-C-12 ester method, and (b) by ball milling 1 part color with 9 parts of salt in a quart can for 72 hours, followed by extraction with dilute HCl and drying.

Evaluation:

(a) in linseed oil ink - The salt milled material showed better strength in ink than the acid pasted product. The former was very jet and strong vs. "Monastral" Fast Blue

G, Lot 14. The shade of NiPC lies between that of CPC and Metal-Free PC and is duller than either.

(b) in nitro-cellulose lacquer (Parlin formula) (T.L. Memo. 4256)- (1) acid-pasted sample: masstone flat and dark, reduction green, dull and weak vs. "Monastral" Fast Blue B. In settling this sample was equally poor vs. Blue B. (2) salt-milled sample: masstone jet and dark, reduction green, dull and slightly strong vs. "Monastral" Fast Blue B. This sample showed no settling in 20 hours.

After 2-1/2 months outdoor exposure both samples showed at least as much bronzing as "Monastral" Fast Blue B.

Conclusion:

NiPC appears not to be of sales interest because of its dullness of shade and tendency to bronze in paint.

Preparation and Finishing of Lead PC
JLNB 3666-74, -100, -128, -154

The following was found satisfactory for the preparation of PbPC Crude. Charge the small nickel rotary baker with 150 g. phthalonitrile and 60.6 g. of lead metal in the form of thin strips cut from foil. The mixture is baked 12 hours at 255 to 260° and ground during cooling in the baker. The crude prepared by this method is a bright green powder. Usually it is uncontaminated by excess Pb metal as shown by its complete solubility in concentrated H_2SO_4. In those cases where unreacted lead is present, it may be removed by settling during the extraction step.

Lead PC also can be prepared by the reaction of litharge with phthalonitrile (JLNB 3395-91). The reaction is quicker and more vigorous than with the lead metal, but the crude must be freed from excess litharge by repeated extractions with ammonium acetate solution.

The lead PC crude was finished by milling 72 hrs. in a one-quart can with 9 parts of salt followed by extraction with hot water and drying.

Evaluation:

(a) in linseed oil ink: Very jet, yellow and extremely dull vs. "Monastral" Fast Green G when first laid down. Upon standing overnight even when protected from light the tints of PbPC undergo very marked fading, becoming duller, bluer, and very, very much weaker. The presence of the PbPC also inhibits the drying of the oil, the masstone ink remaining sticky for at least a week. This behavior is shown both by the pigment prepared from PbO or from Pb.

(b) in nitro-cellulose lacquer (Parlin formula): (salt ground sample from Pb + PN) - very dark and very dull in mass-tone; tint-yellow and very dull; strength - too dull to judge well compared with "Monastral" fast Green G. The lead PC was superior and equal in bronzing vs. Green G and very much superior to Blue B in bronzing.

(c) in glyptal resins (salt ground sample from PbO + PN) (T.L. Memo. 2165): very much yellower, very much duller, inferior in alcohol bleed and in light fastness and superior in bronzing vs. "Monastral" Fast Green G Lot 53.

Conclusions:

The Technical Laboratory requested preparation of a larger sample of lead PC for more thorough evaluation. However, the Fabrics and Finished Division in spite of improved bronzing properties were not interested in this color because of the dullness and weakness of the tint.

Preparation and Finishing of Chromium PC
JLNB 3666-82, -114, -162, 3737-6, -60, -62

No pigment was obtained from $CrCl_3$ and phthalic anhydride in the urea-kerosene process.

Crude CrPC containing some nuclear chlorine was obtained by baking 150 g. of phthalonitrile + 46 g. sublimed $CrCl_3$ for 6 hours at 275° in the small nickel or monel rotary baker. The crude was extracted with hot 5% HCl and dried. The analysis indicated that this product was not pure:

	% Found	Calculated for $C_{32}H_{13.8}N_8Cl_3.2Cr$
Chlorine	15.22	15.22
Chromium	6.69	7.85
Nitrogen	16.53	16.90

The yield of extracted crude was 94% of theory.

Treatment of this crude with strong sulfuric acid either as in acid pasting or as in acid crystallization resulted in a chromium analysis appreciably greater than theoretical. The reason for the behavior was not discovered.

The chromium PC crude was finished by (a) acid pasting the extracted crude in 98% H_2SO_4, drowning at high turbulence and converting to a barium rosinate lake and (b) ball milling, acid-crystallized CrPC with 9 parts of salt for 72 hrs. in a quart can, followed by extracting with dilute acid and drying.

Evaluation:

(a) in linseed oil inks: Both the salt-milled and the acid pasted samples were very jet, very weak, very green and very dull vs. "Monastral" Fast Blue G.

(b) in nitro-cellulose lacquer (Parlin formula)
(1) Acid pasted sample: dark, very flat masstone, tint-green, very, very dull and very, very weak, settling much superior vs. "Monastral" Fast Blue BND. After 3 months' outdoor exposure the CrPC showed no bronzing while the CPC was considerably bronzed.
(2) Salt-milled sample: flat, very black masstone, slightly thinner viscosity, tint slightly red, very, very dull and very weak, settling much superior vs. "Monastral" Fast Blue B. Outdoor exposure tests are not yet complete on this sample.

(c) in glyptal resin: Salt-milled sample: jet and very black in masstone, very green, very dull in shade and probably somewhat weaker vs. "Monastral" Fast Blue B. The mill base viscosity was similar to "Monastral" Fast Green G and superior to the Blue B. Outdoor exposure tests and can-drift tests are not yet complete.

Conclusion:

In spite of improvement in bronzing and settling properties, CrPC appears not to be of sales interest because of weakness and dullness of shade.

Preparation and Finishing of Dichloro-Tin Phthalocyanine - JLNB 3666-120, -176

Crude was prepared by baking 150 g. phthalonitrile with 61 g. atannous chloride (previously dehydrated by heating up to 450° in a distilling flask until water evolution ceased) in the small monel rotary baker for 6 hours at 275°. The crude was extracted with hot water and dried. Yield - 88% of theory. Analysis -

	% Found	Calculated for $SnCl_2PC$
Tin	16.3	16.9
Chlorine	6.54	10.1
Nitrogen	15.22	16.0

The extracted crude was finished by ball milling with 9 parts salt in a 1-quart can for 72 hours, followed by extracting with hot water and drying.

Evaluation:

(a) in linseed oil ink: Masstone-blue and milky, tint - bluer, duller and weaker vs. "Monastral" Fast Green G.

(b) in nitro-cellulose lacquer (Parlin formula) - very, very blue, weak, superior in viscosity and in settling vs. "Monastral" Fast Green G. Outdoor exposure tests are not yet complete.

(c) in glyptal resin - not yet tested.

Conclusion:

This color appears to be of no interest for printing inks because of its weakness and dullness of shade. Tests in paint systems are too incomplete to draw any conclusions as yet.

Preparation and Finishing of Cobalt PC (JLNB 3666-72, -86, 96, 124, 3737-58, 100, 104, 136, 156, 158, 174

The most satisfactory method for preparation of cobalt phthalocyanine of high purity was as follows: 300 g. phthalic anhydride, 450 g. urea, 150 g. $CoCl_2.6H_2O$, 7.5 g. boric acid, 0.75 g. ammonium molybdate and 1200 cc. of Deo Base were heated together using the usual conditions for CPC by the UPK process. The crude color was filtered. One-third (198 g.) of the wet filter cake was crystallized by adding to 2800 g. of 90% H_2SO_4 at 80°C. The color dissolved in the acid and the Deo Base separated as a distinct liquid layer. The mixture was cooled rapidly to 0°, the Deo Base was separated and the crystals of CoPC sulphate were filtered on a carborundum nutsch and washed with four 100 gram portions of cold 90% H_2SO_4. The cake was slurried in water, filtered, washed and dried. The yield at this step was only 33% of theory, but it is believed that with more judicious washing of the crystal cake, particularly with respect to the use of a lower concentration of acid for washing, the yield probably could be doubled. The analysis of the crystallized sample was as follows:

	% Found	% Calculated for CoPC
Cobalt	11.06	10.31
Nitrogen	19.65	19.62

The crystallized CoPC crude was finished by acid pasting in 98% H_2SO_4, and drip-drowning. After acid pasting the analysis was found to be:

Cobalt - 10.36 Nitrogen - 19.52

CoPC Crude also was prepared by a bake reaction: 256 g. of PN was melted in a glass flask and 65 g. anhydrous $COCl_2$ was added in small portions during about 1 hour. Reaction temperature was 210°-230°. Charge was held at this temperature for 30 minutes to 1 hour after addition was complete. The crude was extracted with hot dilute HCl and dried. Yield 64% of theory. Analysis:

	% Found	% Calculated for $C_{32}H_{15.5}N_8Cl_{0.5}Co$
Chlorine	2.82	3.03
Cobalt	9.87	10.02
Nitrogen	19.52	19.04

Crystallization of this type from hot 90% H_2SO_4 of crude gave a product which contained only 6% to 7% of cobalt.

Reaction between PN and $CoCl_2$ in the small rotary baker gave a crude of much lower purity (approximately 80%) but in higher yield (approximately 92%).

A sample of crystallized crude prepared in the baker was finished by milling 72 hours with 9 parts of salt in a quart can, followed by extraction with dilute HCl.

Evaluation of CoPC Prepared by the Urea Process, Purified by Acid Crystallization, and Finished by Acid Pasting

In linseed oil inks (T.L. Memo. 510) - the freshly prepared drawdown from acid pasted CoPC when tested as barium rosinate lake was very bronzy in masstone, much redder, much duller, close in strength vs. "Monastral" Fast Blue BND. It was also bronzy in masstone, much greener, very much duller and 5% weaker vs. "Monastral" Fast Blue 2RP Paste. However, after drying overnight the tints were very badly bleached and the masstone ink was still very wet and sticky.

Evaluation of CoPC prepared by Salt-Milling of Crystallized Crude from the Baker Reaction

(a) In linseed oil ink: this sample gave substantially the same result as acid pasted CoPC from the urea process.

(b) in nitro-cellulose lacquer (Parlin formula) (T.L. Memo. 379): very jet, slightly thinner in viscosity, red, dull, slightly weak, very much superior in settling vs. "Monastral" Fast Blue B Lot 99. The CoPC was also greener and duller vs. "Monastral" Fast Blue 2RP.

Outdoor exposure tests are not yet complete.

(c) in glyptal resin (T.L. Memo 378): very black and jet in masstone, red, very dull, similar in strength vs. "Monastral" Fast Blue B. In mill base viscosity the CoPC was similar to "Monastral" Fast Green G and much superior to Blue B.

Outdoor exposure and can-drift tests are not yet complete.

Conclusion:

CoPC is of no interest in inks because of its instability. Its dullness makes it of little interest in point, in spite of improved settling and viscosity properties.

Preparation of a Pigment from 3,6-Dichloro-Phthalic Anhydride and Zinc Chloride by the Urea Kerosene Reaction - JLNB 3737-110, -132

53.2 g.	3,6-Dichloro-phthalic anhydride (purified from ICI material by recrystallization; purity 106% by chlorine analysis)
56.0 g.	Urea
11.2 g.	$ZnCl_2$ freshly fused
1.0 g.	Boric Acid
0.1 g.	Ammonium molybdate
700 cc.	Deo Base

The urea was added to the other ingredients, first at 140° to 150° until NH_3 began to be evolved, then the remainder at 180° to 190°. Charge was held at 200°-210° for 6 hours. Color did not begin to form until after all the urea had been added. The crude was filtered and dried, giving 76.8 g. of a black crude contaminated with yellowish crystals.

This crude was acid pasted in 98% H_2SO_4, drip-drowned and tested as a paste for flushing. The product was found to be (T.L. Memo. 915) very, very jet, bluer and very much duller, weaker 225:100 and inferior in light fastness vs. "Monastral" Fast Green GF Paste.

The analysis of the acid pasted material was:

	% Found	% Calculated for $C_{32}H_{12}N_8Cl_8Zn$
Chlorine	27.04	33.3
Zinc	3.85	7.68
Nitrogen	13.54	13.13

Conclusion:

This product is of no interest because of extreme weakness and dullness of shade.

Sulphonation of NiPC - JLNB 3737-184

A mixture of 75 g. crystallized NiPC (purity, 98%) and 487 g. of 20% oleum was agitated at room temperature until solution was complete, then warmed to 80°-85° and held for 30 minutes, when a test portion showed complete solubility in 1% NaOH. The charge was drowned into 15% NaCl solution, filtered and washed acid-free with 5% NaCl solution and dried. Weight 162 g. Analysis showed Ni = 4.21% and S = 5.03%, indicating a formula of $C_{32}H_{13.81}N_8Ni(SO_3H)_{2.19}$, a strength of 53.5% in the crude, and a yield of 87.5% of theory. The solubility of the free acid in water was much greater than that of sulpho CPC. The dry crude was standardized by mixing with 15% of its weight of soda ash and tested for beater dyeing of paper. It was reported (T.L. Memo 1090) to be slightly red, somewhat dull, somewhat superior in light fastness and approximately equal in strength on an equal color basis vs. Pontamine Fast Turquoise 8GL. Also considerably greener and somewhat superior in light fastness vs. DuPont Anthraquinone Blue BN.

Conclusion:

The Technical Laboratory states that the sulphonated NiPC appeared not to have any particular advantage over Pontamine Fast Turquoise 8GL for beater dyeing.

Sulphonation of CoPC - JLNB 3737-170

A mixture of 20 g. crystallized CoPC (from urea process crude) and 130 g. 20% oleum was agitated at room temperature until solution was complete, then heated to 80°-85° and held for 1 hour 40 minutes when a sample showed complete solubility in 1% NaOH. The charge was drowned into 15% NaCl, filtered, washed acid-free with 15% brine and dried. Weight 46 g. Analysis: S = 6.26%; Co = 4.77%, indicating a formula of $C_{32}H_{13.6}N_8Co(SO_3H)_{2.42}$, a purity of 61.9% and a yield of 94%. The crude was submitted to the Technical Laboratory without standardization. It was reported to be (Memo 968) considerably redder, somewhat duller, somewhat superior in light fastness and weaker 135:100 vs. Pontamine Fast Turquoise 8GL. Compared with DuPont Anthraquinone Blue BN the Sulpho CoPC was considerably greener and somewhat superior in light fastness.

Conclusion:

The Technical Laboratory expressed the opinion that this product has no particular advantage over Pontamine Fast Turquoise 8GL and that its dyeing properties are essentially similar to this standard.

Literature:

B.P.'s - 410,814, 453,767, 441,332 - all assigned to ICI.

JLR-59-1-UK, No. 1 - Serial Number 16266
JLR-59-1-UK, No. 4 - Serial Number 17133
JLR-59-1-UK, No. 41 - Serial Number 17880

APPENDIX

April 24, 1942

August

DR. W. S. CALCOTT, DIRECTOR
JACKSON LABORATORY
Attn: Dr. O. Stallmann

LEAD PHTHALOCYANINE
CHROMIUM PHTHALOCYANINE
NICKEL PHTHALOCYANINE

Our exposure panels of these three colors were shown to members of the Philadelphia Laboratory staff. They agreed with us that these colors are probably of no interest in spite of some rather interesting properties which they have.

Lead phthalocyanine shows improved bronze over "Monastral" Fast Green G and has a pleasing green masstone. It is, however, so blue, dull and weak in tint that it is of no interest.

Chromium phthalocyanine shows improved bronzing over "Monastral" Fast Blue BND. It is too green, dull and weak, however, to be of interest.

Nickel phthalocyanine has a jet masstone but is equal in bronze to "Monastral" Fast Blue B. It is green, slightly dull and slightly weak and shows no improvement over our present standard.

DR. R. E. ROSE, DIRECTOR

Per: C. K. Black

C.K.Black
HCE

Submitted for Typing - June 19, 1942
Typed - August 18, 1942
Jeanette L. Blocksom