JOURNAL
OF THE
OIL AND COLOUR CHEMISTS' ASSOCIATION

✓Vol. 47 No. 11 November 1964

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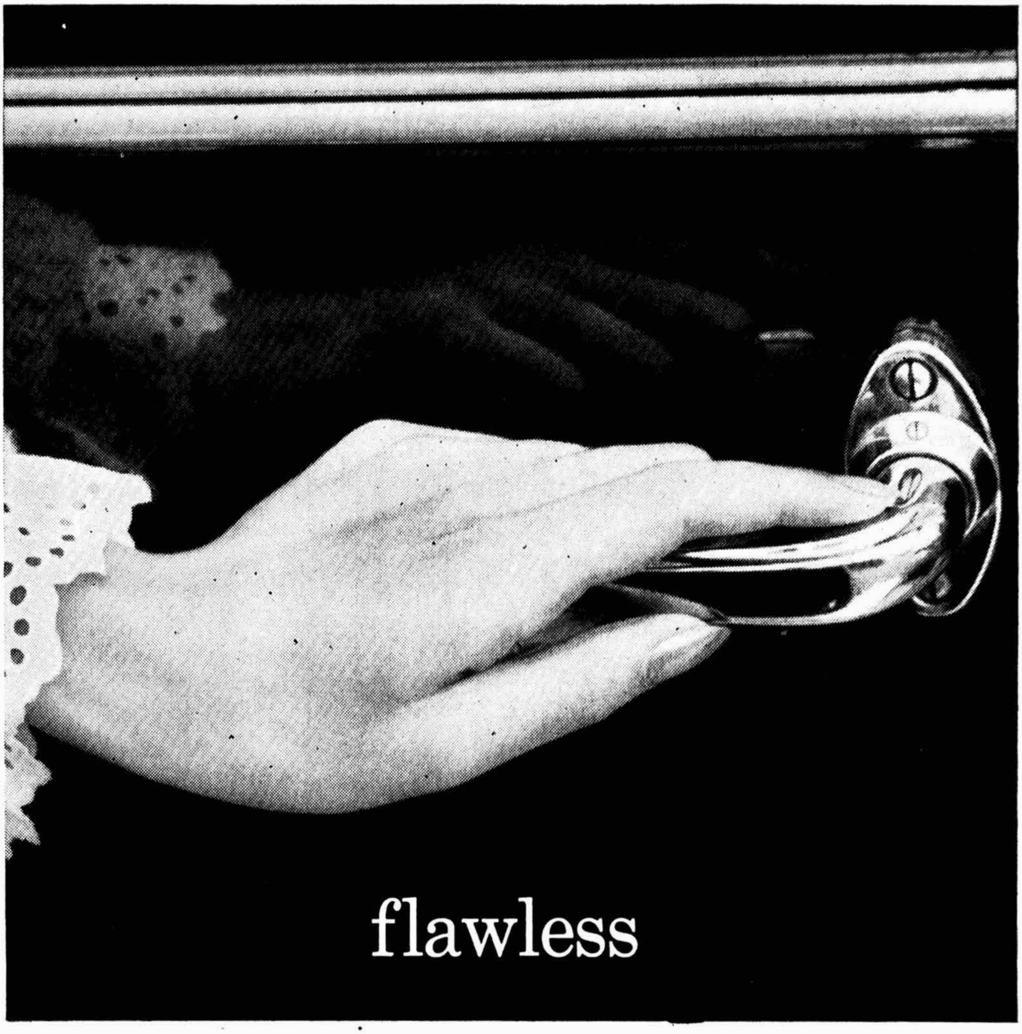

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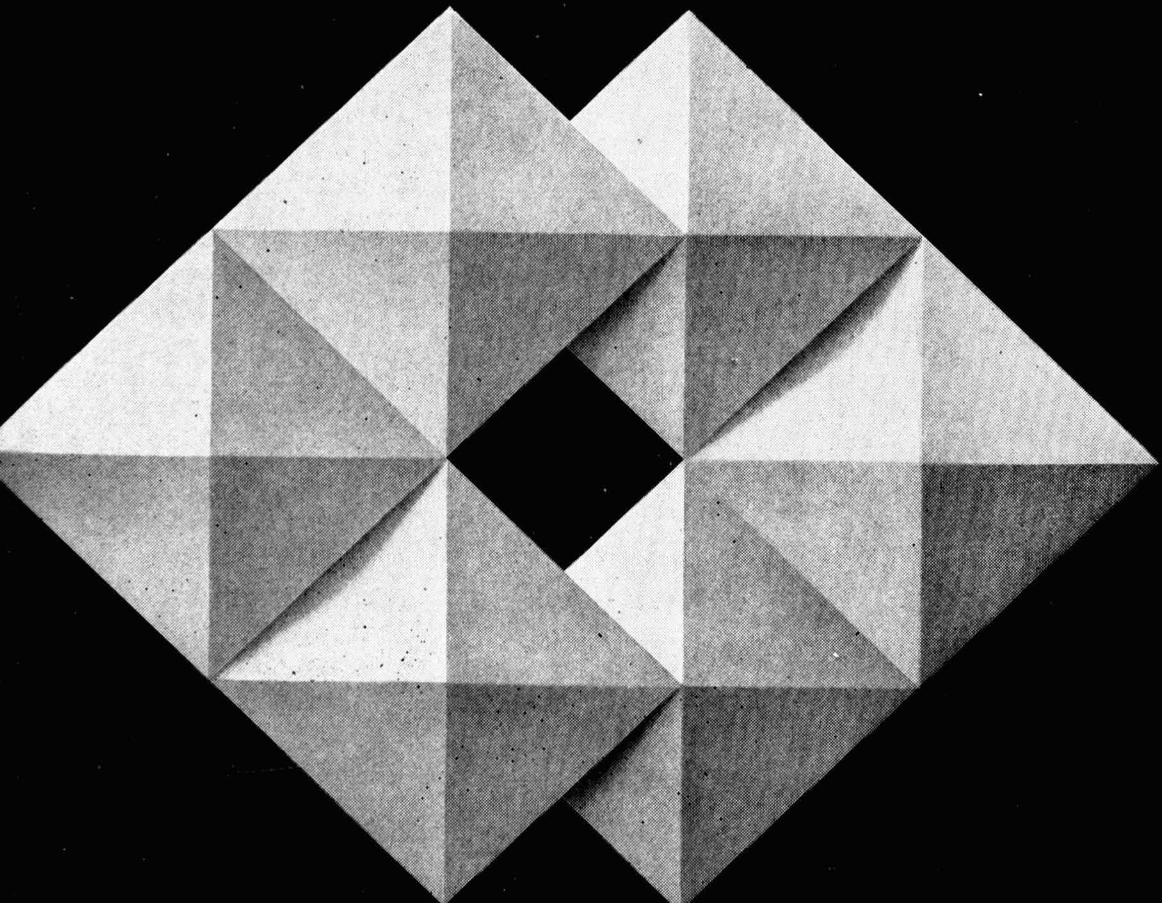

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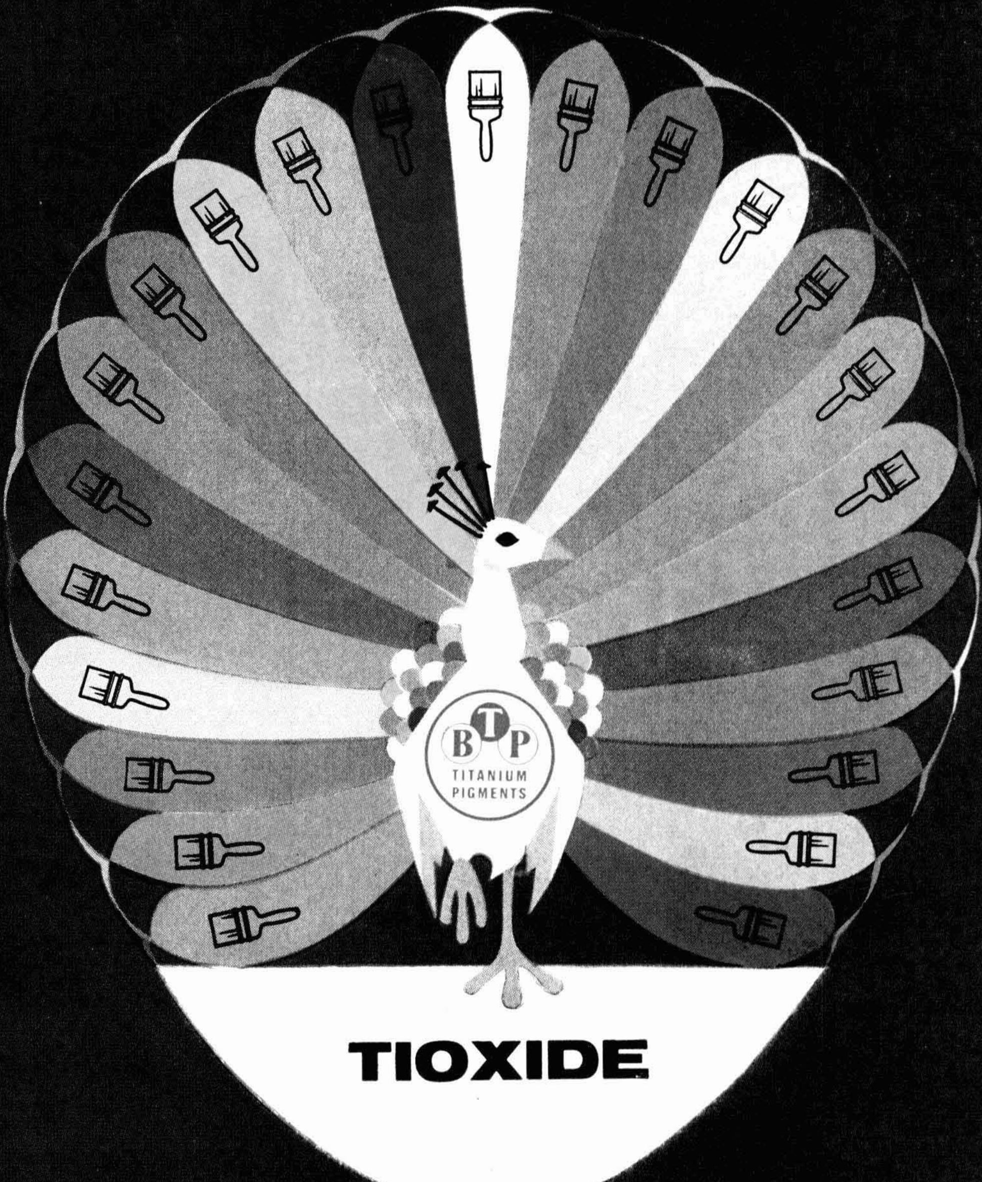

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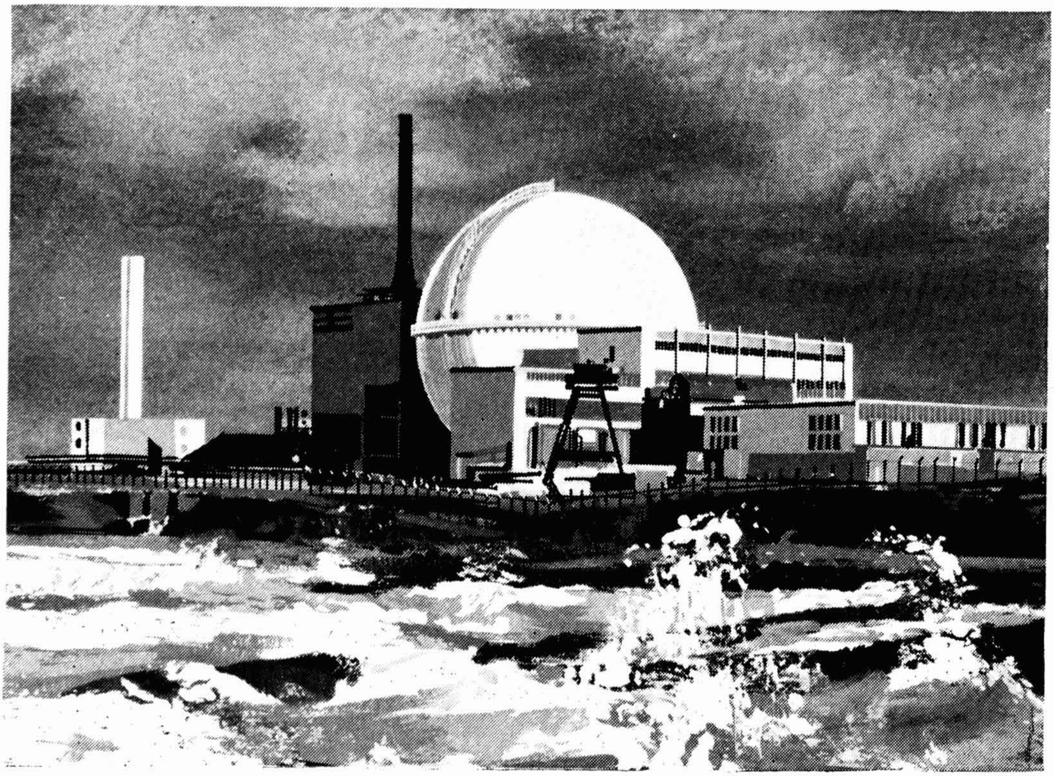

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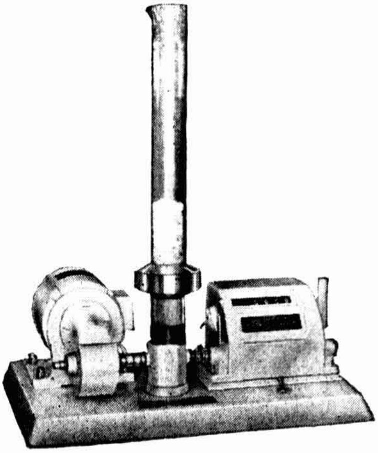

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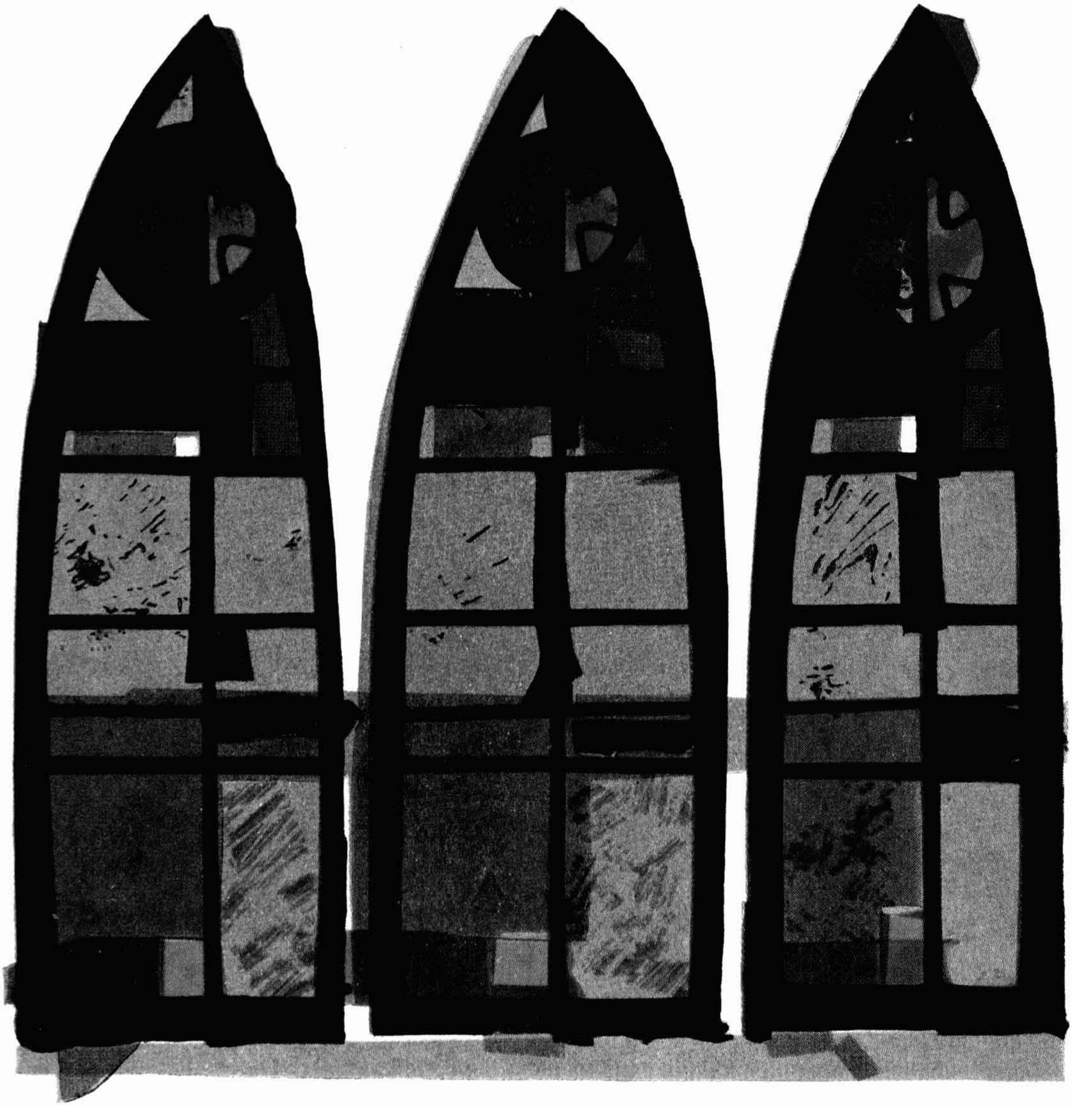

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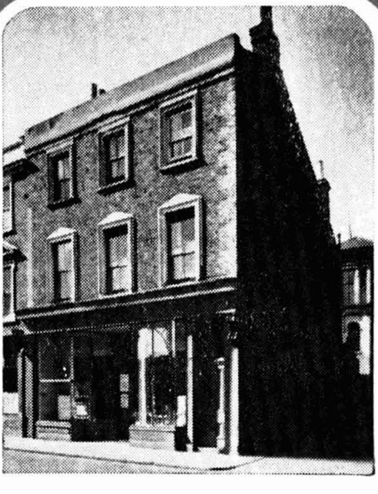

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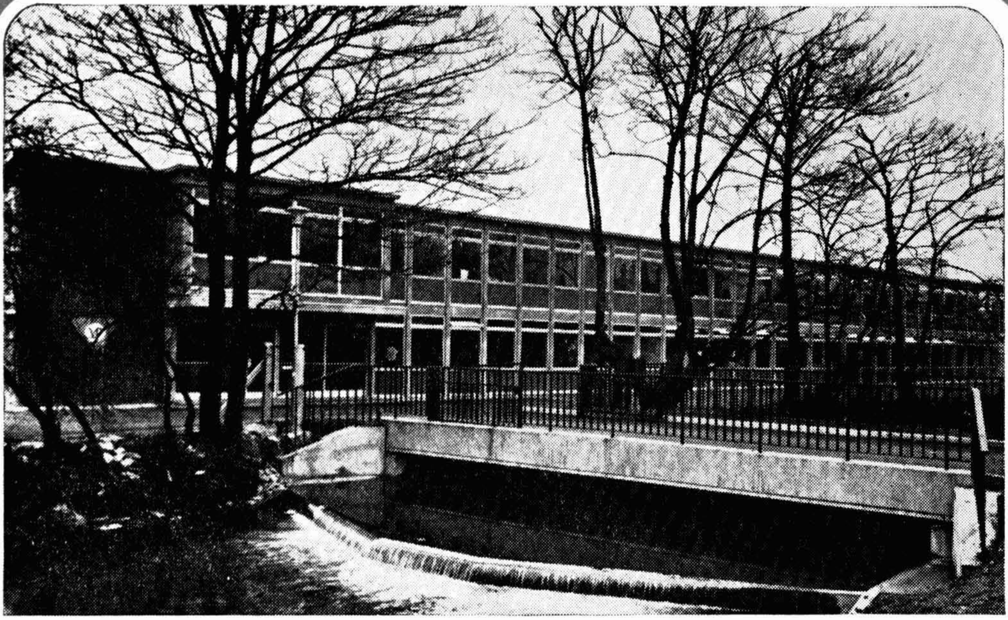

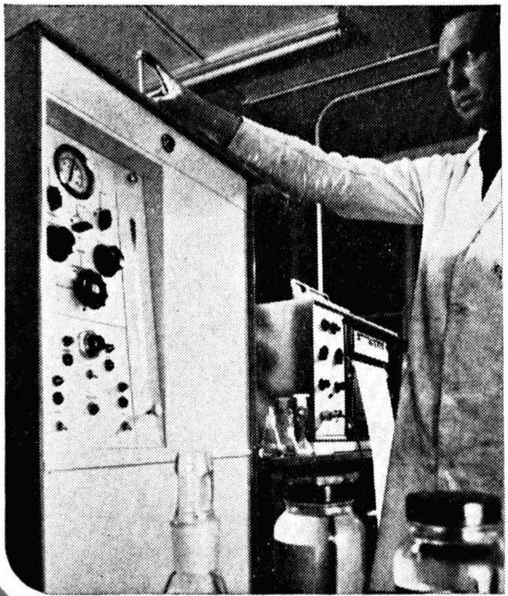

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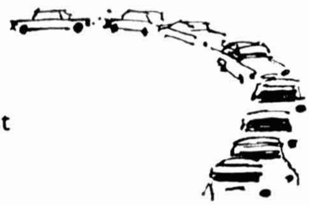

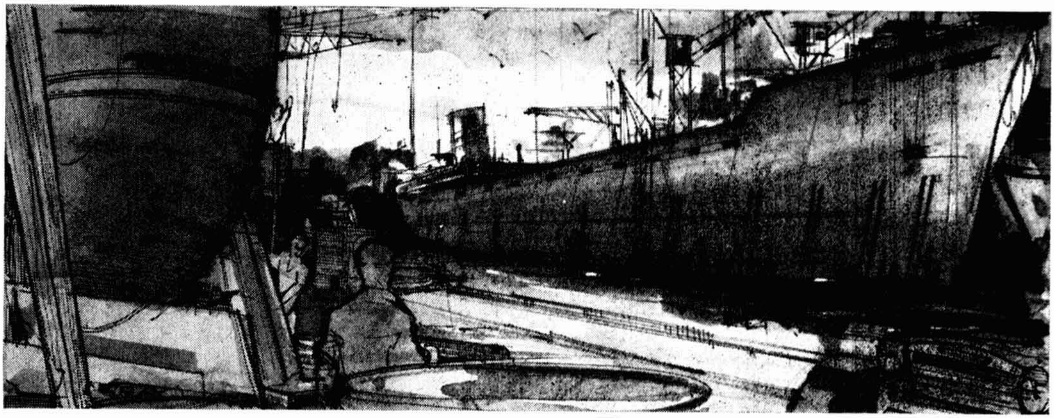

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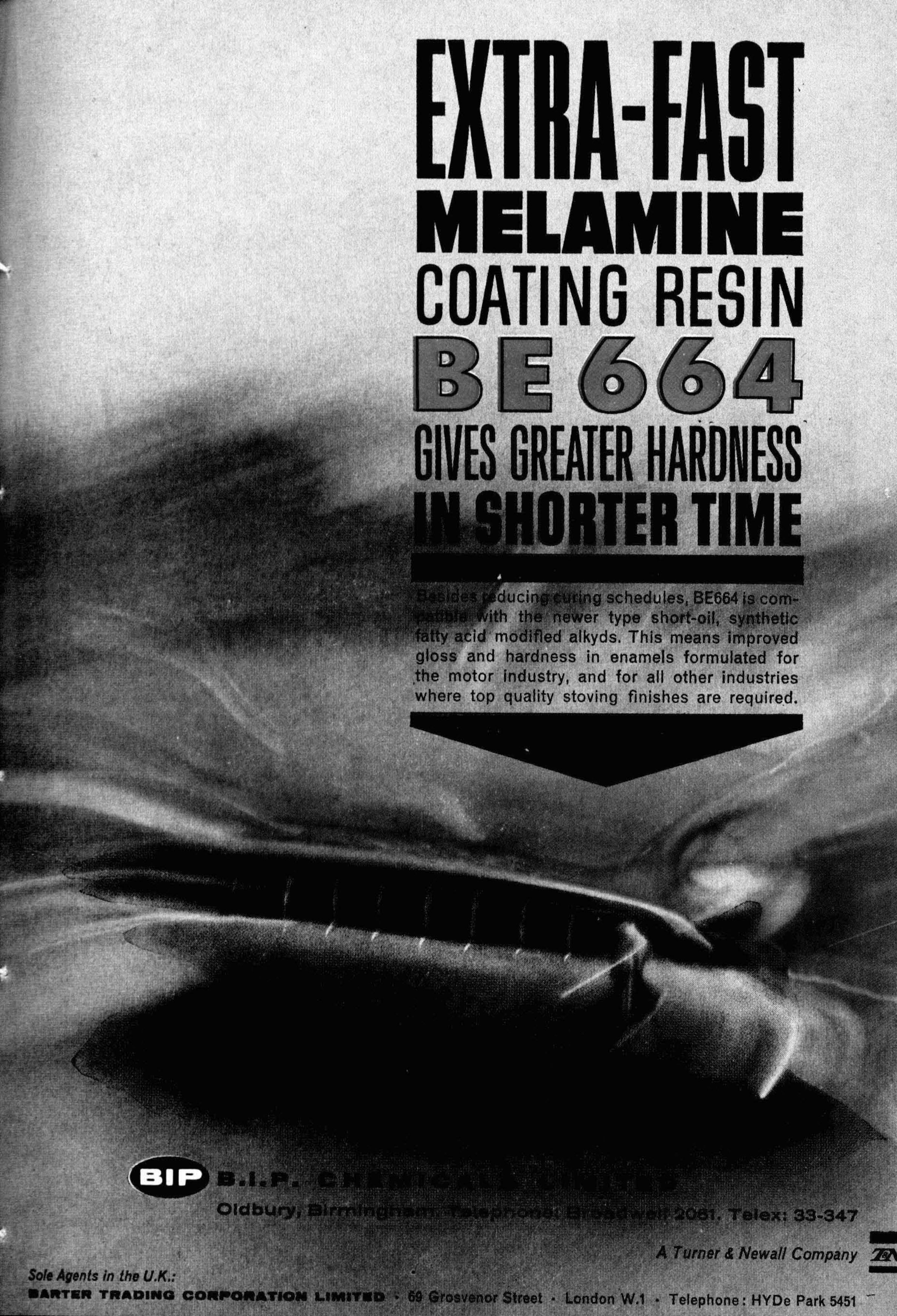

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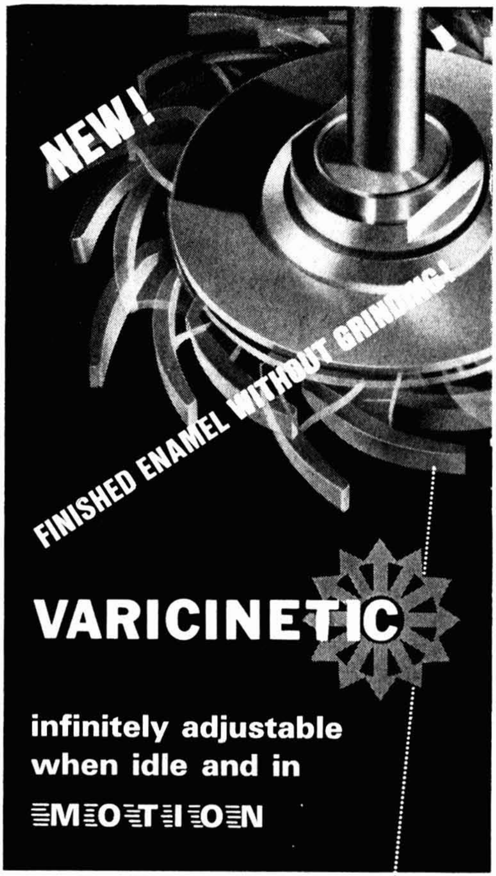

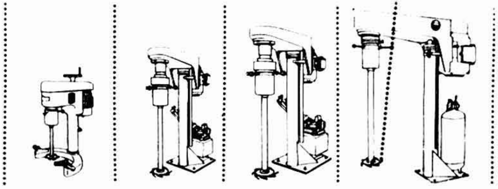

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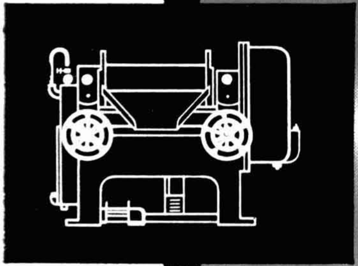

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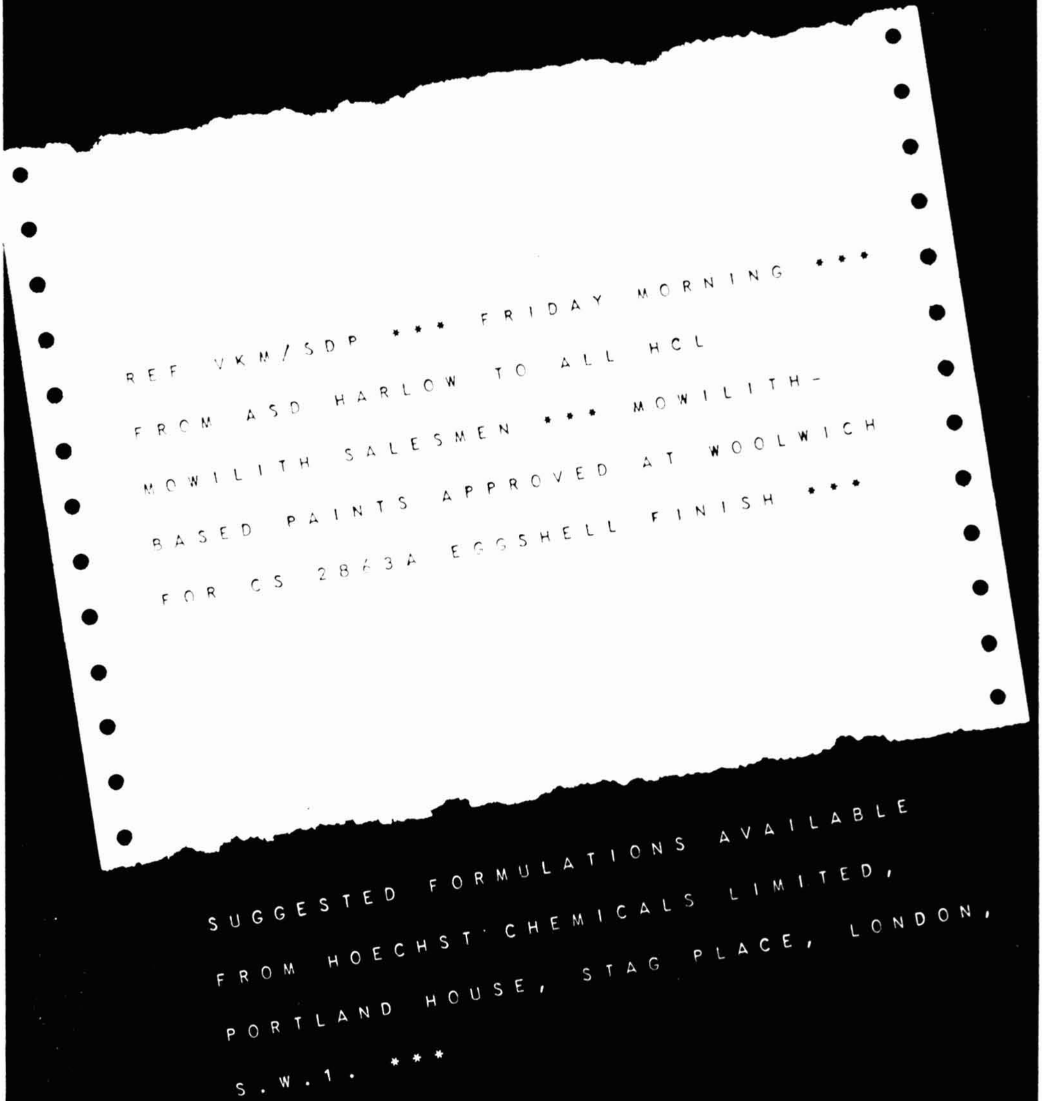

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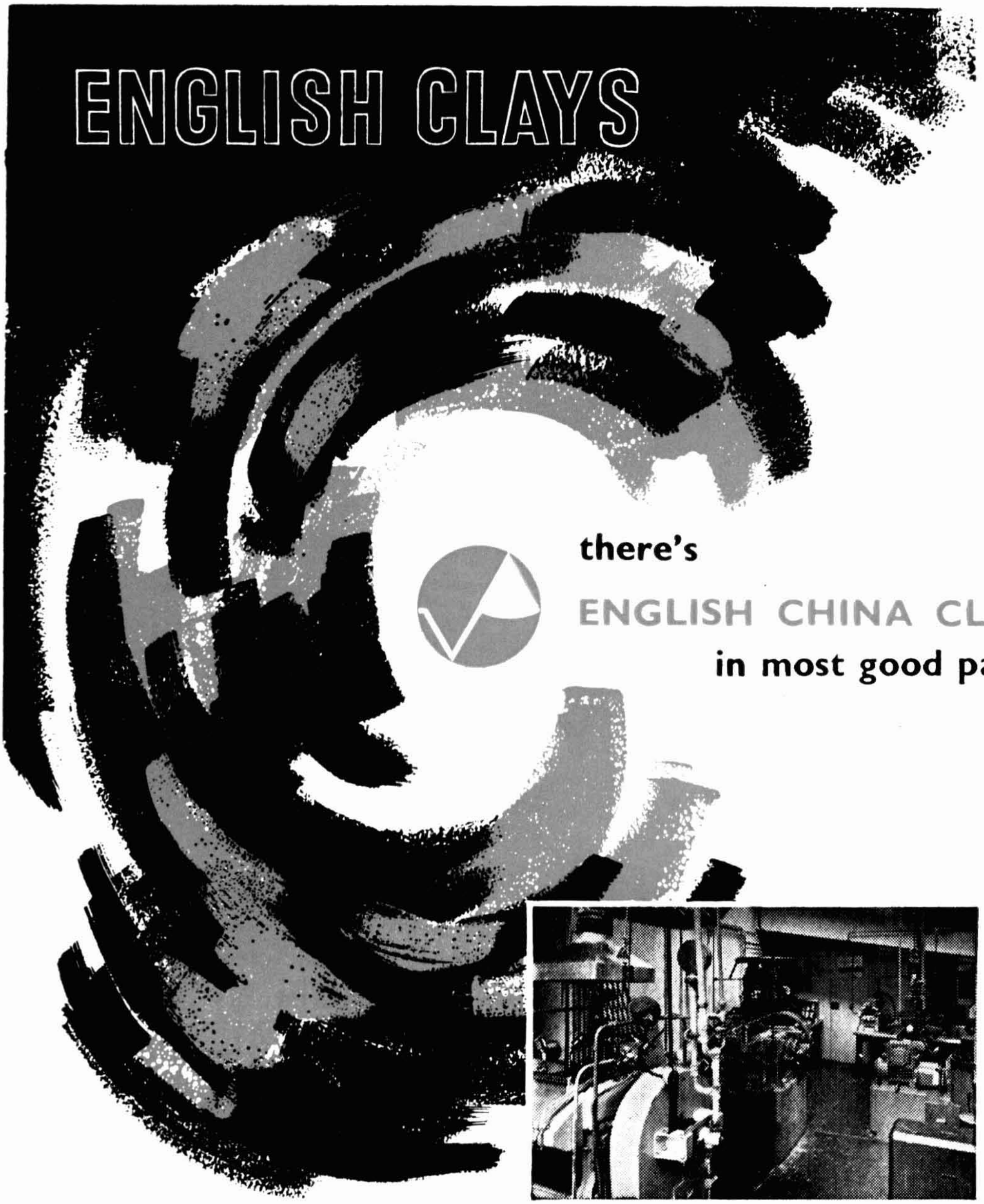

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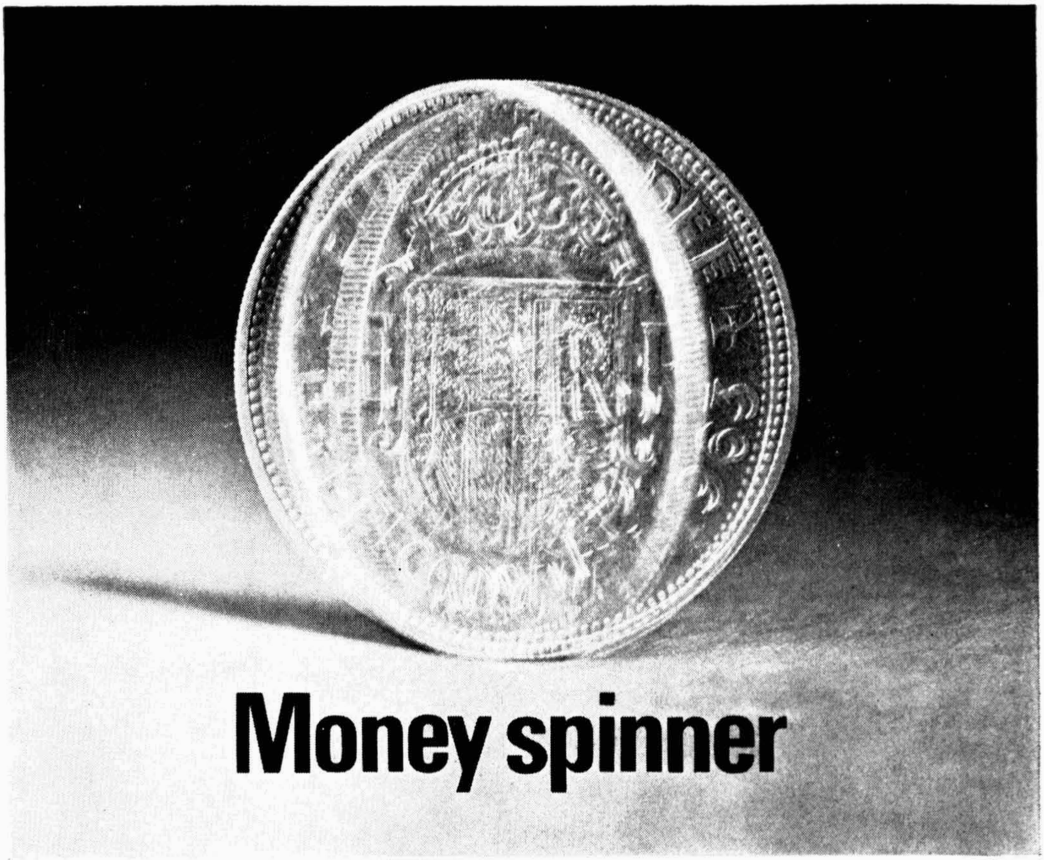

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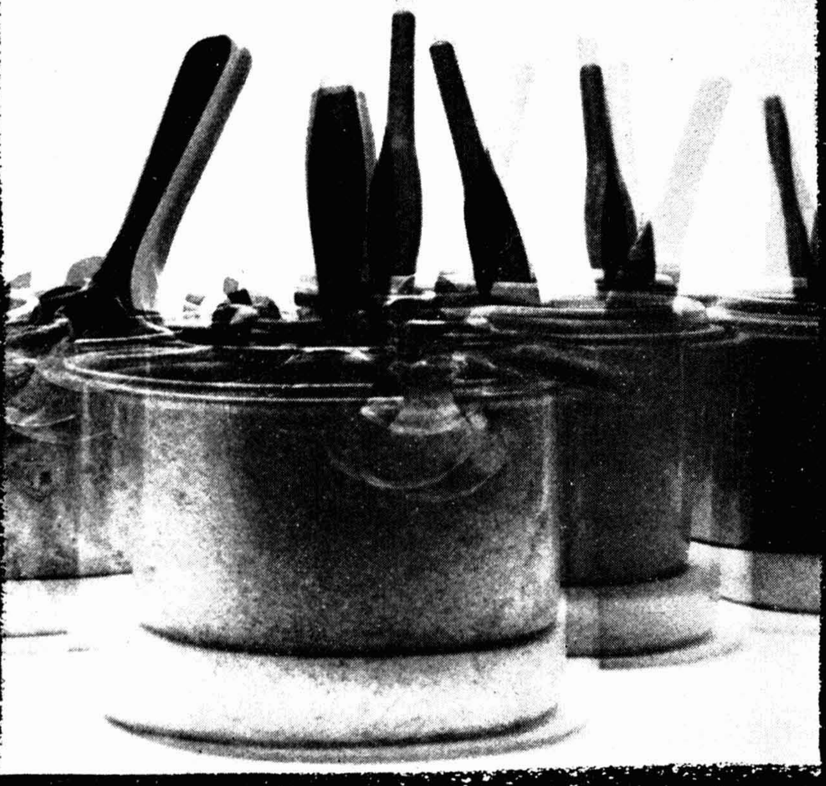

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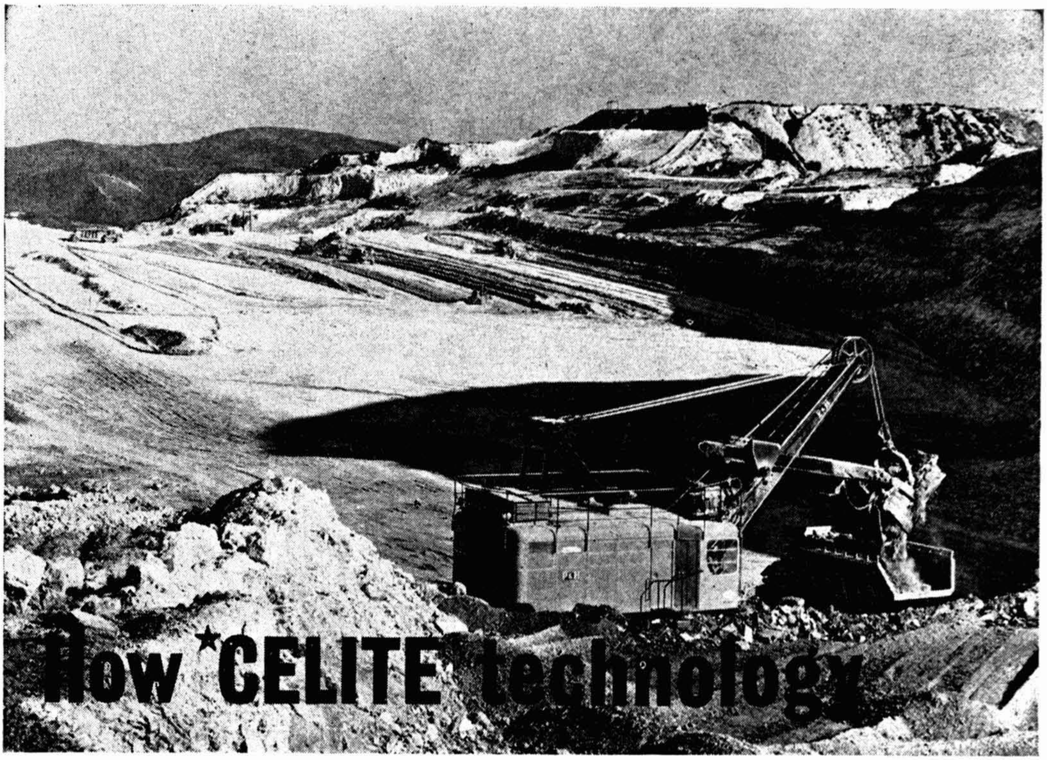

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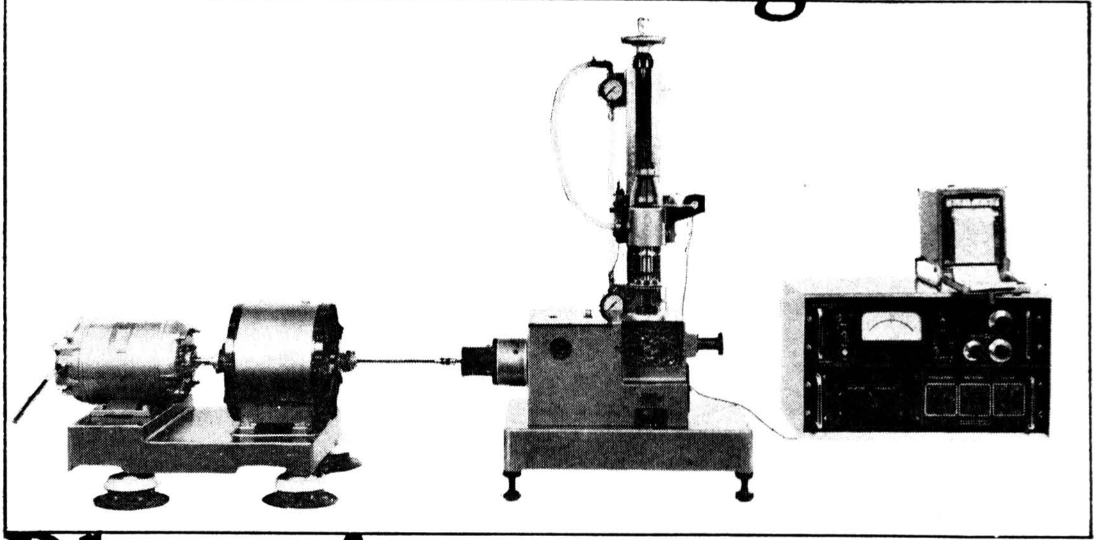

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TRANSACTIONS AND COMMUNICATIONS

Metallised Alkyd Resins

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INTRODUCTION

A number of methods have been suggested in technical literature to improve alkyd resins and metallisation is one. In this process the resins are made to react with certain organo-metallic compounds and the resulting organo-metallic polymers are likely to prove superior to the conventional alkyd resins.

The different metals suggested for use in metallising alkyd resins include silicon, aluminium, titanium, iron, cobalt, nickel, zinc, boron and antimony. Incorporation of these metals in alkyd resins is achieved in a number of ways, depending upon the type of metal. In the majority of the cases, this is done by the use of organo-metallic compounds though it has been reported[1] that incorporation of metals like nickel, iron and cobalt could also be achieved by the use of their carbonyls. Of the different metals mentioned above, systematic study has only been done with silicon and to a certain extent titanium. Aluminium has been studied in sufficient detail but the information available is relatively small and most of the processes involved have been patented. Perhaps one of the most informative papers published in recent times dealing with this subject is that of Weiss,[2] who has prepared synthetic oils starting from fatty acids and aluminium alkoxides. The other papers by Schlenker[3] and Turner *et al*[4] give certain clues regarding the metallisation of alkyd resins using aluminium alkoxides, but no details are given about the process conditions. Work was therefore undertaken to investigate the problem of aluminising alkyd resins using enolised aluminium alkoxides and the observations made

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during the initial stages of this work have already been indicated in an earlier communication[5].

EXPERIMENTAL

Preparation and Enolisation of Aluminium Alkoxides

Preparation :

Aluminium alkoxides, the n-butoxide, isopropoxide and amyloxide were prepared by the conventional method, using mercuric chloride as catalyst.

Enolisation :

The aluminium alkoxides mentioned above were enolised by refluxing with a keto-enol tautomer (in a 1 : 1 mol ratio) for 3½ hours. The alcohol liberated in each case was distilled off (under vacuum in the later stages) and the solvent-free alkoxides were then dissolved in white spirit to give a 50 per cent solution. The solutions were analysed to find out the aluminium content and hence the concentrations. The different aluminium alkoxide—keto-enol tautomer combinations studied were as follows, (*a*) aluminium n-butoxide—ethyl acetoacetate, (*b*) aluminium n-butoxide—acetyl acetone, (*c*) aluminium n-butoxide—diacetone alcohol, (*d*) aluminium isopropoxide—ethyl acetoacetate, and (*e*) aluminium amyloxide—ethyl acetoacetate.

The aluminium contents of the different alkoxides were determined by the standard oxinate method[6].

Preparation of Alkyd Resins

Linseed glycerol alkyds of four oil lengths 90, 80, 70 and 60 per cent oil were prepared by the monoglyceride process. In each oil length five different alkyds were prepared with various amounts of glycerol and phthalic anhydride. A 60 per cent oil length safflower-glycerol and a 70 per cent oil length DCO glycerol alkyd were also prepared. The various ingredients used in the preparation and the quantities employed are given in Table I.

The chemical constants of the various alkyd resins prepared are given in Table II.

Metallisation of Alkyd Resins

All the metallisation reactions were carried out in a 500 ml three necked flask fitted with a water condenser and a mechanical stirrer. Heating was effected by an electric mantle and the quantity of alkyd resin used in each experiment was about 30 g.

With each of the alkyd resins, aluminium alkoxide was made to react in four different proportions, 25, 50, 75 and 100 per cent of the theoretical quantity calculated on the basis of gross hydroxyl value, where *gross hydroxyl value = apparent hydroxyl value + acid value.*

TABLE I

Ingredients for Alkyd Resins

Batch size = 600 g. Amount of triphenyl phosphite per batch = 6.00 g.

No.	Alkyd	Oil g.	Glycerol g.	Sodium hydroxide g.	Phthalic anhydride g.	Linseed fatty acids g.
1	A_1	510	48	0.125	56	—
2	A_2	510	64	0.167	56	—
3	A_3	510	86	0.224	56	—
4	A_4-A_5	180	80	0.209	50.6	342
5	B_1	348	72	0.188	101	126
6	B_2	348	90	0.235	101	126
7	B_3	348	102	0.266	101	126
8	B_4-B_5	348	72	0.188	101	126
9	C_1	420	90	0.235	150	—
10	C_2	420	100	0.261	150	—
11	C_3	420	110	0.287	150	—
12	C_4-C_5	300	76	0.198	150	115
13	D_1	360	90	0.235	200	—
14	D_2	360	115	0.300	200	—
15	D_3	360	190	0.365	200	—
16	D_4-D_5	360	82	0.214	200	—
17	E	360	90	0.235	200	—
18	F	420	90	0.235	150	—

Note : (a) Resins of series A consist of 90 per cent oil length alkyds, series B of 80 per cent oil length, series C of 70 per cent oil length and series D of 60 per cent oil length.

(b) Alkyds with subscripts 4 and 5 were prepared from the same batch.

(c) Resin E is a 60 per cent oil length safflower-glycerol alkyd while resin F is a 70 per cent oil length DCO glycerol alkyd.

TABLE II

CHEMICAL AND PHYSICAL CONSTANTS OF UNMETALLISED ALKYDS

No.	Code	Percentage non-volatiles	Viscosity poises	AV mg.KOH/g.	SV mg.KOH/g.	Hydroxyl value mg.KOH/g.	Oil length percentage
1	A_1	100	2.50	7.4	236	73.0	88.8
2	A_2	100	3.00	3.3	236	98.0	88.8
3	A_3	100	3.00	1.7	232	137.0	89.9
4	A_4	100	1.40	21.0	236	68.0	88.8
5	A_5	100	1.25	33.0	234	75.0	89.3
6	B_1	100	4.70	9.3	271	41.9	80.0
7	B_2	100	4.70	11.0	270	92.0	80.0
8	B_3	100	5.00	6.5	268	169.0	80.7
9	B_4	100	4.70	20.2	273	60.4	79.4
10	B_5	100	5.00	31.1	264	79.6	81.7
11	C_1	51.8*	0.50	7.2	306	62.0	71.0
12	C_2	52.4*	0.85	8.4	308	91.0	70.5
13	C_3	52.8*	0.85	8.0	308	120.0	70.5
14	C_4	51.2*	0.50	26.0	310	74.0	70.0
15	C_5	50.0*	0.50	37.0	306	64.0	71.0
16	D_1	50.0*	2.00	13.8	347	62.5	60.7
17	D_2	51.7*	2.25	8.3	343	72.0	61.7
18	D_3	50.0*	2.00	4.1	348	135.0	60.4
19	D_4	50.8*	2.00	11.1	346	37.0	60.9
20	D_5	51.2*	2.00	23.1	348	43.0	60.4
21	E	48.5*	0.60	14.0	350	60.4	60.0
22	F	50.6*	3.25	14.9	307	78.2	71.0

Note: The above alkyds have been arbitrarily prepared so as to obtain different acid and hydroxyl values for the purpose of studying their effect on the properties of metallised products and no correlation between the values of individual samples is expected.

*Thinned with white spirit.

In order to arrive at the optimum reaction conditions, with regard to temperature and time of reaction, experiments were carried out with a 90 per cent oil length alkyd A_2, using theoretical quantity of aluminium butoxide, for varying periods (one, two and three hours) and at different temperatures (100°C, 150°C and 170°C). The metallised alkyd samples were then dried in a vacuum oven at 90-100°C under a vacuum of 150 mm of Hg and analysed for their residual hydroxyl and butoxyl contents, by the standard methods. However, all the methods proved to be unsuitable since the butyl alcohol retained in the " dried " films was found to interfere. Hence it was decided to carry out the metallisation reactions to a pre-gelation stage.

In the actual procedure, the alkyd resin was heated to 150°C and a solution of enolised aluminium alkoxide was added slowly from a separating funnel, fitted to one of the smaller necks of the flask. There was a sharp rise in viscosity, with the addition of alkoxide solution and this was controlled by the addition of white spirit until the solids content of the solution was about 45 per cent. The reaction was continued further under these conditions to the pre-gelation stage. The time of reaction varied with the oil length and the chemical constants. Thus, in case of 70 per cent oil length alkyds, it was found that, while the time of reaction for high hydroxyl alkyds was 3½ hours, high carboxyl alkyds proceeded to the pre-gelation stage, in about an hour. Similarly in the case of 60 per cent oil length alkyds, the time of reaction for resins D_1, D_2 and D_3 was about 3½ hours, but the resins D_4 and D_5 gelled within 15 minutes of the addition of the enolised butoxide solution. The final viscosity in most of the cases had to be adjusted by the addition of stronger polar solvents, such as butanol.

While the attempts to react enolised aluminium alkoxides with preformed commercial alkyds at elevated temperatures failed because of the gelation trouble, cold cut mixtures of these alkyds with enolised aluminium alkoxides showed poor storage stability though they exhibited improved film properties.

Evaluation of Metallised Alkyds

The evaluation of metallised alkyds was performed in both unpigmented and pigmented finishes. Film properties of unpigmented finishes such as drying time, rocker hardness, scratch hardness and water resistance, were determined by standard methods.

From the preliminary studies, it was observed that a 60 per cent oil length alkyd with a low hydroxyl value and a reasonably high acid value as in D_1 gave the best performance. (Properties of the metallised 60 per cent alkyds are given in Table III.) Work was then undertaken to study the influence of alkoxide group by metallising resin D_1 with aluminium isopropoxide and aluminium amyloxide (both enolised by ethyl acetoacetate), using the optimum conditions. The role of keto-enol tautomer was also investigated by metallising the alkyd with aluminium butoxide, enolised by acetyl acetone and diacetone alcohol.

Of the products studied, it was found that linseed glycerol alkyd D_1 gave the best performance, on metallisation, with aluminium isopropoxide enolised by ethyl acetoacetate and hence was studied in pigmented finishes.

TABLE III

TEMPERATURE : 150°C. TIME : 3.5 HOURS METALLISING AGENT : ALUMINIUM BUTOXIDE ENOLISED WITH ETHYL ACETOACETATE

Driers : 0.02% Co, 0.50% Pb } On non-volatile

Alkyd	Metal content theory	Viscosity poises	Percentage non-volatile	Thinners	Drying time			Rocker hardness %	Scratch hardness g.	Water resistance		
					Touch dry	Tack free	Hard dry			Initial blush hr.	Final blush	Blush recovery hr.
D_1	0.25	2.5	47.6	White spirit +butanol	30 min.	1½ hr.	2 hr.	16	2,000	3	Mild	45 min.
	0.50	2.0	40.0	,,	30 min.	1½ hr.	2 hr.	18	2,000	3	Mild	45 min.
	0.75	1.0	40.0	,,	30 min.	1½ hr.	2 hr.	20	>2,000 No scratch	3	Mild	45 min.
	Theoretical*	1.25	44.0	,,	30 min.	1½ hr.	2 hr.	22	,,	3	Mild	45 min.
	Unmetallised	2.0	50.0	White spirit	8 hr.	Overnight		14	2,000	1½	Heavy	4 hr.
D_2	0.25	2.0	48.3	White spirit +butanol	45 min.	1½ hr.	2½ hr.	16	2,000	4	Mild	45 min.
	0.50	2.25	46.0	,,	45 min.	1½ hr.	2½ hr.	14	2,000	4	Mild	45 min.
	0.75	1.65	45.5	,,	45 min.	1½ hr.	2½ hr.	12	2,000	4	Mild	45 min.
	Theoretical*	2.25	46.2	,,	45 min.	1½ hr.	2½ hr.	14	2,000	4	Mild	45 min.
	Unmetallised	2.25	51.7	White spirit	8 hr.	Overnight		8	2,000	1½	Heavy	4½ hr.
D_3	0.25†	2.0	48.5	White spirit +butanol	2 hr.	2½ hr.	4 hr.	6	2,000	3	V. heavy	1½
	0.50†	2.0	48.2	,,	1 hr.	2½ hr.	4 hr.	10	1,300	3	V. heavy	1½
	0.75†	2.0	48.0	,,	1 hr.	2 hr.	3 hr.	10	1,300	3	V. heavy	1½
	Theoretical†	2.25	48.2	,,	30 min.	2 hr.	3 hr.	12	1,100‡	3	V. heavy	1½
	Unmetallised	2.0	50.0	White spirit	8 hr.	Overnight		6	2,000	1	Heavy	Overnight

*Reaction time : 1 hr. †Separation of white scum ‡Brittle

Pigmented finishes

Two types of pigmented finishes, synthetic enamels and primer compositions, were prepared with the following compositions :

White Synthetic Enamel	*Percentage*
Rutile titanium dioxide	25.0
Aluminised alkyd (40 per cent solution)	75.0
	100.0

Red Synthetic Enamel	*Percentage*
Toluidine red	9.0
Aluminised alkyd (40 per cent solution)	91.0
	100.0

Zinc Chromate Primer	*Percentage*
Zinc chromate	25.0
Rutile titanium dioxide	5.0
Zinc oxide	5.0
Indian whiting	7.5
Talc	7.5
Aluminised alkyd (40 per cent solution)	50.0
	100.0

Calcium Plumbate Iron oxide Primer	*Percentage*	
Calcium plumbate	20.0	
Red oxide of iron	10.0	
Indian whiting	7.5	
Talc	7.5	
Aluminised alkyd (40 per cent solution)	40.0	
Non-leafing aluminium pigment	11.0	Separate mixture added after grinding
White spirit	4.0	
	100.0	

Synthetic enamels were prepared by grinding the pigments in a pot mill, till the sample showed a Hegman gauge reading of 7+ while primer compositions were prepared on a laboratory triple roll mill, in about three passes to get a gauge reading of 5-6.

The film properties of the synthetic enamels were evaluated by the same method as used for unpigmented finishes. In addition to drying time, rocker hardness, scratch hardness and water resistance, these films were also tested for their acid and alkali resistance. Flexibility was tested on a conical mandrel tester, while tendency for skinning was observed visually. All the properties were evaluated in comparison with the commercial samples of respective shades. The results of the evaluation of a few unpigmented finishes are shown in Table IV while those of the pigmented ones are given in Table V.

TABLE IV

COMPARATIVE EVALUATION OF DIFFERENT ALKYDS

Metal content : Theoretical

No.	Properties	Commercial 64.8% oil length linseed-penta alkyd	Isopropoxide modified 60.7% oil length linseed-glycerol alkyd	Butoxide modified 60.7% oil length linseed-glycerol alkyd	Amyloxide modified 60.7% oil length linseed-glycerol alkyd	Cold cured commercial 64.8% linseed-penta alkyd-butoxide. Temp. 25°C metal content 0.5 theoretical
1.	Percentage non-volatile matter . .	52.4	42.2	44.0	45.3	52.4
2.	Thinners	White spirit	White spirit +butanol	White spirit +butanol	White spirit +butanol	White spirit +xylene
3.	Viscosity (poises) . .	2.0	1.65	1.25	1.65	1.25
4.	*Drying time*					
	Touch dry hr.	2.5	0.75	0.50	1.0	—
	Tack free hr.	5.4	2.0	1.50	2.0	—
	Hard dry hr. . .	6.0	2.5	2.0	2.5	1.5
5.	Rocker hardness %	24	24	22	18	36
6.	Scratch hardness (g)	1,300	2,000	2,000	2,000	1,400
7.	*Water resistance*					
	Initial blush hr.	5	7.5	3.0	5	8
	Final blush	mild	very faint	mild	faint	mild
	Blush recovery hr.	2.5	0.50	0.75	0.50	2

TABLE V

PERFORMANCE OF SYNTHETIC ENAMELS BASED ON METALLISED ALKYDS

No.	Property	White		Post office red	
		Metallised alkyd based	Commercial	Metallised alkyd based	Commercial
1.	Grind	7+	7+	7+	7+
2.	Viscosity (Ford Cup 4) seconds	65	68	70	67
3.	Driers based on NVM ..	0.02% Co 0.50% Pb	—	0.02% Co 0.50% Pb	—
4.	*Drying time* Touch dry hr. .. .. Tack free hr. .. .. Hard dry hr.	 0.75 1.50 2.0	 1.0 2.5 4.0	 0.75 1.50 2.0	 1.0 2.5 4.0
5.	Rocker hardness (%) ..	22	20	28	24
6.	Scratch hardness (g.) ..	1,800	1,600	1,800	1,700
7.	Water resistance	Good	Fair	Good	Good
8.	Acid resistance	Good	Good	Good	Good
9.	Alkali resistance	Poor	Very poor	Poor	Poor
10.	Flexibility	Passes	Passes	Passes	Passes
11.	Skinning	Thick tough skin	Thick skin	Thick tough skin	Thick skin

Primer compositions were evaluated for their performance on metal substrates against the standard compositions obtained from industry. Zinc chromate primer was studied on aluminium metal while calcium plumbate-iron oxide primer was studied on both galvanized tin and mild steel panels. Mild steel panels were phosphatised before use.

Exterior Durability

Exterior durability of the synthetic enamels and primer films was determined according to ISS—520/1954. The panels were exposed for a period of two months at an angle of 45° to the vertical, facing south ; the panels were found to be free from cracking, chalking, etc. The decrease in gloss could not be judged properly, as the films tended to bloom from the beginning.

DISCUSSION

Among the alkyd resins studied in the present investigations, those with 60 per cent oil length have given perhaps the best results on metallisation. Of the three resins studied in this oil length, D_1, D_2 and D_3, the resin D_1 with a sufficiently high hydroxyl value (but less than the other two) and a fairly high acid value (higher than the other two) has given optimum performance, which could be compared with a pentaerythritol alkyd of similar oil length in properties such as rocker hardness and water resistance, while the drying time is much faster, even with a lower cobalt drier concentration. The scratch hardness is also considerably higher than that of a penta-alkyd. Resin D_3 has not given the expected results, though it can accommodate more aluminium, with its high hydroxyl value. This again may be due to the retention of hydroxyl groups, as it is in the case of resins A_3, B_3 and C_3. Resins D_4 and D_5 by virtue of their high acid value, combined with a fairly complex structure of a 60 per cent oil length resin, could not be metallised under the conditions tried.

Of the three alkoxides of aluminium studied, aluminium isopropoxide gave the best results, followed by the butoxide and amyloxide. The drying time, hardness and water resistance were superior in the case of the former, which is probably due to its higher reactivity, resulting in a better end product. The faster drying could be also due to a faster rate of evaporation of isopropyl alcohol.

Two oils, other than linseed, studied for alkyd modification were dehydrated castor oil (DCO) and safflower oil. Since it was difficult to prepare a 60 per cent oil length DCO alkyd because of the risk of gelation, a 70 per cent oil length resin was prepared. This also had a complex structure (as seen by a fairly high viscosity in a 50 per cent solution) and it was not possible to metallise it as the product gelled within a short period of addition of enolised butoxide solution. In the case of a 60 per cent oil length safflower alkyd, it was possible to get an aluminised product, comparable to a safflower-penta alkyd of an equivalent oil length.

Determination of acid values of a few metallised alkyds shows that they have very low acid values. As such they should be very useful in certain types of pigmented finishes, such as those for galvanised surfaces. It is an observed fact that galvanised surfaces pose a serious problem to paint formulators because of the poor adhesion of the coating compositions, since the acidity of the vehicle used forms zinc soaps at the surface. A metallised alkyd resin was tried for this purpose, pigmented with calcium plumbate and red iron oxide and it was found that the adhesion of the film was good, even after subjecting the painted panels to salt-spray and corrosion resistance tests.

Aluminised alkyds could also be used in primer compositions for aluminium metal and should prove superior in adhesion, etc. as compared with other vehicles because of the presence of aluminium in the former. Results of the evaluation of the performance of zinc chromate primer, based on aluminised alkyd on aluminium surface were very encouraging.

The presence of unreacted alkoxyl groups in the film former should further improve the corrosion resistance of the primer films, because the alkoxyl groups are highly reactive towards groups containing active hydrogen and can take up the fatty acids formed during degradation of the film-forming constituent. The work of Chatfield[7] with epoxidised oils also stresses a similar point, wherein he expects the unreacted epoxy groups to react with the acids and improve the corrosion resistance. In this connection it may be pointed out that, though optimum results could be obtained with 50 to 70 per cent of the theoretical metal content, it is advisable to add the theoretical quantity, as this slight excess will probably be advantageous from the point of view of corrosion resistance.

Evaluation of aluminised alkyds in synthetic enamels has shown that, while in such properties as hardness, water, acid and alkali resistance, they have given superior performance to the commercial samples, the films had considerable bloom. Blooming is a property generally exhibited by vehicles of the spar varnish type, which possess a high degree of water resistance, since they do not accept even the moisture present in the atmosphere, during film formation. This is also observed in pentaerythritol alkyds pigmented with zinc oxide which exhibit superior water resistance, due to the formation of zinc soaps.

The present work has shown that the performance of metallised glycerol alkyds is superior to conventional glycerol alkyds and is comparable to that of pentaerythritol alkyds of comparable oil length. While one cannot overlook the fact that considerable amount of work would be required to standardise the conditions for the manufacture of these metallised alkyds on a commercial scale, the results obtained are very promising and should promote a more detailed investigation. The particular advantages of aluminium incorporated alkyds lie in their faster and better through drying. Also, the lower concentration of cobalt drier required results in improved exterior durability.

So far as the economics of the process is concerned, though the initial cost of the equipment is likely to be higher, it could be balanced by the subsequent advantages of improved performance. It is evident, from the results obtained that the pentaerythritol-based alkyds could also be modified in a similar manner to produce products useful for typical end uses and work is in progress in this direction.

ห้องสมุด กรมวิทยาศาสตร์

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PAPERS ACCEPTED FOR PUBLICATION

The Honorary Editor has approved the following papers for publication in future issues of the *Journal* :

Variations on Urethane Oils : *A. C. Jolly.*

The Natural and Accelerated Weathering of Zinc Dust Primers : *D. S. Newton* and *B. M. Guest.*

Crosslinks Between Plastics, Paint and Textile Polymers : *L. Valentine.*

Interior Gloss Retention of White Enamels : *D. S. Newton.*

Metallic Lead Pigment for Anticorrosive Protection : *G. L. E. Wild.*

The Laboratory Evaluation of the Behaviour of Coloured Pigments on Ball-Milling : *H. G. Cook.*

The Progress of Water Soluble Resins in Industrial Finishes : *L. Tasker* and *J. R. Taylor.*

The Colour System in the Methuen Handbook of Colour : *A. Kornerup.*

Mould Resistance Decorative Paints for the Tropics : *P. Whiteley.*

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The Corrosion of Uranium and its Prevention by Organic Coatings : *S. Orman* and *P. Walker.*

Measurement of Viscosity at High Rates of Shear ; a Cone and Plate Attachment for the Roto-Thinner : *C. J. H. Monk.*

A Visual Method of Gloss Estimation

By F. Goodier

Research Division, Pinchin, Johnson and Associates Limited, Minerva Works, Silvertown, E.16

INTRODUCTION

On a large exposure station with between 4,000 and 5,000 coatings undergoing test and covering some acres of land, the regular estimation of gloss presents a problem.

In the absence of an electrical supply it is difficult to measure the gloss on site by photoelectric means and equally cumbersome to transfer the panels to some central point each time a gloss measurement is required.

The instrument described below and illustrated in Figs. 1 and 2 was developed as a rapid, portable means for regularly estimating the gloss of paint films on exposure. The results can be recorded and the information disseminated widely.

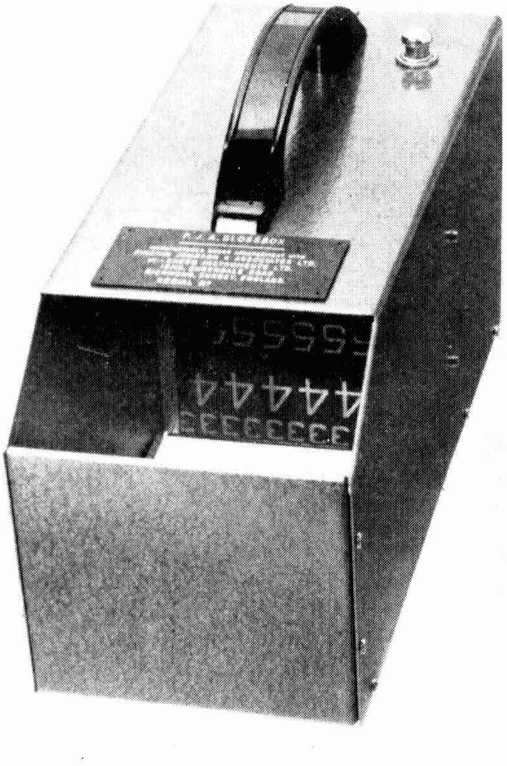


FIG. 1. THE PJA GLOSS BOX
(Reproduced by permission of Sheen Instruments Ltd.)

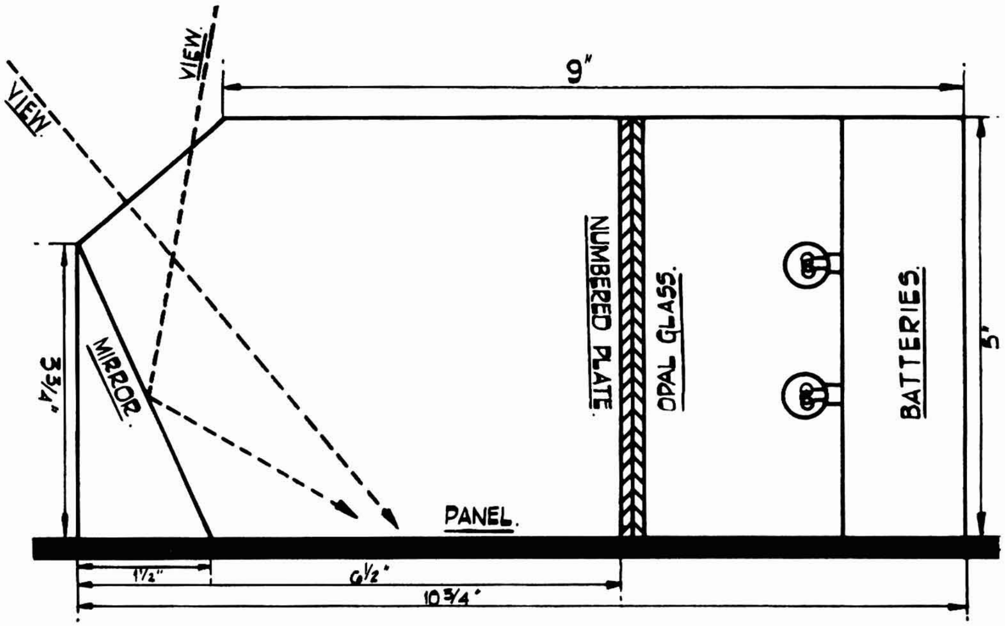


FIG. 2. A SECTIONAL REPRESENTATION OF THE GLOSS BOX

The readings cover ten approximately equal steps, ranging from matt (Gloss 1) to full gloss (Gloss 10).

The instrument was developed for use in the PJA organisation. It has since become more widely used and is now being manufactured commercially. It has been adopted as a standard test method by the Society of Motor Manufacturers and Traders and, in common with all SMMT standards, has been submitted to the British Standards Institute for adoption as a British Standard in the new Automobile Series.

APPARATUS

The instrument consists essentially of a vertical glass plate, illuminated from behind, on which are printed horizontal rows of characters. The characters are identical in each row, but vary from row to row in size, identity and distance from the lower edge of the plate. The plate is prepared photographically and is printed so that the numbers are transparent on a black background.

This plate is illuminated by two 3.5 v bulbs in parallel, powered by a 4.5 v battery. An opal glass diffusing screen is placed between the light source and the numbered plate. The intensity of illumination is not critical within working limits.

FIG. 3. THE NUMBERED PLATE

Method of Use

The instrument is placed on the surface of the panel and the reflected image is observed. This may be done either directly or in a mirror incorporated in the instrument. The mirror is useful if the panels are in an awkward position for direct viewing. Gloss is recorded as :

10 when the 0's are clearly distinguishable
9 when the 0's are distinguishable but only with difficulty
8 when the 8's are clearly distinguishable
7 when the S's are clearly distinguishable
6 when the 6's are clearly distinguishable
5 when the 5's are clearly distinguishable
4 when the 4's are clearly distinguishable
3 when the 3's are clearly distinguishable
2 when only the lower halves of the 3's can be distinguished
1 when there is no reflected image

The letter S is used in preference to the figure 7. A figure seven is, because of its simple, angular shape, too easily distinguished when viewed between 6 and 8.

Examples of various degrees of gloss are shown in Figs. 4, 5 and 6.

FIG. 4. GLOSS 10 FIG. 5. GLOSS 6 FIG. 6. GLOSS 2

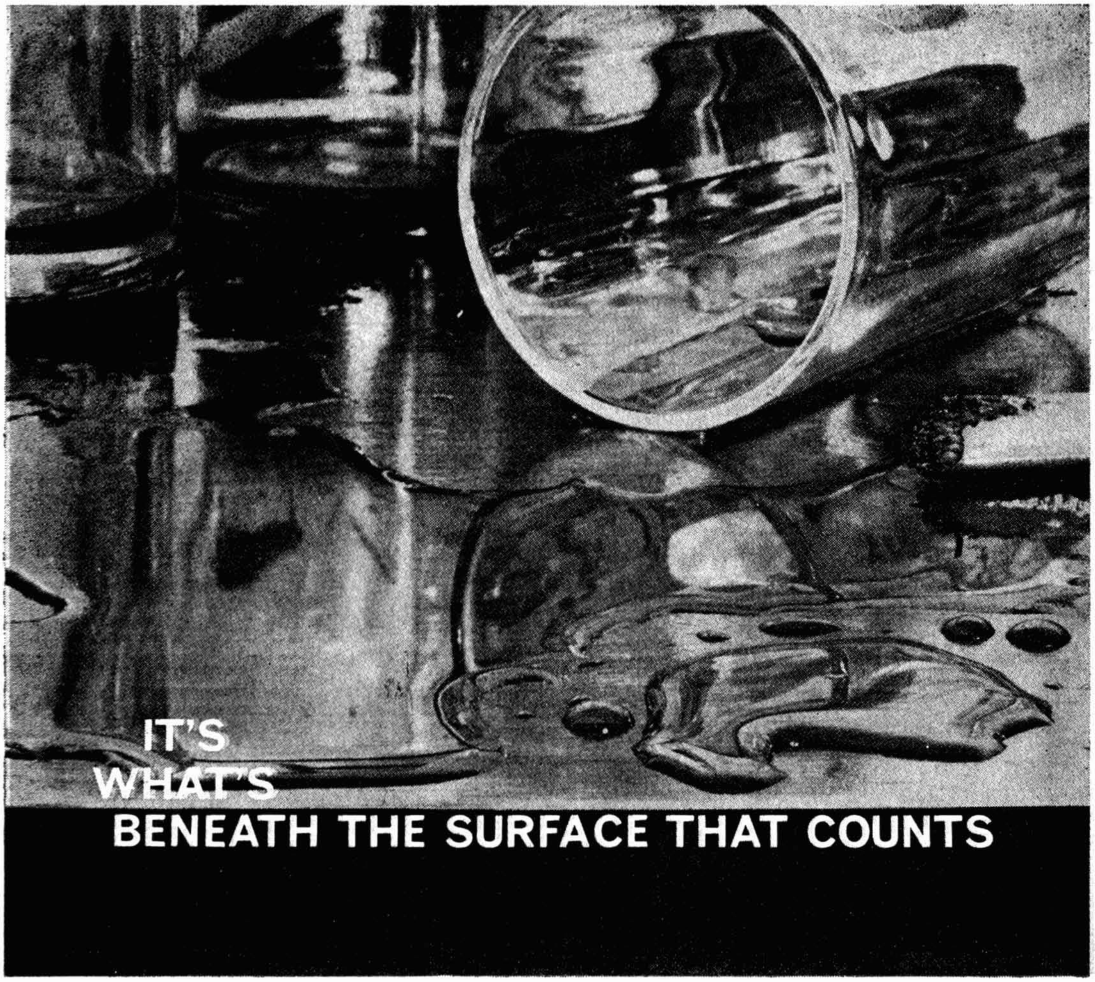
READINGS OF VARIOUS DEPTHS OF GLOSS

This instrument is in no way intended to be a substitute for the photoelectric glossmeter. It does, however, provide a robust, reproducible means of measuring, recording and reporting gloss variations when other means are not convenient.

ACKNOWLEDGMENTS

The author wishes to thank Mr. E. A. Gardner for the photographic work involved, and *Pinchin, Johnson and Associates Limited* for permission to publish this paper.

[*Received* 13 *May* 1964



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Phenylmercury Compounds as Fungicides: Part III*

By E. Hoffmann and B. Bursztyn

Division of Building Research, Commonwealth Scientific and Industrial Research Organisation, Melbourne, Australia

Summary

Paints of varying compositions and each containing a mercury fungicide are exposed outdoors and indoors under various conditions, and are analysed for their mercury content. Differences in the rate of disappearance of mercury from paint films of different formulations is unimportant. The greatest loss of mercury is found in paint films exposed at high humidities.

Composes au Phenylmercure Utilises Comme Fongicides : Chapitre III

Résumé

Des peintures de compositions diverses et chacune contenant un fongicide au mercure, sont exposées tant à l'air libre qu'en local fermé, sous différentes conditions, pour être analysées quant à leur teneur en mercure. Les différences caractérisant le taux de disparition du mercure que renferment des pellicules de peintures de formules distinctes, sont insignifiantes. La perte de mercure la plus élevée s'avère affecter les pellicules de peintures ayant été exposées à de fortes humidités.

Pilztötende Phenylquecksilber-Verbindungen: Teil 3

Zusammenfassung

Es wird das Bewetterungsverhalten verschiedener Lacke mit einer pilztötenden Quecksilberverbindung im Freien und in Innenräumen untersucht ; die Lacke werden auf ihren Quecksilbergehalt hin analysiert. Der unterschiedliche Verflüchtigungsgrad des in den Lackfilmen enthaltenen Quecksilbers ist unbedeutend. Am meisten verflüchtigt sich das Quecksilber in Lackfilmen, die starker Feuchtigkeit ausgesetzt sind.

INTRODUCTION

In an earlier paper[1] the authors reported on the loss of phenylmercury succinate (PMS) from a gloss paint film on outdoor exposure, and on the possible mechanism of this decomposition. Two further points seemed to be worthy of further investigation :

(*i*) The relation between the stability of the PMS and the formulation of the paint, and (*ii*) the amount of PMS lost from a paint film exposed indoors under various conditions.

EXPERIMENTAL

Paints containing PMS were brushed out on sheets of a polyethylene terephthalate polyester film, and then exposed under the desired conditions.

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*Portion of a paper read at the Fifth Australian Convention of OCCA at Broadbeach, Queensland, 13-16 June 1963.

The paint films were analysed for their mercury content at intervals of a few months, using the analytical technique described earlier[1]. Results for specimens exposed simultaneously at Highett, Victoria, on outdoor racks facing north at 45° are given in Table I. The last column gives the average rate of decomposition per month, which is a useful indication of the stability of PMS in the paint.

The figures in the table show that PMS disappears from the paint film very quickly, and it appears that the composition of the paint does not make a practical difference to this.

Table II gives the results of exposures of paint film in a fog room at 20°C, a condition which is highly favourable for the growth of mould.

The loss of mercury from a paint film at high humidities is very fast, and this could be due to decomposition of the PMS to mercury or mercury oxides which are much more volatile than the original compound. Zimmerman and Crocker[2] have shown that this is possible and have proved the formation of mercury from organic compounds buried in wet soil. Further support is given by the work of Dimond and Stoddard[3], who investigated damage to roses in greenhouses by paints containing a phenylmercury fungicide. They found that the damage was caused by mercury vapour and not by the vapour of the fungicide.

The loss of a fungicide is high even under mild conditions. The mercury content of paint film kept at constant temperature (20°C) and relative humidity (65 per cent) is recorded in Table III. Fluorescent lighting was used in this room for eight hours a day.

Paint films were also exposed in houses in which conditions were known to be conducive to mould growth, and the results are shown in Table IV.

The analyses show that there was a big loss of mercury in the first 11 months and from then the mercury content of the paint film appeared to be relatively constant. The slight increase in mercury content found in some samples may be due to unequal distribution of the mercury compound through the paint films.

The behaviour is due to the formation of sparingly volatile mercuric sulphide by reaction between the mercury compound and the hydrogen sulphide contained in the atmosphere. The presence of sulphide was shown by the azide test. The fact that the sulphide was combined with mercury and not with some other heavy metal in the paint was shown by exposing a film of a similar paint free of mercury under the same conditions ; only the merest traces of a sulphide were found. One of the authors[4] has shown that there is sufficient hydrogen sulphide in a dwelling to form lead sulphide, and mercuric sulphide, which is much less soluble, could be formed more readily.

Dimond and Stoddard[3] have shown that the volatility at room temperature of mercuric sulphide contained in a paint film is too low to be detected with the present methods of analysis. They measured the quantity of mercury given off by a paint which contained PMS, and found that the release of mercury could be stopped by applying a coat of a lime-sulphur paste.

TABLE I

MERCURY IN PAINT FILMS OF DIFFERENT COMPOSITIONS, AFTER EXPOSURE OUTDOORS

Type of paint	Mercury in 100 mg paint film before exposure (μg)*	Mercury in 100 mg paint film after exposure (μg)									Average rate of decomposition per month over whole period (%)
		3 months	4 months	6 months	7 months	8 months	9 months	10 months	11 months	15 months	
a Flat enamel†	49			41					22	15	4.6
	193			120						55	4.8
	324			252						111	4.4
b Semi-gloss enamel† ..	60			51					27	24	4.0
	195			157					112		3.9
	370			316					240	162	3.8
c Gloss enamel† ..	502		356					188		144	4.7
d Gloss enamel† ..	480		365		240				153		6.2
e Gloss enamel† with ultra-violet absorber	480		316		152				117		6.9
f Varnish	412									214	3.2
g Alkyd piant pigmented with ZnO	340			79			49		27		8.3
h Alkyd paint pigmented with r-TiO_2	323			135			64		43		7.9
i Mixture of *g* and *h*	332			127			96		51		7.7
k Linseed oil paint pigmented with ZnO ..	249		82	60							12.6
l Alkyd paint pigmented with iron oxide ..	302	141				66					9.8
m Alkyd paint pigmented with r-TiO_2	460	191				144					8.6
n Alkyd paint pigmented with a-TiO_2	450	114				105					9.6
o Flat enamel†	431	111		52							14.6
p Flat enamel with water-repellent surface ..	451	107		41							15.1
q Gloss enamel† ..	455	201		93							13.2
r Gloss enamel† with water-repellent surface	424	228		155							10.6

*100 μg mercury per 100 mg paint film is equivalent to 0.1 per cent.

†paints pigmented with r-TiO_2

TABLE II

MERCURY IN PAINT FILMS OF DIFFERENT COMPOSITIONS, AFTER EXPOSURE IN FOG ROOM

Type of paint	Mercury in 100 mg paint film before exposure (μg)	Mercury in 100 mg paint film after exposure (μg)							Average rate of decomposition per month over whole period (%)
		2 months	3 months	4 months	5 months	7 months	8 months	11 months	
a Flat enamel	324				61		38		11.0
*a_1** Flat enamel	356				104		54	28	8.4
*a_2** Flat enamel	360	196			28		20		11.8
f Varnish	412		248				214		6.0
g Alkyd paint pigmented with ZnO	340					34			12.9
h Alkyd paint pigmented with r-TiO_2	323					44			12.3
i Mixtures of *g* and *h*	332					32			12.9
k Linseed oil paint pigmented with ZnO	249			56			42		10.4
l Alkyd paint pigmented with iron oxide	302		40			33			12.7
m Alkyd paint pigmented with r-TiO_2	460			258			215		6.7
n Alkyd paint pigmented with a-TiO_2	450			261			194		7.1
o Flat enamel	431		75						27.6
p Flat enamel ; water-repellent surface	451		209				88		10.0
q Gloss enamel	455		313				233		6.1
r Gloss enamel ; water-repellent surface	424		345			213			7.1

* Commercial product

TABLE III

MERCURY IN PAINT FILMS KEPT AT 20°C AND 65 PER CENT RELATIVE HUMIDITY

Type of paint	Mercury in 100 mg paint film before exposure (μg)	Mercury in 100 mg paint film after exposure (μg)					Average rate of decomposition per month over whole period (%)
		3 months	4 months	5 months	6 months	8 months	
f Varnish	412	311				275	4.2
k Linseed oil paint pigmented with ZnO	249					158	4.6
l Alkyd paint pigmented with iron oxide	302	208				115	7.7
m Alkyd paint pigmented with r-TiO$_2$	460		296			252	5.7
n Alkyd paint pigmented with a-TiO$_2$	450		334			230	6.1
o Flat enamel	431	298			278		5.9
q Gloss enamel	455	299			232		8.2

TABLE IV

MERCURY IN PAINT FILMS IN DWELLINGS IN WHICH MOULD GROWTH OCCURRED

House	Paint	Mercury in 100 mg paint film (μg)			Average rate of decomposition per month over whole period (%)
		Before exposure	After 11 months	After 15 months	
1	Flat enamel	67	35	32	3.5
		115	46	40	4.3
		263	146	146	2.8
	Gloss enamel	142	80	58	3.9
		243	177	103	3.8
2	Flat enamel	67	40	42	2.5
		115	46	59	3.2
		253	150	167	2.3
	Gloss enamel	142	79	75	3.1
		243	149	167	2.1
3	Flat enamel	67	35	36	3.1
		115	86	97	1.0
		253	176	177	2.0

DISCUSSION AND CONCLUSIONS

The data presented here show that PMS is lost fairly quickly from paint films exposed outdoors or under various conditions indoors. This suggests that it would be hopeless to find a paint composition from which the loss of fungicide would be slow enough to ensure that fungicidal properties would be retained for even two years. This statement assumes loss of fungicide of 3.2 per cent per month (the lowest found) from an initial mercury concentration in the paint film of 0.4 per cent, and no appreciable fungicidal activity below 0.1 per cent mercury.

Experiments have, so far, been carried out only with phenylmercury dodecenyl succinate, but trials with other phenylmercury compounds will be made to see if they will function more favourably. However, data published by O'Neill[5] do not give much hope of finding a phenylmercury compound which has a low rate of disappearance from a paint film. Five compounds were studied and the losses were found to exceed 50 per cent in three months.

The low assessment of permanent fungicidal properties imparted to a paint by phenylmercury compounds is confirmed by Whiteley's work[6, 7]. In the first paper he estimated that the compounds were effective for 18 months, but in the second paper this estimate was reduced to 12 months. Similar results were also recorded by Australian workers[8], who found that specimens exposed in New Guinea lost fungicidal properties in seven months.

Dimond and Stoddard[3] also studied the effect of paint components on the decomposition of PMS by measuring the amount of mercury lost. They found, for instance, that the decomposition of PMS by an enamel grinding oil is increased tenfold as compared with mineral spirits. Probably a number of other variables, as, for example, fineness of grind and pigment origin, will have an effect on the rate of decomposition, and it is therefore not surprising that the rate of disappearance of PMS from paint films varies widely.

It is pertinent to speculate on the mechanism of decomposition into mercury. At first the authors thought that the decomposition could have been by bacteria, especially under humid conditions, but as fungicide is also lost under circumstances which are not conducive to bacterial growth, the explanation is not a likely one. It is most likely that phenylmercury compounds are thermodynamically unstable and can decompose spontaneously, the various ingredients of a paint acting as catalysts. The large surface areas of pigments exposed in a paint film could also play a role in this catalysing action.

Unfortunately not enough data are available to evaluate, for example, the equilibrium constant of such a simple reaction as

$$2C_6H_5HgCl \rightarrow (C_6H_5)_2 + 2Hg + Cl_2$$

but the above speculation seems to fit the observed facts best.

The instability of PMS in a paint film appears to be the reason for the limited protection it confers against fungus attack.

ACKNOWLEDGMENT

The co-operation of Smith and Walton (Australia) Pty. Ltd. in preparing the paints used in this investigation and the financial support of the Victorian Housing Commission are gratefully acknowledged.

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Modern Aqueous Organic Pigment Dispersions

By P. BIRRELL

James Anderson & Co. (Colours) Ltd., Hawkhead Road, Paisley, Renfrewshire

Summary

A survey is made of the most important aspects in the selection of the constituents of aqueous organic pigment dispersions. This mainly concerns the selection of the pigment itself, of the type and amount of surface-active agents to be used and the various dispersion mills which are available for preparing the dispersion. A survey of the fields of application for these pastes is also included.

Les Dispersions de Colorants Organiques Aqueux à l'heure actuelle

Résumé

Il s'agit d'une étude touchant aux aspects les plus importants couvrant le choix des composants propres aux dispersions de colorants organiques aqueux. Ceci s'applique essentiellement au choix du colorant lui-même, du type et de la quantité d'agents actifs de surface devant être utilisés et aux divers broyeurs-malaxeurs existant pour la préparation de la dispersion. Cette étude comprend également un exposé détaillé des champs d'application propres à ces pâtes.

Moderne Organische Pigmentdispersionen in wässriger Lösung

Zusammenfassung

Es werden die wichtigsten Aspekte bei der Auswahl von Bestandteilen einer wässrigen organischen Pigmentdispersion untersucht. Es geht dabei hauptsächlich um die Wahl des Farbkörpers selbst, um die Art und Menge der zu verwendenden oberflächenaktiven Stoffe, sowie die für die Herstellung solcher Dispersionen zur Verfügung stehenden Vorrichtungen. Ausserdem wird ein Überblick über die praktischen Anwendungsmöglichkeiten gegeben.

INTRODUCTION

In the last fifteen years the pigment-using industries, particularly those working on aqueous media, have become more and more accustomed to the use of pigments in predispersed form, i.e. pigment preparations that have been " tailor-made " for a given application or for a number of applications. These preparations can be used with the expenditure of the minimum amount of effort on the part of the consumer since in most cases the pigment preparation can be incorporated into the system by simple agitation. This paper covers the formulation and the preparation of these special dispersions.

Pigment dispersion occurs when mechanical and physico-chemical forces are used to reduce the size of pigmentary aggregates and to distribute the resulting pigmentary particles evenly and permanently throughout the system. For these so-called " tailor-made " dispersions to be effective they must preserve this uniformity and permanency of distribution when mixed with the minimum of agitation into the appropriate medium or media.

In this field, as in others, the pigment manufacturer aims at the preparation of the crude pigment with an inherently fine particle size which can be flocculated readily to facilitate filtration and which can be redispersed without difficulty after isolation and possibly drying. Two points must be stressed however. (*a*) The work applied by the pigment manufacturer or user to disperse the pigment results at the best only in his achieving the original particle size distribution of the pigment. The main improvement, provided the correct formulation is adopted, will be that the dispersion will be more homogeneous and stable. (*b*) In addition to possessing a fine particle size a pigment dispersion must be completely compatible with the system in which it will be used. This dual function of the pigment dispersion is often overlooked although apparently obvious.

As an example of the particle size distribution of a typical pigment dispersion for viscose application, the curve for *Dianisidine Blue* can be taken. In this the percentage of particles of a given range of diameters is plotted against the mean diameter of particles in microns. Fig 1.

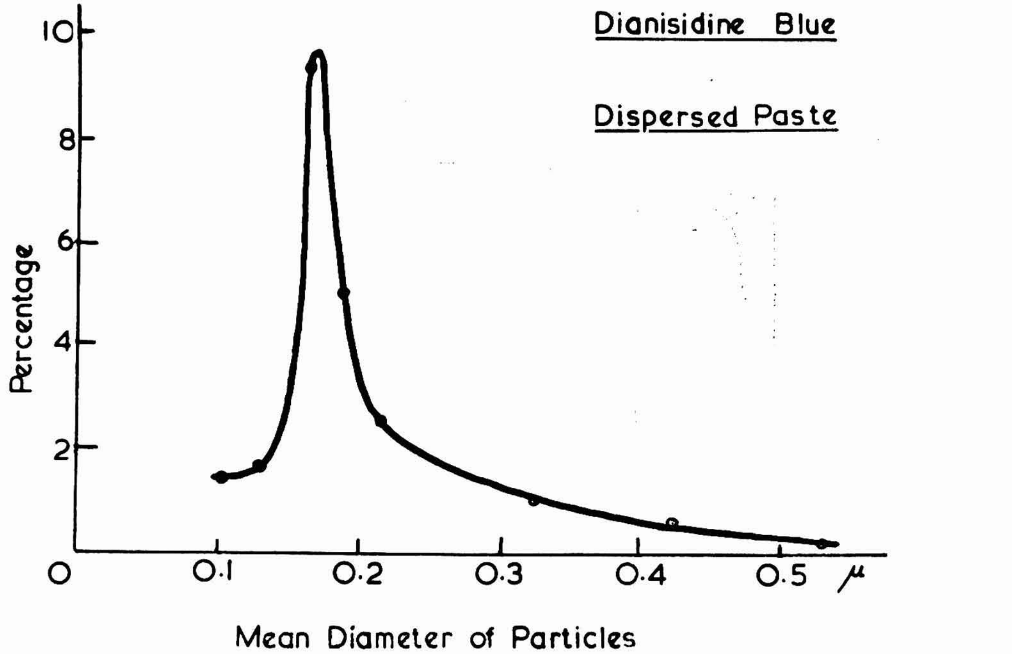


FIG. 1.

It will be noted that the majority of the particles are in the 0.1 to 0.2μ region, i.e. below the limit of resolution of the optical microscope.

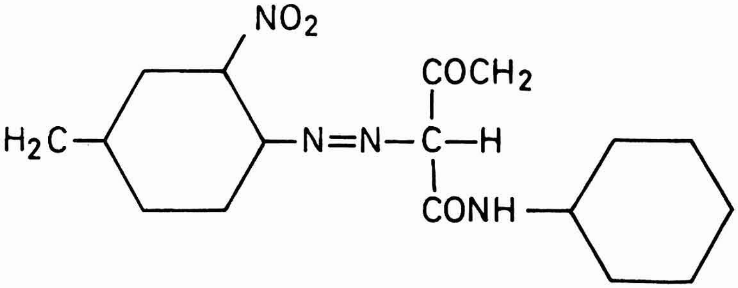
SELECTION OF PIGMENT

The most important factor which influences the selection of pigment is the range of applications for which the pigment is required as pigments vary considerably in their chemical constitution and their stability to different media varies accordingly.

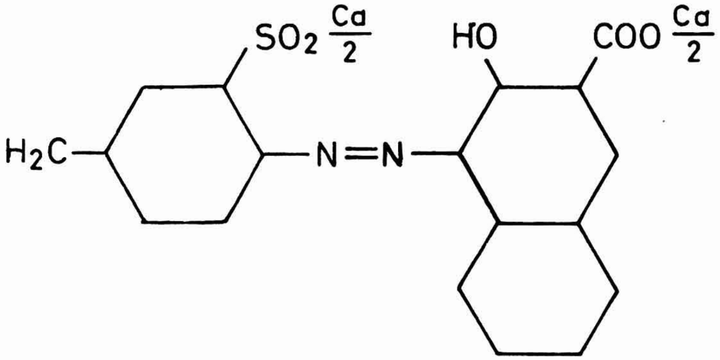
For example, for the mass dyeing of viscose the ideal azo pigment should be free of nitro groups as these may be reduced during the spinning process with subsequent deterioration in colouristic and fastness properties. In addition, it should possess good fastness to light, dry cleaning solvents, bleach, perspiration, acid and alkali. The latter two requirements alone exclude the use of most metal complex pigments and all metal toners for use in this application.

The following examples of the various types of organic pigments available to the consuming industries are given to illustrate the effect of their chemical constitution on their suitability for various aqueous media and are not intended as a survey of the complete range of organic pigments.

Such surveys have been carried out and offer excellent assessments of the various types of pigments which are available at present[1, 2, 3, 4].



ARYLAMIDE YELLOW G



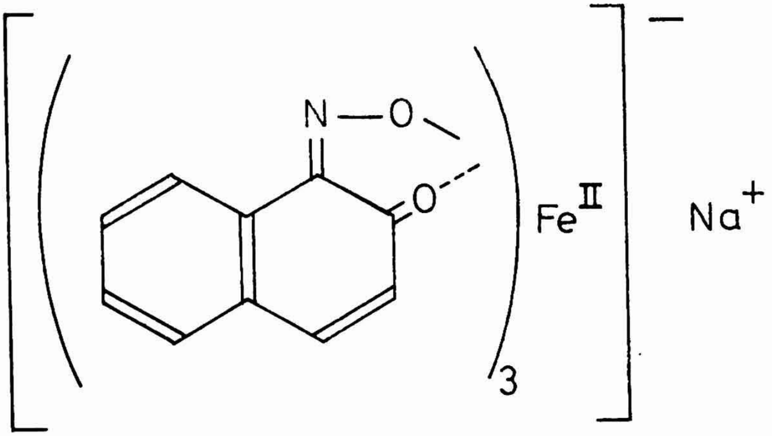
RED 4B TONER

FIG. 2. (*Top*) FIG. 3. (*Bottom*)

Arylamide Yellow G (Fig. 2) is an example of one of the simpler pure azo pigments, i.e. it is free of polar water-solubilising groups and is therefore non-bleeding in aqueous systems. Because of its low molecular weight and the absence of polar groups its fastness to solvents is only moderately good.

Arylamide Yellow G is however used extensively for paper-coating, paper-dyeing, pva paints and other aqueous applications in which its solvent and light fastness properties are wholly adequate.

The 4*B Toner* illustrated in Fig. 3 is the calcium salt of an azo dyestuff which is slightly soluble as the sodium salt. Toners are therefore excluded from viscose application due to the highly alkaline nature of the viscose dope and from pva paints where contact with freshly plastered alkaline walls could cause the heavy metal salt to revert to the yellower water soluble salt. They are however suitable for aqueous paper-coating and paper-dyeing applications.

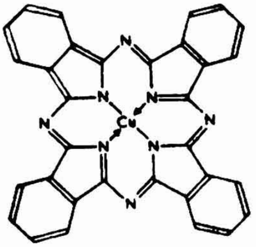


PIGMENT GREEN B

FIG. 4.

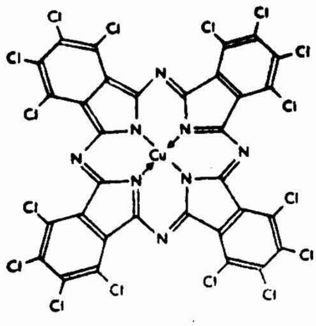
This is a metal complex pigment in which the degree of metal co-ordination is not strong enough to withstand the attack of acid. *Pigment Green B* is therefore excluded from use in the mass dyeing of viscose due to the acid nature of the spinning bath but it is a very popular pigment in other aqueous systems, e.g. paper-dyeing, paper-coating and pva paints.

Phthalocyanine Pigments



PHTHALOCYANINE BLUE

FIG. 5.

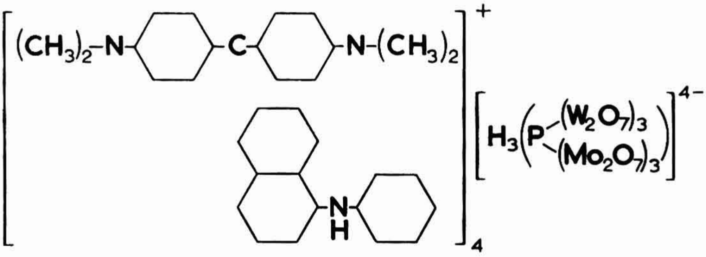


PHTHALOCYANINE GREEN

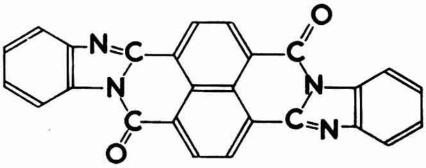
FIG. 6.

In contrast to the previous type of metal complex pigment, the phthalocyanines are extremely stable and can withstand the most severe acid conditions.

Light and solvent properties are excellent and the two problems associated with phthalocyanine blue, i.e. pigment crystallisation and flocculation, have been investigated thoroughly and sufficient progress made to eliminate these defects and make this group of pigments almost perfect. They are ideally suited for all aqueous applications.



VICTORIA BLUE LAKE



BRILLIANT ORANGE GR.

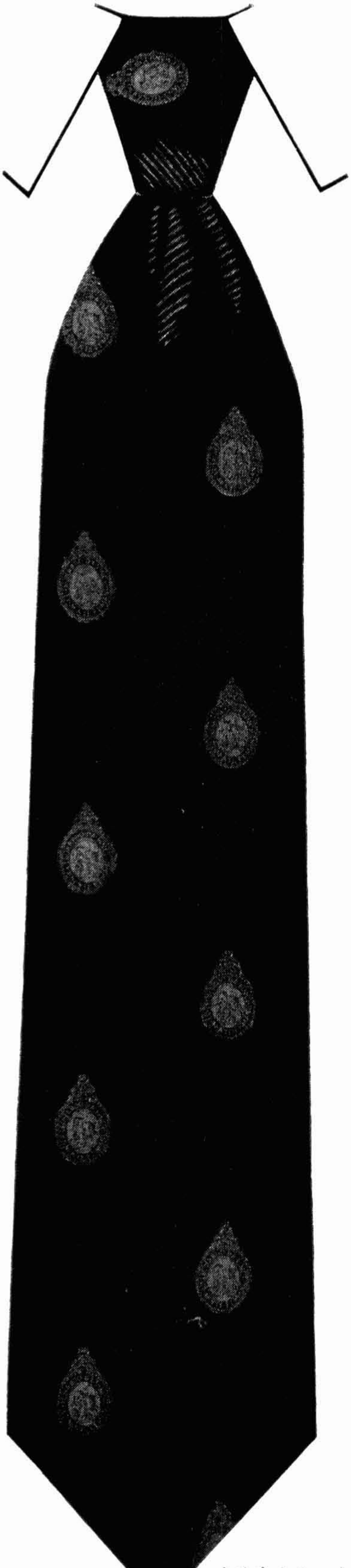
FIG. 7. *(Top)* FIG. 8. *(Bottom)*

This lake is representative of the basic dyestuff/complex acid pigments which offer vivid, high strength pigments in shades which are not easily obtainable by other means. As with metal toners they are suitable for paper-coating and paper-dyeing but not for viscose application or for pva paints.

Brilliant Orange GR is one of the limited number of vat dyestuffs which can be used as pigments. They tend to be expensive, not too bright and difficult to disperse. They are used in a number of aqueous applications where good fastness properties particularly at low concentration are required.

This colour belongs to a group of pigments in which the complexity, symmetry and lack of labile groups in the molecule ensure good solvent and light fastness. It is also expensive and can be classified with vat pigments in its applications.

Representing one of the most recent types of pigments to be offered to the pigment-using industries this pigment also depends for its excellent fastness properties on its symmetry and chemical constitution. The high cost of this type of product also limits its use to applications where cost is of secondary importance or where high fastness properties at low concentration are essential.



Artist's impression

O.C.C.A. TIE

The Council has authorised the production of an exclusive Tie for Members of the Oil & Colour Chemists' Association and it is expected that the ties will be available early in November. The Association's insignia will be woven in red and gold silk on a dark blue terylene background.

The tie will be sold only to Members of the Association for **20s.** (sterling) post free. **If** Members resident outside the continent of Europe wish the tie to be sent by airmail **5s.** (sterling) should be added to cover postage and insurance. The tie will be available only from :

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and orders should be sent as soon as possible since it is expected that there will be a heavy initial demand.

November, 1964

To : Thresher and Glenny Ltd.,
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As a Member of the Association please accept, in advance, my order for an O.C.C.A. Tie. Remittance to the value of **20s.** (sterling) (if required to be sent by **airmail** to addresses outside Europe, please add **5s.** (sterling) to cover postage and insurance) is enclosed.

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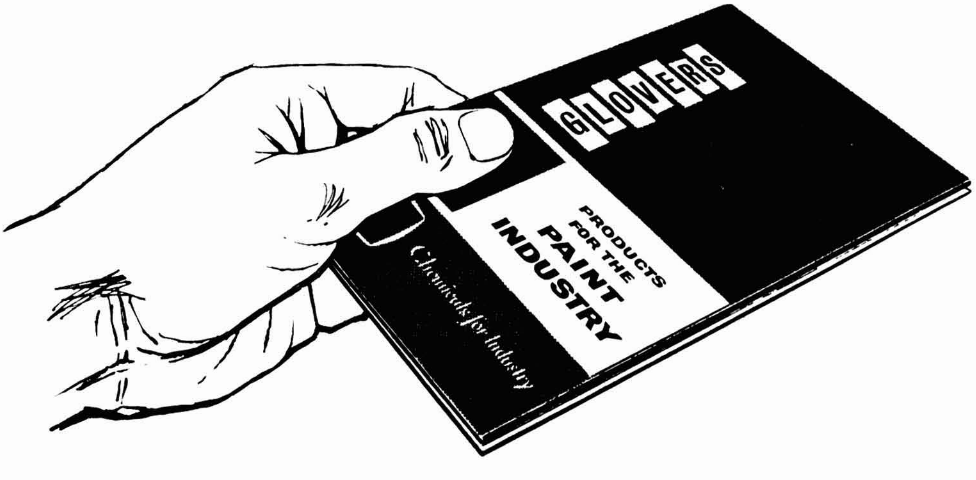
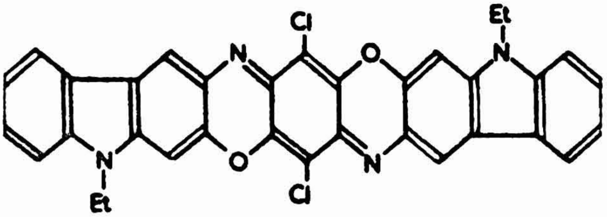
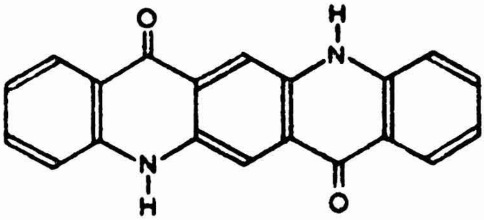




DIOXAZINE VIOLET



QUINACRIDONE RED

FIG. 9. (*Top*) FIG. 10. (*Bottom*)

SELECTION OF SURFACE-ACTIVE AGENT

Having considered the preparation and selection of an organic pigment for a particular application, the means, both mechanical and physico-chemical, must be considered whereby the crude pigment can be dispersed. Forces of shear and impact may be employed but these forces must be used in conjunction with a suitable chemical compound, i.e. a surface-active agent.

The function of the surface-active agent at this stage is not only to assist in the breaking down of the pigmentary aggregates but primarily to maintain the dispersion of the particles once produced, i.e. the particles in the aggregates are forced apart by mechanical and physico-chemical means and maintained in a dispersed form by the latter. The surface-active agents operate to this end by coating the fine particles with an ionic or solvated sheath which promotes mutual repulsion of the particles and hence produces a stable dispersion. A survey follows of the various types of surface-active agents which are available for use in aqueous media. There are four groups of surface-active agents available, i.e. the anionic, the cationic, the non-ionic and the amphoteric.

Anionic Surface-Active Agents

Anionic surface-active agents are characterised by their dissociation in water into large negative ions which are predominantly oleophilic and which are absorbed on to the pigment with the water solubilising groups presented to the water phase. The pigment surface therefore acquires a negative charge and mutual repulsion of the particles can occur. Anionic compounds contain one of three hydrophilic groups, i.e. carboxyl, sulphonate, sulphate.

For example, dinaphthyl methane disulphonic acid (sodium salt).

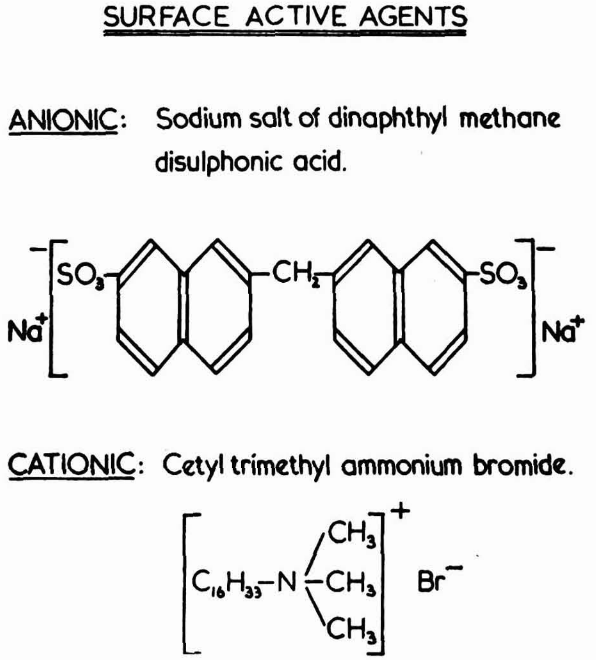


FIG. 11. (*Top*) FIG. 12. (*Bottom*)

Anionic compounds must be avoided where cationic surface-active agents may be encountered as mutual inactivation can occur. They are however used extensively in aqueous pigment pastes for the mass dyeing of viscose, for pva paints and for paper-dyeing and paper-coating applications.

Cationic Surface-Active Agents

These compounds are not used as dispersants in aqueous pigment dispersions to any great extent because the systems to be pigmented are often anionic in nature or are stabilised by anionic surface-active agents. They are normally prepared from straight chain fatty amines by treatment with hydrochloric acid or acetic acid to give a water soluble salt or by alkylation of a fatty amine to give a quaternary ammonium salt. For example, Cetyl trimethyl ammonium bromide.

Quaternary ammonium salts of this type dissociate into large cations which orientate themselves initially on the pigment surface in such a manner that

---

FIG. 15.

(1) PVA PAINT CONTAINING TOLUIDINE RED PASTE EXHIBITING GOOD DISPERSION CHARACTERISTICS

(2) PVA PAINT CONTAINING TOLUIDINE RED PASTE EXHIBITING EXTREME PIGMENT FLOCCULATION

FIG. 16.

ARYLAMIDE YELLOW 10G PASTE/AFTER STORAGE FOR 1 MONTH

Left to right : 2%, 5%, 10%, 25%, 50% and 100% disperser on pigment weight

N.B. The band at the foot of the 2% sample indicates the extent of pigment sedimentation

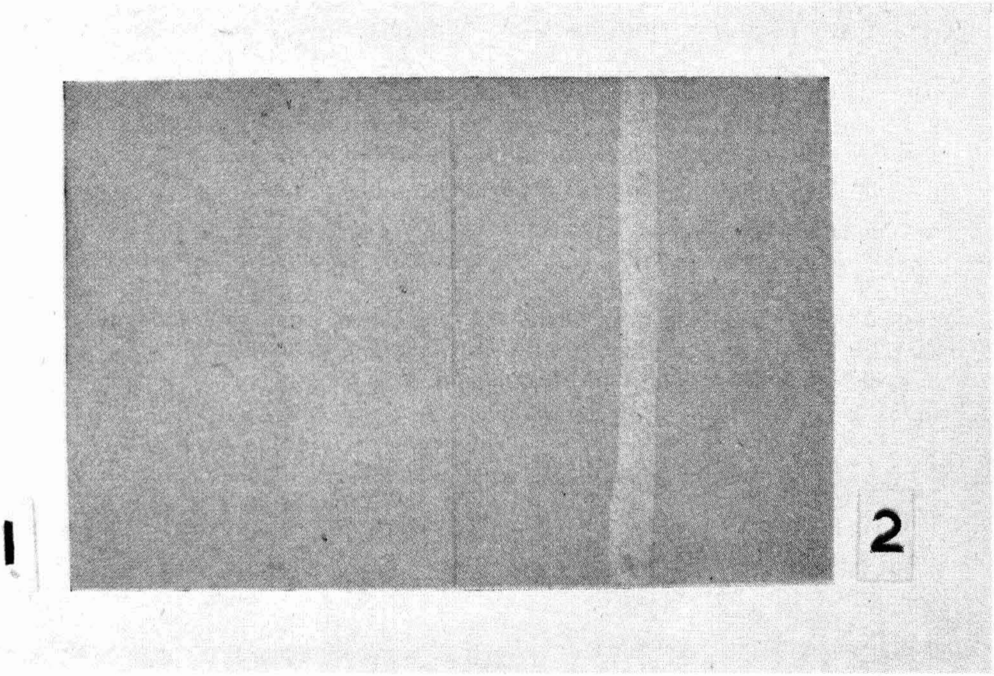


FIG. 15.

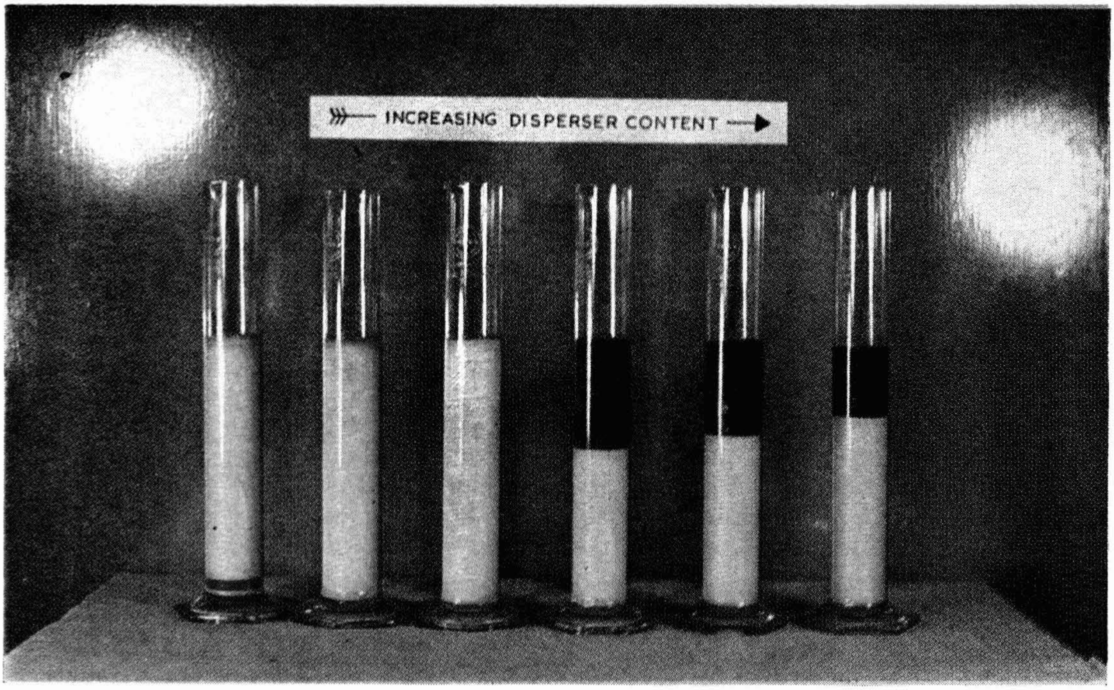


FIG. 16.

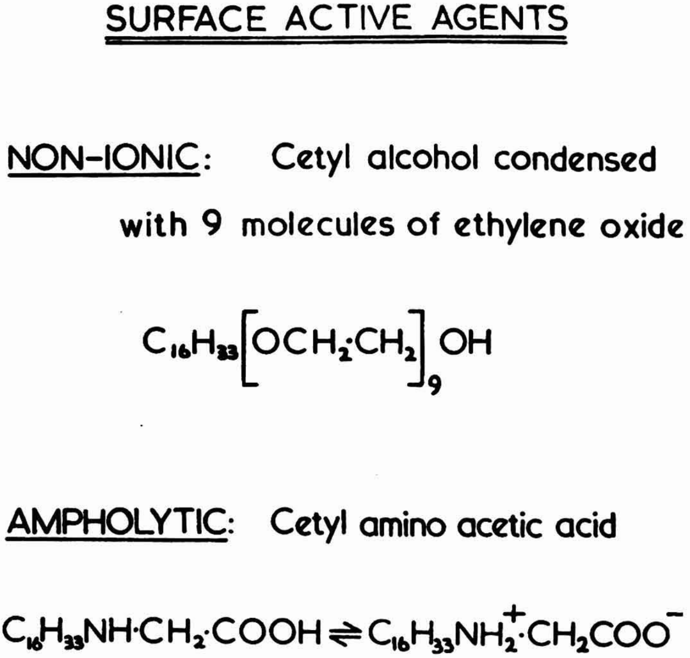
the oleophilic part of the ion is presented to the aqueous phase, i.e. the reverse type of orientation to that described under anionic compounds.

This reverse orientation thereby makes the pigment more hydrophobic and more prone to flocculation in aqueous media. Increasing the amount of cationic agent leads to a stage where this reverse orientation is replaced by a secondary adsorption of the type detailed under anionic compounds, i.e. deflocculation in aqueous media occurs.

Non-Ionic Surface-Active Agents

These compounds are not capable of dissociation and are therefore mainly unaffected by pH conditions and the presence of other types of surface-active agents. The most common types of non-ionic surface-active agents are the ethers and esters prepared from an alkyl phenol or fatty alcohol or from a fatty acid reacted with ethylene oxide or a polyethylene glycol.

For example, Cetyl alcohol condensed with 9 molecules of ethylene oxide.



SURFACE ACTIVE AGENTS

NON-IONIC: Cetyl alcohol condensed with 9 molecules of ethylene oxide

$$C_{16}H_{33}\left[OCH_2\cdot CH_2\right]_9OH$$

AMPHOLYTIC: Cetyl amino acetic acid

$$C_{16}H_{33}NH\cdot CH_2\cdot COOH \rightleftharpoons C_{16}H_{33}\overset{+}{N}H_2\cdot CH_2COO^-$$

FIG. 13. (*Top*) FIG. 14. (*Bottom*)

The polyoxyethylene chain confers increasing water solubility with increasing chain length and in aqueous media the molecules orientate themselves on the surface of the pigment with the hydrophilic polyoxyethylene chains associated with the water. The hydrated sheath round each pigment particle acts as a buffer against similarly coated particles and produces mutual repulsion or dispersion.

Amphoteric Surface-Active Agents

These products contain both potential anionic and potential cationic groups which will respond to certain pH conditions.

For example, Cetyl amino acetic acid.

Whilst these products apparently combine the advantages of both anionic and cationic agents, it may also be said that they combine the disadvantages of both types of surface-active agent.

As further illustrations of the various functions which the surface-active agents must perform in the pigmentation of pva emulsion paints the following points must be considered when making up the disperser formulation.

(*i*) The dispersed paste should be easily mixed into the paint at a concentration higher than the maximum normally expected on full shade use and there should be no change in the viscosity of the paint after pigmentation.

(*ii*) On storage of the paste or the pigmented paint at 40°C for 1 month there should be no change in colour properties. This assesses the stability of the pigment under tropical conditions of storage.

(*iii*) There should be no tendency for the pigment to transfer from the aqueous phase to the resin phase. This tendency for the pigment to flush, i.e. to transfer from the aqueous to the non-aqueous phase, can be assessed by subjecting the pigmented paint to conditions of high shear, i.e. by high speed stirring. Loss of strength on high speed stirring for 30 minutes indicates that the pigment dispersion has a tendency to flush in the particular system under examination.

(*iv*) As with other paint systems the tendency for pigment flocculation to occur must be avoided. This describes the behaviour of fine particles which associate in loose clumps but which can however be re-dispersed readily. This property can be assessed by comparing the brushed film with a strip of paint which has been allowed to run down the film whilst the latter is still wet. In extreme cases the " run-down " will show no colour at all due to severe pigment flocculation.

Alternatively, the film can be rubbed whilst on the point of drying ; a decrease in strength will indicate pigment flooding, i.e. a uniform drift of pigment to the surface of the film whilst an increase in strength on rubbing up will once again accompany pigment flocculation.

The effect of flocculation as illustrated by this " run-down " technique is shown in Fig. 15. p. 885.

The Amount of Surface-Active Agent Required

It has already been explained that the surface-active agent has two prime functions to perform in the dispersion of pigments, i.e. it must assist in the breakdown of the pigmentary aggregates and it must stabilise the dispersion and ensure its compatibility with the system to be coloured. In addition, however, it must have no adverse effect on the finished pigmented film, e.g. excess water-soluble surface-active agent may be leached out from a pva film on a wet wall. Its cost must also be reasonable.

Even omitting the last item from consideration it may still be necessary for one property to be sacrificed to some degree in order to improve another. To illustrate this point the effect of using an increasing amount of an anionic surface-active agent of the dinaphthyl methane disulphonic acid type to disperse an aqueous pigment paste can be considered in detail. If 2 per cent of this dispersant calculated on the dry weight of pigment is added to the paste, the latter is sufficiently deflocculated for it to be dispersed in a ball or similar mill.

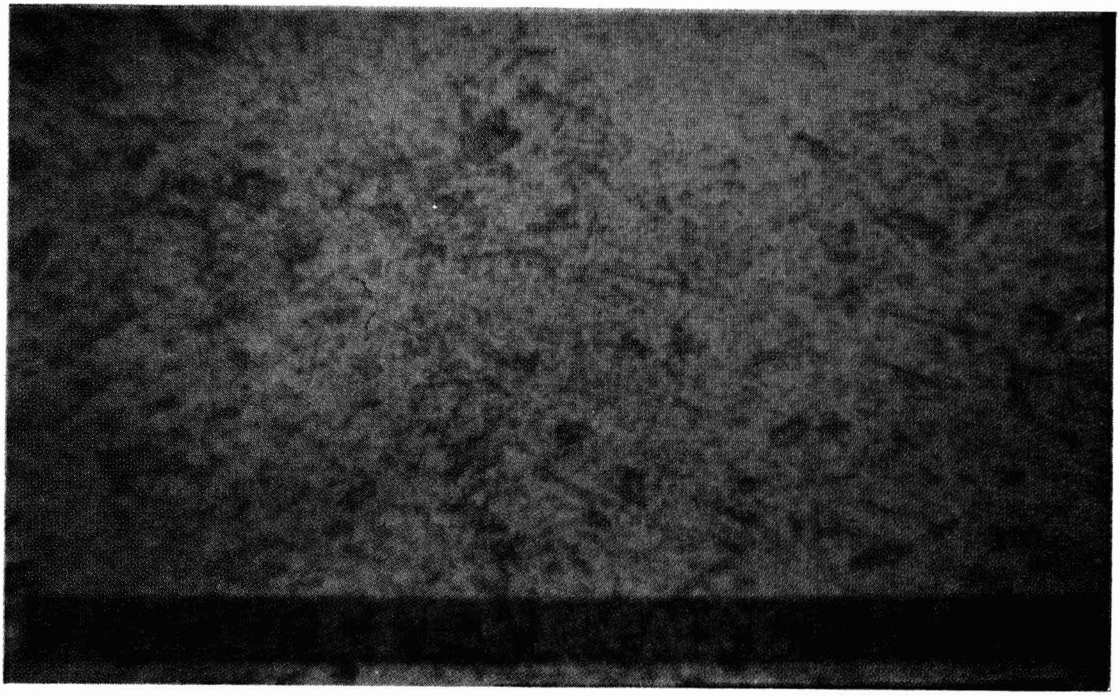


FIG. 17.

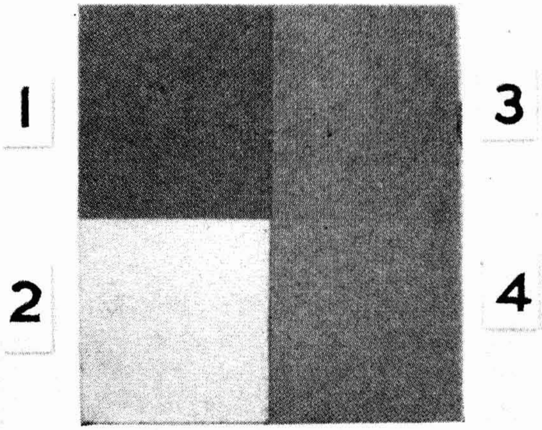


FIG. 18.

On storage, after dispersion, there is however insufficient dispersant to maintain the dispersion and the pigment may settle or the paste may flocculate to a thick paste or form a gel. Whilst the latter type of paste may be useful for some applications, the amount of dispersant is insufficient for it to have a wide use. Increasing the amount of dispersant to 10 per cent on pigment dry weight gives a paste which will remain fluid after dispersion and which probably possesses good storage properties. Should it be necessary however to increase the dispersant content beyond this figure, e.g. to improve the compatibility of the paste with a particular medium, it may be found in the range 25-50 per cent dispersant on pigment that pigment flocculation and separation of water occur once more. If the dispersant figure is increased even further, e.g. to 100 per cent on pigment dry weight, the pigment flocculation may still occur but the paste will be so thick, because of the increased solids content, that the separation of pigment and water will be reduced (Fig. 16. p. 885), or alternatively not shown at all.

A possible explanation for the secondary pigment flocculation is that rather than building up a mono-layer on the surface of the pigment which would of course reach a saturation point, the surface-active agent is adsorbed in excess of this and may build up partly from the surface of the pigment as chains. The structure of the surface-active agent in question is not known definitely but dimers and polymers of the basic molecule are possible. Mechanical interaction of these chains from one particle with those from other particles could lead to flocculation of the pigment. The complete explanation of the above behaviour may however require the concept of sites of varying activity on the pigment particle which lead to different phases of adsorption. It should be noted however that each pigment must be examined individually to ascertain the optimum amount of dispersant to be used as no pattern of behaviour can be assumed for all pigments.

An illustration of the type and amount of surface-active agents which offer the compromise properties required for a paste for the coloration of pva paint is given as follows.

If a dispersed paste is prepared with the optimum amount of an anionic surface-active agent to give good milling and storage properties as already described, it is usually found that the emulsion system coagulates completely on the addition of this paste to it. This is to be explained when it is considered that both systems are artificially stabilised and on being brought together,

---

FIG. 17.

CRYSTALLISATION OF ARYLAMIDE YELLOW G

SCALE 1 division = 10 microns

FIG. 18.

(1) Dianisidine Blue prepared without surface-active agent during coupling/Unexposed portion

(2) Dianisidine Blue prepared without surface-active agent during coupling/Exposed portion

(3) Dianisidine Blue prepared in the presence of an alkyl phenol polyoxyethylene condensate/ Unexposed portion

(4) Dianisidine Blue prepared in the presence of an alkyl phenol polyoxyethylene condensate/ Exposed portion

competition for the available stabilising agents can occur. In general, the pigment has a greater affinity for the stabilising agent of the resin system, so much so that the emulsion is completely destroyed and coagulation of the resin occurs. If, however, the pigment paste is treated with a similar quantity of a protective colloid or a suitable stabilising surface-active agent before it is added to the emulsion system, a satisfactory pigmentation can be achieved.

A further illustration of the care which must be taken in selecting the type and amount of surface-active agent to be used in a given paste concerns the crystallisation of Arylamide Yellow G on storage in aqueous systems. This defect of Arylamide Yellow G has been reported in emulsion paint systems and has been attributed to the crystallising effect of the plasticisers, thickening agents and surface-active agents in the paint[5]. The organic pigment manufacturers did not escape from this trouble, however, with their aqueous pastes containing certain surface-active agents, namely the non-ionic polyoxyethylene condensates which have a solubilising effect on certain organic pigments.

Particularly with Arylamide Yellow G which has only a moderately good solvent fastness, crystallisation (Fig. 17. p. 888) with an accompanying loss of strength could occur. Fortunately for the pigment manufacturer the cure for this defect was a simple one once the cause was known and current production of Arylamide Yellow G is such that this deterioration no longer occurs. The solubilising action of these surface-active agents as dilute aqueous solutions has been explained as being due to the presence of micelle centres where the oleophilic parts of the molecules are concentrated and give areas of high solvent power for substances which are normally insoluble in water.

This property of the surface-active agents may however be utilised by preparing the crude pigment in the presence of such surface-active agents. By this means it may be possible to alter the size and shape or even the crystal form of the pigmentary particles which may result in a considerable change in the strength, shade or fastness properties of the pigment. In this connection it may not be necessary for the surface-active agent to have a solubilising effect on the pigment as its adsorption on to the pigment during its preparation may be sufficient to encourage growth at certain faces of the pigment crystal at the expense of others, so that the physical and colouristic properties of the pigment are altered (Fig. 18. p. 888).

TECHNIQUES OF DISPERSION

There are many methods of preparing aqueous dispersions and the choice will be largely determined by the quality of dispersion required, the cost of producing it and whether the pigment is available as paste or dry powder. For some applications, e.g. the mass coloration of viscose rayon, there must be few, if any, particles above 1 μ, but for many applications this high degree of dispersion is unnecessary or even undesirable. The quality of dispersion required for the mass coloration of viscose is made necessary by the fact that the pigmented dope has to be passed through filters to free it of viscose gels, etc., and extruded through very fine holes (as small as 60 μ in diameter) to form the individual filaments of the yarn. The presence of oversize particles or aggregates may be sufficient to block these filters and spinneret holes with subsequent deterioration in the quality of the yarn being spun. Even for viscose, however, it may be possible to produce the pigment in too fine a form. To explain this apparent paradox it must be remembered that the finer pigment particles will be more prone to flocculation and that any additions made to cure this may have undesirable side effects.

In this and other applications, aqueous and non-aqueous, there is evidence that it is not necessarily very fine dispersions that are required, but dispersions with a narrow particle size distribution, i.e. free of very fine particles and oversize aggregates.

In preparing a dispersion of the desirable quality from the crude pigment paste, it is necessary to select a method which allows maximum energy to be applied to the pigmentary aggregates so that they can be broken down as quickly and economically as possible. The amount of energy and the rate of dispersion is, to a great extent, determined by the nature of the paste to be processed. If it is prepared from filtercake, instead of from dry pigment powder, the viscosity of the deflocculated paste will be low as the pigment content will be in the range 15-40 per cent. It is not possible to use a multi-roll mill or a kneading machine to disperse this type of paste and the use of the ball mill or some other mill suitable for processing low viscosity pastes must be considered. Conversely, very thick heavy pastes prepared from dry powder cannot be processed in the ball mill.

At this stage it is opportune to refer in some detail to the various types of mills which are available for dispersing pigments. Colloid or cone mills, edge runners and high speed impeller mixers are excluded from this survey as being incapable of achieving the quality range of dispersion required, i.e. with few, if any, particles above 1 μ.

Whilst ball mills have been used by the paint and ink industries for many years, it is true that they are still a very useful means of obtaining high quality aqueous pigment dispersions. The disadvantage of batch processing and cleaning are obvious, but labour requirements and costs are low. Balls, pebbles or gravel may be used as grinding medium and the selection of one or another of these is dictated to some degree by the viscosity of the paste being processed and by the quality of dispersion required. The grinding medium selected should be as small as possible and its specific gravity as high as possible, whilst the viscosity of paste should be as high as possible provided that the grinding medium can still fall freely.

The relationship of charge size to mill size, the ratio of grinding medium to pigment, the time of grinding and the speed of rotation of the mill must be considered when determining the milling cycle for a given product.

The ball mill therefore copes adequately with the dispersion of aqueous dispersions of low viscosity. More modern mills which cater for this type of paste are as follows :

The Kady mill is a high speed vertical mill incorporating a special rotor/stator arrangement in which a high degree of kinetic energy is imparted to the pigment aggregates. The agitator can be further modified to force the pigment slurry upwards and downwards into the rotor/stator assembly. Disintegration of pigmentary aggregates can occur by impact on the faces of the slotted stator or by shear due to the sudden change of direction of the paste on entry into the slots.

Low viscosity pastes can be processed in this machine, but the disadvantages of small batch scale processing and the difficulty of dissipating the heat developed are obvious. For aqueous pastes the quality of dispersion produced, calculated on a strength/cost/time basis, is comparable with that achieved by ball milling.

The Torrance Attritor and the Podmore-Boulton Vibratory Mill, whilst distinctly different in design and operation, are both useful for processing medium viscosity aqueous pastes in the range where the Kady mill and the ball mill are relatively ineffective.

The Attritor is again of the vertical " mixer " design and embodies a special agitator characterised by heavy side arms set at right angles to the shaft which can carry the charge and grinding agent at a speed to suit the type of paste and the dimensions of the dispersion vessel. Dispersion is by shear and impact. Moderately good dispersions can be achieved in a relatively short time with this mill, but the batch type processing is unsuited for large scale bulk production of high quality dispersions of organic pigments.

The Podmore-Boulton Vibratory Mill depends on three-dimensional movement at high frequency to achieve the dispersion of pigments. The grinding agent may be in the form of synthetic capsules (sintered alumina) of a given design. These mills also give pastes with the quality of that obtained by ball milling, although if the paste can be worked at sufficiently low viscosity, it is the author's opinion that the ball mill is to be preferred, on account of its simplicity and low running cost. If this is not possible, the vibratory mill offers a ready solution to the problem of dispersing pigments in viscous media.

The most recent addition to the range of mills in this sphere is the sand-grinder. Whilst there is nothing novel in the use of sand grinding for aqueous dispersions, this mill is of great current interest in the preparation of pigment dispersions in film forming media. In this field, much information and experience has been built up on the use of the sand-grinder and it is certain that it will be of use for aqueous systems too. The sand-grinder possesses the very important advantage of being continuous in operation, if necessary.

It consists of a cylindrical open topped vessel, water jacketed and with a vertical shaft bearing several solid discs at regular spacings. Rotation of the shaft at high speed in the dispersion vessel approximately half-filled with special sand (Ottawa sand) results in areas of vertical circulation where interaction of the forces set up results in breakdown of the pigmentary aggregates by shear.

The material, if satisfactory after one pass, can be discharged at this stage or recirculated through the mill again, by re-entry at the base of the latter.

The high pressure jet pump has also been recommended for pigment dispersion. This consists of a three-cylinder piston pump in which the paste to be dispersed is forced under great pressure (up to 10,000 lb per sq in) against an especially hardened metal surface making up part of the dispersion valve. Breakdown of the pigment is achieved by impact at this stage and by shear forces set up between the faces of the dispersion valve. This machine is useful for treating low viscosity pastes.

Having covered the range of mills available for dispersing low and medium viscosity pastes, the machines which are capable of processing thicker pastes must now be considered. These pastes are encountered when the formulations have pigment contents in excess of the 40 per cent referred to earlier. As already indicated, these high pigment contents cannot normally be achieved by working from filtercake. Instead, it is necessary to work from dry colour, as in the paint and ink industries, and to prepare a thick paste by the addition of water and suitable surface-active agents to it. Machines which cope with pastes of this nature are the multi-roll mills and the kneading machines of the double Z-blade and the worm drive types.

Dispersion in the multi-roll mill is carried out in a thin film of paste which is transferred from one roll to another and is subjected during this process to high forces of shear and compression which quickly result in the breakdown of aggregates. The relative speeds of adjacent rolls and the pressure applied to them determines the amount of energy applied to the paste, assuming that the latter is at the correct viscosity, i.e. the maximum viscosity at which the mill will run without overloading. Normally maximum pressure is applied at the front or fast pair of rolls, where the greater part of the dispersion takes place, whilst the pressure applied at the back pair of rolls acts to control the rate of feed of paste to the front pair.

If it is necessary to process more viscous pastes than those dealt with on the multi-roll mills, the double Z-blade mixer may be used. This machine, giving up to 1.5 h.p. per lb pigment capacity, can deal with extremely viscous pastes and in fact depends on this ability for its basic action.

The paste is kneaded in the mixer and in this way strong forces of shear are set up within the paste and between the blades and the side of the dispersing chamber so that breakdown of pigmentary aggregates follows. The paste must have a very high viscosity otherwise the proper dispersing action of the mixer is not achieved. One disadvantage of this type of machine is that there is no guarantee, on a short processing cycle, that all aggregates will be treated. This type of machine is also used for the process of flushing pigments from a water paste into a solvent or oil system. Good quality non-aqueous dispersions can be achieved by this means, primarily because the pigment has not been dried out and therefore is much finer or more easily dispersed. It is necessary in order to achieve this transfer to select a suitable surface-active agent to encourage the pigment to move from one phase to the other and to ensure even distribution throughout the non-aqueous phase by applying heavy forces of dispersion during and after the transfer. These forces are most effectively supplied by a machine of the double Z-blade type. The application of heat and the use of vacuum are necessary to remove the last traces of water, the bulk of which is removed earlier by decantation. Once again this type of machine lends itself admirably to these operations.

The Buss Ko-Kneader offers the dual advantages of heavy duty kneading and continuous operation. Working on the principle of a worm drive acting against a series of kneading teeth mounted on the machine housing, the Buss Ko-Kneader represents a series of kneading chambers in which the paste being processed is repeatedly subjected to intimate mixing and kneading at high pressure.

An additional advantage is that the reliance on the probability of any individual pigmentary aggregate's being subjected to high pressure, i.e. as encountered with batch operation in the double Z-blade mixer, no longer holds. The process is carried out positively and all the charge is processed similarly. The Buss Ko-Kneader is particularly suited for the dispersion of pigment in high viscosity media such as plastics and rubber where the development of the heat produced under such conditions may be an added advantage. Effective cooling of the worm drive and casing allows the processing of other systems where heat sensitive pigments or media may be used.

A twin screw kneading machine can also be used for the dispersion of pigments in very stiff paste form and this machine also operates continuously.

The charge can be heated or cooled during processing as required and by alteration of the assembly of triangular discs and screw shapes on the drive it is possible to set the machine to process different media depending on the degree of mixing and dispersion required.

OTHER APPLICATIONS FOR ORGANIC PIGMENT PASTES

Whilst attention has so far been concentrated on the synthetic resin paints and on viscose rayon, it must not be forgotten that a large amount of aqueous pigment pastes is used in other industries.

Paper-Dyeing and Paper-Coating Applications

Here it is necessary to produce good quality dispersions with the minimum amount of disperser, i.e. in the case of paper-coating application to prevent interaction with casein binders on using the dinaphthyl methane disulphonic acid type of disperser and to prevent frothing and to ensure good " keying " of pigment and paper during the paper-dyeing operation. The paste dispersion must be readily dispersible with the simplest form of agitation, i.e. beaters, etc. Pastes for these applications are tested in the laboratory, in the case of coating, by brush or by bar coater application. The latter method is more reproducible, gives a more uniform coating and considerably reduces the human element in this operation. The one disadvantage of the bar coater is that systems which are prone to show pigment flocculation will not develop full strength on this method of application. For paper-dyeing tests, the pastes are tested in a laboratory paper-making machine.

Oil-bound Distempers

Whilst these paints have lost ground to the resin emulsion paints, there is still a need for pigment pastes for this application. Properties required of the pastes are in fact similar to those for emulsion paint systems, i.e. good storage and heat stability, in conjunction with resistance to flushing into the oil phase.

Tests can be carried out as paper coating and may include the standard techniques for checking for pigment flocculation, " flushing " and stability to temperatures up to 40°C. Once again the keynote in the formulation of pastes for application in oil-bound distemper is that of simplicity of formulation and in most cases this can readily be achieved.

Textile Printing

A further use of organic pigments in the textile industry is textile printing, whereby pigments which would normally have no affinity for fabrics can be fixed mechanically to the woven article by means of a resin. The latter may be a synthetic resin (alkyd, urea/formaldehyde, melamine/formaldehyde, etc.) and may be applied in the form of a water-in-oil emulsion or as an oil-in-water emulsion. In the case of the latter the pigment paste is required to be of a quality which will allow it to be stirred into the textile printing binder emulsion with the minimum of effort. To test whether this has in fact been achieved, the paste may be stirred in a high speed mixer after the initial mixing and only when no further strength development is noted is it assumed that a suitable pigmentation has been achieved. Problems of formulation for the pigment paste manufacturer are more difficult for systems of this type, presumably because the non-aqueous phase is more oleophilic than in the resin emulsion paints and pigment flocculation and " flushing " can occur more readily.

Some evidence from examination of pigmented textile printing binders using the optical microscope suggests that the pigment must be loosely associated with the non-aqueous discontinuous phase whilst still free to move in the aqueous phase. This possibility would appear to be reasonable as at some stage the pigment must transfer from the aqueous phase into or on to the resin, i.e. when the printed paste is dried out and the film finally cured. For it to be in some intermediate position between the two phases would suggest a suitable state for good pigmentation. If the pigment was too oleophilic, premature transference would lead to low strength development as experienced with other resin systems. This occurrence can be shown up on the high speed stirring test referred to already. The final test, as always, is to carry out a full scale laboratory textile printing test.

In the water-in-oil emulsion system the pigment may be applied as an undispersed paste, but in this case heavy kneading machines may be necessary to flush the pigment into the continuous non-aqueous phase by a technique similar to that described for the preparation of non-aqueous systems.

RECENT DEVELOPMENTS

In the title of this paper and the applications covered so far, emphasis has been on the coloration of aqueous systems. In view of the ease with which aqueous systems can be pigmented with the " tailor-made " aqueous pastes, it was not long before the pigment-using industries were looking for similar preparations for non-aqueous systems and preferably for one for incorporation into both aqueous and non-aqueous systems, i.e. the so-called universal tinter. Whilst the industry had had previous experience of the use of non-aqueous tinting concentrates and of resin treated pigments, these in many cases required a further pre-treatment or grinding before use and were quite unsuitable for pigmenting aqueous media.

At this time, one must admit that the universal tinter, giving a completely satisfactory dispersion in all systems, has not been and may not be achieved, but, at the same time, a large advance in the search for such products has been made by the introduction of the multi-purpose stainers. These are pigment pastes which, whilst still retaining all the advantages of the tinter for aqueous systems, are capable of being mixed into certain non-aqueous media with the minimum of effort and with the attainment of maximum strength development and stability properties.

These products applied to aqueous and non-aqueous paints compare very favourably with the results achieved using an aqueous tinter for the aqueous paint and by ball milling the equivalent dry powder into the non-aqueous paint by standard methods. The problems involved in preparing a suitable dispersion for multi-purpose application are concerned with the development of a system which will be rather delicately balanced so that it can be dispersed by simple agitation into both types of paint. The balance must be such that the properties necessary for one application do not impair the functioning of the system as a whole. This balance has to be considered in all aspects of the paste, i.e. the pigment, the surface-active agents and the medium. For example, pigments of relatively low solvent fastness which may be more than adequate for aqueous paints will be completely unacceptable for solvent systems. Surface-active agents which rely on ionic dissociation may be useless in non-aqueous systems where dissociation will be impossible.

As a further extension of the use of dispersed pastes, the coloration of industrial water-based paints may be referred to. These systems contain water-soluble or water-dispersible resins and may include a proportion of water-miscible solvent. Here again, the multi-purpose tinter can be used to great advantage in the coloration of such systems. The use of organic pigments, however, in such applications is limited at present due to the fact that the quality of water-based paints for " top-coat " application has not reached the quality of the conventional paint or lacquer treatment. The bulk of pigments used are therefore inorganics applied as priming or under coats in the metal coating industries. It should be reassuring to the users of such systems that when their techniques improve for final coat application, suitable organic pigment dispersions will be available.

Conclusions

It was stated at the beginning of this paper that the pigment-using industries were becoming more and more accustomed to using " tailor-made " pigment preparations.

The pigment manufacturers have responded to this demand as illustrated in this paper by preparing special dispersions for both established and new applications. In the author's opinion, this trend will continue with an increasing emphasis on ease of incorporation, compatibility and stability. This trend will also involve attempts to reduce the amount of surface-active agent necessary to give these properties and a preference for dispersible powders for aqueous and non-aqueous systems.

Acknowledgments

Thanks are given to the Board of James Anderson & Co. (Colours) Ltd. for granting permission to present this paper.

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Reviews

ENCYCLOPAEDIA OF SURFACE ACTIVE AGENTS—VOLUME II

By J. P. SISLEY and P. J. WOOD. New York : Chemical Publishing Co., N.Y. Pp. 501. Price $16.50.

The number of surface active agents available to industry has increased so rapidly since 1949, when Volume I was published, that the authors have been able to produce a second volume with, it is said, little duplication. This present volume is in two parts. Part I describes recent advances in surfactants in a review manner and includes some statistical tables of world production and consumption. It concludes with a comprehensive list of agents grouped according to their chemical constitution.

Part II comprises an alphabetical list of commercial brands of surfactants, each product being described under a short series of headings including Composition, Class (cross-reference to Part I), Form, Properties, Reaction and Application, with, in some cases, a reference to original published data.

One cannot review a book of this type in the normal manner, all that can be done is to check the cross-references between the two parts at random. This exercise revealed that there were a number of cases where these were at variance, due to omissions in Part I of products described in Part II and a number of instances where the chemical classifications for the same product differed in the two sections. This is to be regretted, but it does not impair the book's usefulness to any great extent, since most readers will go to Part II for information rather than to Part I.

Only one or two typographical errors were noted, but one might indulge in mild criticism of the layout of one large table in which the descriptive headings are printed in an inverted position relative to each other. As a reference book, one to be recommended since it covers European and US products.

D. S. NEWTON.

PHYSICAL ORGANIC CHEMISTRY

By KENNETH B. WIBERG. John Wiley & Sons, Inc., 1962. Pp. 591. Price 80s.

In his preface the author suggests that the field of physical organic chemistry originated with the publication in 1940 of L. P. Hammett's book, bearing the same title as this work. A comparison of the two books (which incidentally cover much the same topics) demonstrates the extensive developments that have taken place in the last 24 years. Wiberg's treatment is much fuller, more mathematical, and brings his subjects right up to date.

The author has taken great care in the selection of three topics, so dividing the book arbitrarily into three parts. The subject matter of each part has been skilfully integrated so that the argument develops logically from one chapter to the next and even from one part to the next.

In Part 1, Bonding and Spectra, a consideration of the covalent bond leads naturally to a study of the energy state of bonding of a molecule and so on to a study of spectra. At the end of this part there is a useful chapter on magnetic nuclear resonance spectra.

In Part 2, Equilibria, the concept of energy levels and intrinsic energy of molecules forms an introduction to a study of various non-ionic reactions which is extended to the effects of solvents and then to ionic reactions.

In Part 3, Kinetics, a study of rate constants and rate laws is followed by the examination of reactions involving the effects of solvents and finally some acid-catalysed reactions.

An unusual feature of the book is the inclusion of over 140 pages of appendices. These include various tables and aids to the analysis of data and quite a comprehensive introduction to computer planning.

The author does not claim it to be a reference book, but considers it a text-book for a one-year graduate course ; nevertheless he has included a large number of recent references.

G. L. HOLBROW.

Correspondence

INK TECHNOLOGY FOR PRINTERS AND STUDENTS

With reference to the third paragraph of the review of my book *Ink Technology for Printers and Students* (*JOCCA*, **47**, 586). The General Preface makes it clear that this book is about *printing inks* and claims to deal with printing ink technology sufficiently for the City and Guilds examinations. It does not claim to deal with printing processes, paper technology, etc., which are adequately covered in other books ; indeed some of these books are listed in the preface to Part 2.

E. A. APPS.
[30 *August* 1964.

26 *South Drive*,
Ruislip, *Middlesex*.

I found Mr. Apps's letter surprising in that he regards printing ink technology as dealing with ink in isolation from the means of applying it and the nature of the surface to which it is applied. Apart from the fact that inks cannot be properly designed without this knowledge, this definition is completely opposed to that of the Technical Training Board of the industry and the appropriate Committees of the City and Guilds.

Furthermore, despite his disclaimer and as stated in my review, Mr. Apps *does* deal with some of the ancillaries in various places throughout his book, but inadequately for the City and Guilds examinations, all of which makes it difficult to know just what is the intended ambit of Mr. Apps's book.

Finally, the large volume reviewed contained no prefaces to the three parts and the General Preface gave no indication to the reviewer of Mr. Apps's highly individual and restricted definition of printing ink technology.

R. F. G. HOLNESS.
[6 *October* 1964.

90 *Lakenheath*,
Southgate, *London*, *N*.14.

Information Received

(In case of difficulty regarding addresses, members and subscribers to the Journal *should apply for details to the General Secretary of the Association at the address shown on the front cover)*

A new resin from HERCULES POWDER COMPANY to be marketed under the name *Dresinol* 303 has been developed, it is stated, to meet industrial requirements for an ester type resin dispersion capable of being readily mixed with either natural latex or synthetic high-polymer latices.

* * *

BASF AG are increasing their *Neozapon* range of dyes by the introduction of two new members, *Neozapon Yellow GR* and *Neozapon Orange G.* The company claims that they can be used mainly for the printing of aluminium foil but can also be used for the staining of paint, and printing inks.

* * *

The Technical Services Laboratory of LAPORTE TITANIUM LTD. has been incorporated into the Marketing Services Department. The Marketing Services Department is at the following address : Battery Works, Stallingborough, Grimsby, Lincs.

* * *

The Second Annual Report of the ZINC PIGMENT DEVELOPMENT ASSOCIATION on the research programme on the development of zinc rich paints has just been issued. This report gives details of welding tests carried out on those paints which in the first year showed the best resistance to the accelerated corrosion tests as used in the motor industry.

* * *

Two large companies have expanded their premises in the past month. ICI LTD. have opened their new research centre at Runcorn Heath for the Mond Division ; this also provides premises for the Petrochemical and Polymer Laboratories. UNION CARBIDE LTD. have opened their new Technical Service Laboratory at Hythe.

* * *

The PAINTMAKERS ASSOCIATION OF GREAT BRITAIN LTD. has informed us that at the request of the Paint Industry, the British Standards Institution has been undertaking work as a matter of urgency to examine test methods covered by Ministry of Defence specification DEF-1053, and similar methods already in being in British Standards. The aim is to commence publication at an early date of a comprehensive series of BS methods, which will also be put forward for consideration by the International Organisation for Standardization (ISO).

Despite the fact that, in general, the requirements of purchasing authorities have been adequately met by proprietary branded materials, in recent years there has been a tendency for some of the larger organisations to draw up their own specifications, primarily because they have felt that they had no method of assessing the performance of the products they were purchasing.

The Industry has always felt that the purchaser is best served by using proprietary branded materials and the ever-increasing research and development being undertaken to improve its products and make them meet new requirements underlines this. The availability of a series of BS test methods, which the Industry welcomes, should fill any gap which purchasers have felt existed in the past and so make it unnecessary for them to expend time and money in drawing up their own specifications.

Bristol Section

THE THEORETICAL ASPECTS OF ADHESION

On 25 September 1964 the 135th Ordinary Meeting of the Bristol Section was held at the Royal Hotel, College Green, Bristol. Thirty-eight members and visitors were present to hear Dr. W. J. Dunning, of the University of Bristol, deliver a lecture on the theoretical aspects of adhesion.

This was the first meeting of the 1964-65 session, the 21st anniversary of the Bristol Section, and during the year a series of papers will be presented under the general heading of " Painting, Printing and the Substrate."

The first paper by Dr. Dunning laid a sound theoretical foundation for the remainder of this programme, discussing the following topics.

The forces across an interface originated in the interaction of molecules with each other. Such interaction might be classified as physical (comprising London dispersion, polarisation, dipole interaction and ionic) and chemical (in which covalent bonds are present). Opposing these attractive forces were the repulsive forces arising from the overlap of electron clouds. From a knowledge of the forces involved and the molecular structures of the interface, the change in potential energy could be calculated for the process of adhesion failure. Alternatively, the closely related enthalpy of adhesion might be measured calorimetrically from the heat of immersion and allowed correlation with polarisability and dipole moment.

The work of adhesion $W_{A(SL)}$ required to rupture the interface (SL) and leave the adherent surface S clean and free from adhesive (L) was

$$W_{A(SL)} = \phi_e + \gamma_L (1 + \cos \theta_e) .$$

When an equilibrium film of adhesive (spreading pressure ϕ_e) remained on the adherent surface a different work of adhesion $W_{A(SeL)}$ results where

$$W_{A(SeL)} = \gamma_L (1 + \cos \theta_e)$$

and θ_e is the equilibrium angle of contact. Since $W_{A(SL)}$ was thus greater than $W_{A(SeL)}$, the preferred process of rupture should leave a film of adhesive on the adherent.

Experimental evaluations of $W_{A(SeL)}$ allowed an estimate of the idealised tensile failing load. Practical tensile failing loads were found to be an order of magnitude smaller than this ideal and a re-examination of the kinetic processes involved in joint failure became necessary. The interface would not widen uniformly over its whole area into a parallel-sided gap, as visualised in the idealised process. It was more likely that fluctuations in the positions of molecules would, under tensile stress, lead to the spontaneous generation of a small crack nucleus from which the interface was torn apart. The free energy of formation of such a nucleus was ΔG^* where

$$\Delta G^* = \frac{\omega^2 E^2}{48 \sigma^4} W^3{}_{A(SeL)} .$$

Here ω was a shape factor ($\sim 2\pi$) and E is Young's modulus. The probability of rupture would then be proportional to $exp(-\Delta G^*/kT)$ and the probability of rupture for different interfaces would then be the same when the normal stresses σ were proportional to $[W_{A(SeL)}]^3$. Experiments to test this theory gave irregular and erratic results which suggested that adhesion failure was structure sensitive, i.e. small irregularities catalysed the nucleation of cracks. Alternatively, small ready-made cracks might be present at the interface.

In the same way, slip along the interface under shearing stress did not take place by the simultaneous relative motion of all molecules, but by a caterpillar-like movement similar to the migration of an edge dislocation in its slip plane.

During the discussion which followed Dr. Dunning described some of the experimental methods employed to test the validity of the theories and gave detailed answers to the many questions which were raised.

A vote of thanks was proposed by Mr. C. G. Phillimore.

L. J. T.

London Section

THE ASSESSMENT OF PROCESS INKS

The first technical meeting of the 1964-65 session was held on 23 September 1964 at Manson House with Mr. M. R. Mills in the chair, when Mr. J. M. Adams, of PATRA, presented a paper on " The Assessment of Process Inks."

Mr. Adams said that he was concerned with the inks used for three-colour printing, generally with the addition of black, and that various factors must be considered, (*a*) the colour gamut attainable, (*b*) whether the inks were compatible with automatic processes used in preparing the colour separations, and (*c*) the normal technological factors of cost and printability. Complementary colours were used for the subtractive process, cyan, magenta and yellow, with red, green and blue primary filters, and national standards for inks had been introduced, e.g. BS 2650 and BS 3020, and DIN 16508. Typical inks were not quite complementary to the filters, and some measure of assessment and grading was required. A subtractive primary ink must not scatter light, but must be transparent and either absorb or transmit at a given wavelength, the light being reflected by the paper. With subtractive mixtures, the individual reflection factors were multiplied, i.e. the reflectance was always less than that of the individual inks. The concept of ideal colours was devised by MacAdam, in which the reflection factor at a given wavelength was either 0 or 1, with not more than two transitions in the visible spectrum. It did not follow that such inks would be desirable, since, for example, a green with a narrow reflectance band would be reproduced as a much less saturated colour.

The colour gamut obtainable could be assessed by plotting the CIE co-ordinates of the full colours and overprints on a uniform colour diagram, when the area enclosed would give a value for the range of colours, but this does not take into account luminance factors. Thus with a Hunter diagram, ideal inks give a value of 0.085, BS 2650 inks give 0.050, and BS 3020 inks give 0.092. BS 3020 inks give saturated colours with low luminance. The concept of *vivacité*, developed by Edelmann, was described, and the GATF proposals involved measurement of the densities of the inks in the R. G. and B. regions, which were used to calculate the Hue Error, Greyness and Efficiency. This method can give good comparisons.

In the discussion following a question from Mr. H. A. Idle, Mr. Adams said that the next stage of work should be the study of colour reproduction processes from a colorimetric angle, but considered that it was unlikely that a single method of grading could be devised. Dr. F. A. Askew asked whether an assessment could be based on the areas under spectrophotometric curves of primaries and secondaries. Mr. Adams said that this would give a set with high luminance and low saturation, e.g. an extreme case would be three white inks. The more saturated the inks, the lower were the areas. Mr. R. R. Coupe commented that in the example given a saturated colour could not be matched spectrophotometrically by less saturated colours, but in some cases a visual match could be obtained. Mr. Adams said that a close spectrophotometric match was more important in the green than in other regions, since the saturation of, for example, a broad band yellow or red was high. Mr. A. D. Lott asked why the cut-offs in the ideal inks were made at 500 and 600 mμ. Would not other points have enabled a closer match to the green to have been reached? Mr. Adams agreed that with ideal inks the choice of cut-offs could be varied, provided that there was no overlap, but the effects on the other colours must be considered. In reply to a question by Mr. J. D. Cohen, Mr. Adams said that greyness on the GATF system was an approximation to saturation. Mr. R. G. J. Cooper asked which of the four sets of inks mentioned would be recommended. Mr. Adams said he would prefer the DIN set because of its low mask contrast. If we considered only colour gamut, then any one of the sets could be chosen. Dr. G. L. Fuchs said that he also doubted the usefulness of *vivacité* and asked whether the GATF method using the Hue Error would not have brought out the differences between DIN and BS colours. Mr. Adams agreed that the GATF system was a good guide, but it was not satisfactory for inter-laboratory comparisons.

In proposing a vote of thanks, Dr. F. A. Askew congratulated the speaker on the lucidity with which he had presented the subject.

V. T. C.

Manchester Section

HIGHLIGHTS OF PROGRESS IN PAINT TECHNOLOGY: A LOOK BACK

A very successful meeting for Junior Members was held on 4 September, when a number of Ordinary Members also had the privilege of hearing Dr. Jolly survey developments in the paint industry over the last 40 years. During his lecture, Dr. Jolly reviewed the changes in raw materials and the effects they have had on the properties of paints.

Forty years ago paint making was a craft which depended on trial and error in the combination of natural products. The chemist was only just beginning to be accepted and the Paint Research Station was being founded. During these 40 years, however, paints had now graduated to surface coatings which are largely made from intentionally conceived products.

The lecturer said that paint was more than the sum of its parts, but the film-forming component was undoubtedly the most important part. In general the paint maker had strived to produce paints as near as possible to the final form they would take after application. Forty years ago, when decorating skill was high, paints were made from vegetable oils, genuine American turpentine and, mostly, natural colours. Dr. Jolly stressed the developments of the medium from gum running, tung oil and rosin, through phenol formaldehyde resins, urea and melamine formaldehyde and nitrocellulose to vinyl copolymers. He dealt in detail with the search for alternative natural oils and the introduction of semi-drying oils such as soya and tall oil. He described isomerised, fractionated, dehydrated and styrenated oils and then dealt with the " alkyd chapter."

Describing the progression from the traditional water-based paint or distemper to the emulsion paint which was the almost ideal wall paint, Dr. Jolly reviewed the media used. He thought that the two-pack cold cure paints were perhaps a retrograde step in that they were further removed from the final form that the paint would take and he described the use of epoxy resins and polyesters. They did, however, give paints in which the film-forming depended upon the comparatively uncontrolled oxidation process. There had been a gradual but definite advance in the properties of paints, and Dr. Jolly forecast for the future the development of a synthetic drying oil.

In a very full lecture, the developments in white pigments, organic and inorganic pigments were reviewed with particular reference to the better texture of the modern pigments and the ultimate of very rapid but stable dispersion. The importance of driers and the introduction of naphthenic acids as metal carriers were dealt with. Progress in solvents and the importance of the new low odour white spirit were covered and there was a brief survey of grinding equipment. Dr. Jolly referred to the original massive equipment that was used to grind inoffensive pigments which had been superseded by the triple roll, the edge runner and the single roll, later by the high-speed dispersion mills and perhaps in due course by the bucket and stick.

After questions and further discussion, a vote of thanks was proposed by Mr. K. W. G. Butcher. It was generally considered that the gratifying response by Junior Members to this second lecture should encourage the Section to have further lectures for younger members, although the choice of subject and lecturer is obviously important.

W. F. McD.

Midlands Section

THE SELECTION AND EFFICIENT OPERATION OF SHOT BLASTING EQUIPMENT

The first meeting of the session was held at the premises of Messrs. Griffiths Bros. & Co., Wednesfield, Wolverhampton, on 18 September 1964, with Mr. W. A. Edwards in the chair. The speaker was Mr. W. R. Macmillan, and his subject, " The Selection and Efficient Operation of Shot Blasting Equipment."

Mr. Macmillan said that two basic types of throwing wheel were used. With the batter type the abrasive obtained its velocity in the same way as a billiard ball struck by a cue, whereas the sliding vane type, being fed through an impellor, could be compared with the delivery of a bowler at cricket. The sliding vane action caused less breakdown of abrasive, but imparted less velocity for a given wheel speed. The wheel was enclosed in a cabinet incorporating suitable means of presenting the work to the wheel. An elevator, usually consisting of buckets on a rubber belt, retrieved the thrown abrasive and fed it to a separator and dust arrester. Abrasive freed from contaminants was then recycled to the throwing wheel.

The speaker then surveyed the principal applications of airless blasting processes, including descaling, cleaning, castings and weldments, etching surfaces ready for surface coatings, cleaning for reconditioning, removing flash from plastic mouldings and shot peening to relieve surface stresses.

The speaker went on to illustrate methods of presenting the work to the wheel with examples of standard machines. These included the Tumblast, the Rotary Barrel, Swing Tables and Multi-Tables. Special types had been developed for the cleaning of billets, for external pipe cleaning, for descaling steel strip, for shot peening of coil springs and for plastic deflashing. A film was then shown featuring many of these machines.

Mr. Macmillan answered a number of questions, mainly concerned with surface preparation for painting. Mr. A. E. Claxton concluded the meeting by proposing a vote of thanks to the lecturer.

L. R. S.

Newcastle Section

PAINT AND THE CONSUMER

The first meeting of the season was held on Thursday 1 October with Mr. J. G. N. Smith in the chair. The local sections of the Paintmakers' Association and the Master Painters and Decorators joined in the meeting, which was addressed by Mr. J. Dukes, a Project Officer of the Consumers' Association. He had been responsible for the report on emulsion paints in the May 1964 issue of *Which ?*

Mr. Dukes started by giving an account of the work of the Consumers' Association, stressing that its finances came entirely from its 400,000 members, which assured its independence when examining products. Its function was to provide simple answers to the simple questions asked by consumers, and one of the first and most important tasks of a Project Officer when starting a project was to decide upon tests that answered questions of real concern to consumers. It was easy to be diverted into doing tests which answered other questions. Advice was taken from independent experts upon suitable tests, and assessed in the light of the consumers' requirements.

There was a great desire in the Association for paint to be tested, and some pilot tests had been done on gloss paints, but emulsion paints were chosen first because the results could be obtained fairly quickly. No attempt was made to assess their outdoor durability or their suitability as undercoats for gloss paints, because the necessary weathering tests would be too lengthy.

Examples of tests which were considered and discarded were viscosity measurement : simple application tests were considered to be more useful ; and scrub tests : because whatever information these provided they did not give a direct correlation with wearing properties in practice, and no one was interested in actually scrubbing emulsion paints. The tests finally adopted related to ease of application, both by the amateur and the professional ; appearance (sheen and colour consistency between samples) ; dirt pickup ; ease of cleaning (using greasy and non-greasy dirt) ; and performance in kitchens and bathrooms.

When the report appeared there were no complaints from manufacturers about the test methods or the results. The only complaints concerned the omission of some brands, which was inevitable.

They now wished to test gloss paints, but the great difficulty lay in assessing durability. He had been advised that accelerated weathering tests were unreliable, and if they relied on natural weathering the paints tested might have been superseded by the time the results were obtained. The best approach they could think of was to do outdoor weathering tests, and to assess the effect of any small changes in formula by means of the weatherometer ; large changes being beyond its scope. The weathering tests would be done by painting model doors, made of outdoor grade plywood in deal frames, with some knots and nails present, and exposing them at three sites : rural, suburban and sea-coast. Industrial atmospheres were rejected as being too variable in composition.

They were concerned at the possible success of new developments such as polyurethanes and water-based alkyds, which again might make tests on present-day paints out of date when the results were obtained.

In discussion it was clear that the OCCA members on the whole had little to quarrel with in Mr. Dukes's work. It was pointed out that paints have many functions, and it was difficult to decide whether one paint was generally better than another because the balance of properties might differ, each being a reasonable compromise. Mr. Dukes agreed with this, and said that if a " best buy " was obvious it would be indicated, otherwise the different merits of the paints would be listed without making a definite choice : this was sometimes done with other products. The difficulties of testing hiding power were also mentioned, again Mr. Dukes agreed, but said that while different painters obtained different absolute results, the order of performance remained consistent. It was said from the Decorators' side that some of the quoted spreading rates of the emulsion paints were very low, but this was disputed from the OCCA side, on the grounds that the figures referred to application of two coats.

The meeting was attended by about 85 people and the hall was full. In moving a vote of thanks, Mr. Deller, of the Paintmakers' Association, on behalf of his Association and the Decorators, praised the speaker, the general work of the Consumers' Association, and their courage in tackling such a difficult subject as paint.

D. M. J.

Victorian Section

DEVELOPMENTS IN THE APPLICATION OF UNSATURATED POLYESTERS

At the September technical session, Mr. J. Samois, a member of the New South Wales Section, presented a paper entitled " Developments in the Application of Unsaturated Polyesters."

In the European market the use of polyesters for surface coatings had remained almost static over the past two years as new finishing systems such as polyurethane finishes had made inroads into the market. However, new techniques of using polyesters had, to some degree, arrested this trend and there were now signs that polyesters would soon once more enlarge their markets.

The basic chemistry of polyester resins was briefly reviewed and the two major types (air inhibited and " gloss ") illustrated by display panels. The pigmentation of polyesters presented something of a problem owing to the marked variation in their wetting properties for different pigments. This could lead to floating problems, although because relatively coarse dispersions could be used (because of the high film-builds normally employed) these problems were not as serious as might appear at first examination. Pigmentation could also affect pot-life and one example was given of a reduction from 25 minutes to seven minutes by the substitution in otherwise identical formulae of one talc by another, which by all normal tests appeared identical to it.

Rapid hardening of polyesters by the inclusion in the formulation of some melamine-formaldehyde resin can lead to yellowing (both in sunlight and in the dark) and this was illustrated by display panels.

The addition of silicone oils to control flooding and flow was well known, but care must be exercised in the choice of silicone as this could interfere with the sanding properties. This might be due to incompatibliity of the silicone resin.

In applying polyester resins to " difficult " surfaces such as non-ferrous metals, stainless steel or concrete, some important advances have been made recently. Special polyesters with distinct " alkyd characteristics " had been developed and these cured by stoving with a melamine-formaldehyde resin as well as by the conventional polymerisable solvent-redox system. Adhesion to metallic surfaces was excellent, but gloss retention on exterior exposure was poor.

An interesting development was the treatment of the substrate with an isocyanate prior to application of the polyester. This acted as a " key," binding the finish to the surface to be pointed. The isocyanate might also be added to the polyester in a three-pack system, to give films having exceptional chemical resistance.

The lecturer concluded with a description of some improved methods of applying polyesters to timber, including the " active base " and " reversal " systems.

Mr. W. Nunn thanked the speaker on behalf of the 57 members present for his well delivered and technically stimulating lecture.

D. W. B.

TORQUAY CONFERENCE, 25-29 MAY, 1965

RECENT PROGRESS IN COATINGS TECHNOLOGY

As already announced in the *Journal*, arrangements have been made to hold the next Association Conference at Torquay from 25-29 May 1965, with headquarters at the Palace Hotel, where the technical sessions will also take place.

The Conference programme and application form will be sent to members at the beginning of 1965, but non-members and visitors from abroad who would like to attend this important biennial Conference are asked to send their names to the General Secretary at the address shown on the front cover, so that their application forms may be despatched at the same time as those sent to members. The Council has fixed the registration fees at £6 for members, £4 for wives and £8 for non-members.

In order to encourage Junior Members, Council has decided that, on this occasion, they may attend on payment of half the fee for members.

The nine technical papers are groups under the general title " Recent Progress in Coatings Technology," and will be presented on the mornings of 26, 27 and 28 May. The order in which the lectures will be given has not yet been decided and exact details will be given in the Conference programme. Brief biographical details and photographs of the lecturers appear below. Synopses of the papers will appear in the January issue of the *Journal* and reprints of these will be available to members and non-members upon application to the General Secretary. Non-members will receive copies of the *Journal* containing the discussions.

In addition to these technical sessions, on the afternoon of Friday 28 May, following the Association's Annual General Meeting, the Council has decided to initiate a new feature in the form of three workshop sessions ; admittance to these will be by ticket only. The titles of these sessions will be " The Influence of Moisture on Surface Coatings," " Critical Design of Experiment " and " International Harmonisation of Testing Methods."

On Tuesday 25 May, following its success at the Scarborough Conference in 1963, a Presidential Reception will be held for members and visitors from overseas. On the following three afternoons there will be coach tours to Becky Falls and Haytor, Slapton Sands and Dartmouth, and Buckfast Abbey, and on the Thursday afternoon (weather permitting) a coastal and river cruise on the Bateau Morgat. Golf tournaments will also be organised at Brixham and Torquay golf courses, and tennis and table tennis tournaments will take place at the Palace Hotel.

For the ladies only during the morning of 27 May a cookery demonstration entitled " Entertaining Made Easy " will be given by Miss Betty Gilley in the Demonstration Theatre at the Torquay District Offices of the South-Western Gas Board. It is also hoped to arrange a theatre party, as usual, for the Thursday evening.

On the evening of Wednesday 26 May the Worshipful the Mayor of Torquay will receive delegates and their ladies at a Civic Reception, and on Friday 28 May the Association will have the pleasure of entertaining representatives of the civic authorities at its own Dinner and Dance at the Palace Hotel.

Other attractions which those attending the Conference might like to visit include Kent's Cavern and the new Model Village at Babbacombe, both of which have offered reduced admission fees to delegates.

BIOGRAPHICAL DETAILS OF THE LECTURERS AT THE 1965 CONFERENCE

Allyl Ethers in Solventless and Water-based Coatings, by L. A. O'Neill and R. A. Brett.

Dr. L. A. O'Neill graduated at Queen Mary College, London University in 1934 and joined the Paint Research Station in 1935. He obtained an external Ph.D in 1949 for work carried out there on the autoxidation of drying oils. He is now Principal Research Officer in charge of research on media, analysis and microbiology.

L. A. O'NEILL

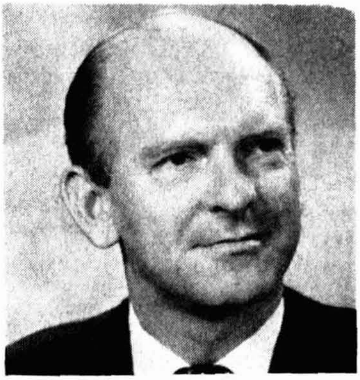
R. A. BRETT

Mr. R. A. Brett graduated with honours in chemistry at London University in 1948, his college studies being interrupted by wartime duties with the Ministry of Supply, concerned with the analysis of explosive compositions, and by service with the RAF.

After the war he joined the Staff of the Paint Research Station where he has been associated with a number of aspects of media research—notably on the general chemistry of drying oils, the relation between structure and performance of alkyd resins and latterly with work in the water-soluble resins field.

The Electrodeposition of Paint, Some Basic Studies, by A. R. H. Tawn and J. Berry

Mr. A. R. H. Tawn was born in Hornsea, Yorkshire, and educated at Kingston High School, Hull Technical College and The Polytechnic where he qualified as an A.R.I.C. and subsequently elected F.R.I.C. After some years with British Oil & Cake Mills Limited, he entered the Forces and, at the end of hostilities, was appointed Head of the Chemistry Department at No. 6 (and later No. 1) Army College. He joined the Coates group of Companies in 1947 where his specialisation in polymer chemistry led to his present appointment as Research and Development Manager of Cray Valley Products Ltd., the synthetic resin division of the group. He is especially interested in the physical chemistry of polymers, the application of mathematical techniques to research and management and teaching. These interests together with his active participation in the affairs of the Association leave little time for his erstwhile hobbies, sailing, cabinet making and bridge.



A. R. H. TAWN

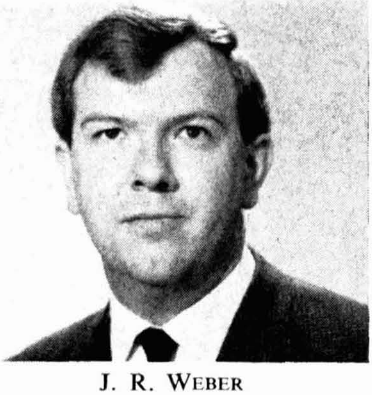
J. R. Berry

Mr. J. R. Berry was educated at Cranleigh and various technical colleges, and acquired B.Sc with honours at London 1954. He started his career with British Resin Products Ltd. in 1946, in the Technical Service Department, subsequently moved to Duresco Products Ltd. to gain first-hand experience of the paint industry, and finally moved to Cray Valley Products Ltd. in 1958, where he is now Technical Service Manager.

Powder Coatings—Adhesion and Permeability Studies, by L. A. Tysall and J. Weber

Mr. L. A. Tysall graduated from Queen Mary College, University of London, and then spent some three years teaching in technical and grammar schools. He then moved to industry, working on explosives, pharmaceuticals and later on industrial paints with Cellon Limited. He joined Shell Chemical Company Limited in 1946 and has been concerned with both staff training and technical service/development work. He is at present in charge of the Development Section of Resins and Surface Coatings Laboratory at Egham, Surrey.

L. A. Tysall



J. R. Weber

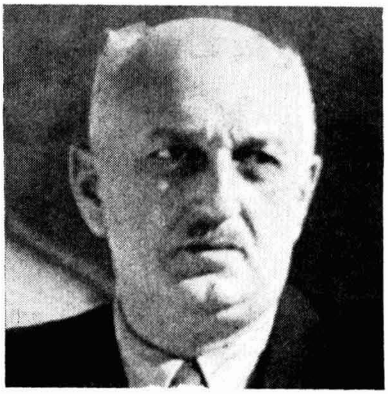
Mr. J. R. Weber graduated at the University of Liverpool in 1955 and obtained his Ph.D. at the same University in 1958. He spent one year on a Research Fellowship at the California Institute of Technology and joined Shell Chemical Company Ltd. in 1960. Is at present a team leader in the Surface Coatings Development Laboratory at Egham, Surrey.

[*Continued overleaf*

Characteristics of Electrostatic Power Spraying, by K. M. Oesterle and I. Szasz

Mr. K. M. Oesterle was born in 1901 in Berne, Switzerland and in 1924 graduated at the Polytechnical High School (ETH), Zurich as electrical-engineer (Dipl.Ing. ETH). In 1927-28 he was assistant engineer at the University of Berne and graduated as a doctor of engineering chemistry at the Polytechnical High School (ETH), Zurich. He has studied electrochemistry, electric engineering and chemical plants and is Chief Chemist and Managing Research Director in the electro-mechanical and the paint and varnish industries. He is also lecturer at the Polytechnical High School (ETH), Zurich.

K. M. OESTERLE



I. SZASZ

Mr. I. Szasz was born at Budapest in 1908 and graduated at the Technical University of Budapest as engineer (Dipl.Ing.) in 1930. He studied in Hungary until 1956 and later in Switzerland as an engineer in research and technical developments in mechanics, hydrodynamic—and pneumatic automatisation, electrostatic—and electrodynamic problems.

The Chemistry of Vinyl Cydic Acetals and their Air-Drying Reactions, by Dr. Seymore Hochberg

Dr. Seymore Hochberg was born in New York City on 15 July 1916, and was educated at College of the City of New York, where he obtained his B.S. degree in 1935. Further degrees (M.A. and Ph.D.) were obtained at Colombia University where he majored in physical chemistry with research in the field of kinetics and thermodynamics in electrolyte solutions.

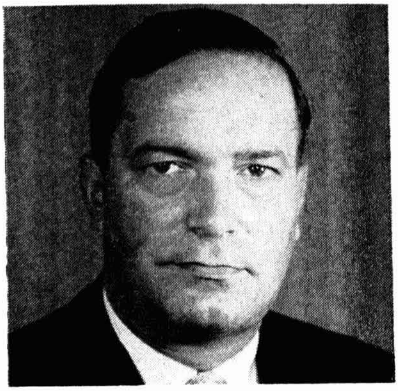
He taught in New York City High Schools for three years and then worked for Columbia University from 1941-45 as a Research Associate in their programme on aerosols. In 1945 he joined Du Pont's Fabrics and Finishes Department and has been working in their Marshall Laboratory in Philadelphia since that time.

His research included optical properties of colloids, generation of fine particle fogs, grinding, and polymerisation.

He lives with his wife and two children in Wynnewood, Pennsylvania.

S. HOCHBERG

The Influence of the Surface-Treatment of Titanium Dioxide Pigments on Electrocoating, by Dr. H. Rechmann



H. RECHMANN

Dr. H. Rechmann was born in Dusseldorf in 1920 and commenced the study of chemistry at Cologne University in 1937 but the Second World War delayed his training by six years. He was awarded the degree of Doctor of Philosophy at the same University in 1949, at which time he had chosen inorganic chemistry as the chief subject, with physical chemistry and physics as subsidiary subjects. Already in the same year, he began his activities in the field of industry by the carrying out of research work with the Titangesellschaft mbH, of Leverkusen. Here, in 1956, he took over the working group of pigment development, which in 1962 he assumed total control of the research department.

A paper entitled "Solventless Polyurethanes" will be given by Dr. Gruber of Farbenfabriken Bayer.

Alkali Silicates in Surface Coatings (with special reference to Zinc Alkalic Silicate Systems), by A. Pass and M. J. Meason

Alfred Pass obtained his early education at Halesowen Grammar School and Queen Elizabeth School, Hartlebury. He went straight from school into industry as a junior chemist with Messrs. Stewarts & Lloyds Ltd. His scientific and technical education was obtained at Birmingham Central Technical College, Sir John Cass Technical Institute, Aldgate, and Borough Polytechnic. He became an Associate of The Royal Institute of Chemistry in 1930, and is now a Fellow of the Institute.

In 1927, he joined Messrs. H. Edwin Coley Ltd. as a chemist and has since remained with the various successor companies which concentrated on extraction and manufacture of zinc and its products. He has been with his present employers, Amalgamated Oxides (1939) Ltd., first, as Chief Chemist, and since 1958, as Technical Director.

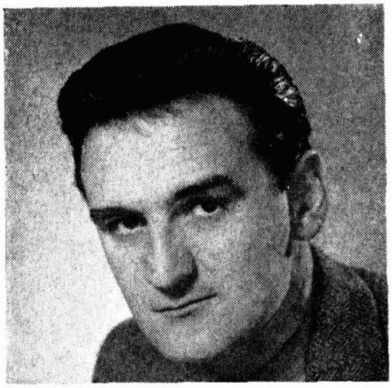
A. PASS

A Member of Council and Technical Committee of Zinc Pigment Development Association, he has also served on Council and London Section Committee of OCCA. He has been author, or joint author, of various papers dealing with zinc pigments, the majority of which have appeared in *JOCCA*.

[*Continued overleaf*

Torquay Conference continued]

M. J. F. Meason was educated at Marr College, Troon and Glasgow University, where he took a B.Sc. in Chemistry. He joined Stewarts & Lloyds Ltd., Corby, in the Department of Research and Technical Development in 1945 and moved to Amalgamated Oxides (1939) Ltd., Dartford in 1946, becoming Chief Chemist in 1961. He is author of several joint papers on zinc rich paints and allied subjects. Member of PVC/1/6 (White Pigments), PVC/1/18 (Zinc Dust) and the technical committee of the Zinc Pigment Development Association.



M. J. MEASON

Surface Coating of Metals in a Glow Discharge by T. Williams

T. WILLIAMS

Mr. T. Williams, who is 29 years old, obtained his Ph.D. in electro-chemistry at the University College of Wales, Aberystwyth in 1960. Before joining BISRA, he was, for two years, a lecturer in chemistry at the Welsh College of Advanced Technology.

As a member of BISRA's coatings research section at Sketty Hall, he was concerned with new surface coatings for steel and in particular glow discharge coatings. Recently he was transferred to the Development Section to take charge of the experimental glow discharge plant now being built for strip coating.

Manchester Section

VISIT TO FORD MOTOR COMPANY, HALEWOOD

On the afternoon of 18 September 1964 the Chairman, Mr. H. F. Clay, and 40 members of the Section visited the modern car manufacturing plant at Halewood. This £30 million plant, completed in 1963, is designed to produce 200,000 vehicles a year and is the largest of its type in Western Europe, covering 50 acres under one roof on the 346-acre site. The models produced at this site are the various types of *Anglia*, *Corsair* and *Capri*.

The plant, which is really two plants under one roof, consists of a stamping and assembly plant, to be supplemented at the end of 1964 by a new £8½ million transmission plant.

Members started their tour at the stamping plant, where 96 giant presses exerting pressures of up to 800 tons cut out and contoured the steel sheets into body panels. A constant supply of steel sheet is supplied from the steel shop by 14 overhead cranes. At the end of the stamping line the steel pressings (up to 4,500 tons in total) were seen stored in the palletisation area.

Following the production flow, members then entered the assembly plant at the body manufacturing area. Here the multitude of body panels are spot welded together in special jigs by individual operations and by multiwelders, the tremendous area given over to this operation being an impressive triumph of organisation, design and layout. A forest of equipment conveys the impression received.

As members moved on through the area, looking rather unusual in their grotesque safety spectacles, most were impressed by the complexity and length of the line, and were most grateful for a contrived break in the line, leading to the modern canteen, where light refreshments were served.

Returning to the line with renewed energy, members then entered the paint shop, where most brought their critical faculties into use—some especially being impressed by the instructions to " keep hands off bodies." The paint shop is a complete and separate unit on the first floor of the building up to which the bodies are lifted on the conveyor line. The bodies are first degreased, then metal pretreated and given two primer coats and three enamel coats. The paint is stoved in ovens reaching 300°C, altogether stretching for one mile up and down the shop. Great care is taken to obtain unblemished finishes, which are subject to the same strict quality control which is a feature of each operation throughout the entire plant.

At the end of the paint shop line the bodies drop down to the trim lines and so on to the final assembly lines. Here members were interested to see the engines coming down the line from the unloading area at the railhead of the Dagenham-Halewood daily, the engine, transmission and suspension all being manufactured at present at Dagenham and transported by this special daily rail link into the factory area.

More surprising to many of the members was the way the complete engine, and gear box with all ancillaries such as starter, dynamo, exhaust box and front suspension, was assembled together and then passed along the line to be met by a body of the correct type for the engine and suspension, these bodies being already fitted with interior trim, wiring and rear suspension from the trim assembly lines.

Lastly on the line, members saw what they had all anticipated, the fitting of wheels, and final trim, seats, etc. Then after filling with petrol, water and oil, being driven off the line for final adjustments, quality control checking for such items as lights, brakes, engine power, and water leaks in special booths.

After grateful thanks to the guide, members were then transported back to the airport rendezvous, where it was agreed that the visit had been most interesting despite the three-mile walk. However, some members wished there had been time to see and pursue the methods used to control the complex organisation of components and assembly in what they could readily believe is one of the most integrated and technically advanced car plants in the world.

In the evening members gathered for dinner and a social evening at the Gateacre Hall Hotel, where the evening was marred only by the Liar Dice Kings being deprived (by the management) of their usual lucrative practice. The frustration generated by this blow, not softened by the music, eventually resulted in a notorious Liverpool member throwing his car keys away over the highest wall available, thus providing the evening's most interesting game of chance.

Members may be interested to know that because of the interest shown in the visit and the strict limitation of numbers, that it is hoped to arrange a further visit later in the session.

W. F. McD.

Midlands Section

LADIES' NIGHT

The Midlands Section Ladies' night will be held this year on 4 December at the Belfry, Moxhull Park, Sutton Coldfield. The function will commence with a reception at 7 p.m. and be followed by the dinner at 7.30 p.m. at which Mr. I. C. R. Bews, the Association's Honorary Secretary, will take the chair. In order that there should be the maximum amount of time for dancing there will be a restricted toast list, dancing will end at 2 a.m. Further information can be obtained from Mr. D. J. Silsby, 356, Baldwins Lane, Hall Green, Birmingham, 28.

Scottish Section

WHITTAKER TROPHY GOLF COMPETITION

Play in the annual Whittaker Trophy Golf Competition took place over Skelmorlie Golf Course on 20 September, commencing at 2.30 p.m. An afternoon of blue sky and sunshine, a none too common experience this year, ensured the maximum of enthusiasm and enjoyment amongst those participating. Competition was keen to the point of there being a tie for first place between Mr. R. Yates and Mr. D. Chesney. The presentation was made by the Vice-Chairman, Mr. I. M. Hutchison, and a very pleasant outing was rounded off with high tea served in the clubhouse.

A. McL.

Victorian Section

PAST CHAIRMEN'S DINNER

The Annual Past Chairmen's Dinner of the Victorian Section was held in the Danish Club, St. Kilda, on 11 September. On this evening, in addition to the seven Past Chairmen who were able to attend, four of the five Past Hon. Editors of the *Victorian OCCA News* were also able to be present, it being considered that this was a fitting occasion to honour the work of these members in raising a local news sheet through progressive stages to the current level of the Australian Federal Committee's *Proceedings and News*. Nine members of the current Committee were the hosts for the evening.

The toast to the Past Chairmen was proposed by Mr. F. Marson and the response given by Mr. R. Goss. Unfortunately the Immediate Past Chairman, Mr. D. Cairns, was delayed by snow from attending, his badge being received on his behalf by Mr. B. Lummis.

The company joined Mr. D. Berryman in toasting the Past Hon. Editors and in paying a sincere tribute to them for their work on behalf of the Section. A presentation was made to each Hon. Editor by the Chairman.

In responding to this toast, the first Hon. Editor, Mr. G. Sterling, drew the company's attention to the " back-room " work of Mr. G. Winter, who has provided the inspiration and drive for the original *Victorian OCCA News*. In accordance with custom, the new members of the Committee, who had not been present at a previous dinner, expressed their thoughts to the meeting on particular aspects of OCCA affairs : Mr. J. Heron, social activities ; Mr. G. Hartshorn, Section co-operation and meeting procedure ; Mr. B. Fells, recent programming experiences.

In the ensuing spirited discussion the Past Chairmen gave their interpretation of current and future OCCA activities for the benefit of the current Committee.

The meeting concluded with suggestions from the assembly to the Hon. Editor of *Proceedings and News* about future issues of this publication.

D. W. B.

CITY AND GUILDS OF LONDON INSTITUTE EXAMINATIONS RESULTS

Congratulations are extended to the following members of the Association upon their success in the recent City and Guilds of London Institute examinations. The class of membership and the Section to which the member is attached are shown in italics.

Printing Ink Technicians Certificate—

R. W. Beadle (*Associate—London*), D. B. Boulton (*Associate—London*), J. C. Watts (*Associate—London*), J. E. Armstrong (*Ordinary—Midlands*).

THE PERKIN CENTENARY TRUST

The Perkin Centenary Scholarship

These awards are offered, each for one or two years, renewable at the discretion of the Trustees for one further year, to enable candidates employed in an industrial firm or other institution concerned with the manufacture or the application of colouring matters to study at a university or technical college. Two types of award are available, some to the value of £100 to be used in conjunction with an LEA grant, and others to a value of £400. The £100 scholarships are intended for students who would normally receive a fairly substantial grant from the Local Education Authority. The higher value scholarships cancel out any LEA award and so they are intended for students whose normal grant, inclusive of fees, would be less than about £300. There will be no formal means test but the Trustees are prepared to discuss with the individual student which type of award would be most suitable. Applications must be received not later than 1 May 1965.

Perkin Travel Grants

These are available to teachers concerned with the study of any aspect of the manufacture or the application of colouring matters at a university, technical college or other institution. Awards will be made primarily to assist those for whom grants are not readily available from other sources and the Trustees expect that preference will be given to application from lecturers, senior lecturers and readers, or the equivalent grades in other institutions, wishing to gain experience at a similar institution or in industry on the Continent of Europe.

The object of the intended visit must be clearly stated (e.g. study of special techniques, apparatus or industrial processes, or to assist some stated research project) and the applicant will be expected to devote sufficient of his time to that object so that effective study is possible. Each application will be considered on its merits but, in general, the Trustees favour an extended stay at one or two institutions rather than brief visits to a larger number of establishments. Applications for which the sole or primary purpose is to participate in a conference overseas will not normally be entertained.

Grants for the year commencing 6 April 1965, will be available towards the cost of travel and maintenance at rates of up to £5 per day for periods of from one to four months. Applications, accompanied by a recommendation from the Head of the Department in which the candidate is working, must be received not later than 31 December 1964.

KEYNOTE ADDRESS

The Federation of Societies for Paint Technology announce that Dr. J. H. Hollomon, Assistant Secretary for Science and Technology, will present the Keynote Address at the 42nd Annual Meeting of the Federation which will be held at the Conrad Hilton Hotel, Chicago, from 4-7 November 1964.

Obituary

H. STAMP

The death took place on 19 July 1964 of Harry Stamp, a well-known Ordinary Member attached to the Hull Section.

He joined Hangers Paints Ltd. (then Hanger, Watson & Harris) in 1917, and after war service in the Army from 1917-19 returned to the paint industry and for some years was the only chemist employed by Hangers. During the major part of his career he was connected with the development of marine finishes and was an expert in this field.

His whole career was spent at Hangers and he retired on 30 June 1964 and died three weeks later. He joined the Hull Section as an Ordinary Member in May 1942 when it was then a Regional Group attached to the London Section, and served on the Section Committee from 1945-52.

W. A. RUTHERFORD.

NEWS OF MEMBERS

Mr. F. Lewis, an Ordinary Member attached to the Manchester Section, has recently been appointed as Chief Chemist (Industrial Paints) by The Walpamur Company Limited at their Darwen factory.

In September the General Secretary was pleased to welcome to the Association's offices Mr. G. Smith, Chairman of the Queensland Section and a member of the Australian Federal Committee. Mr. Smith spent a short time in the United Kingdom en route to the Continent.

Register of Members

The following elections to membership have been approved by Council. The Sections to which the new members are attached are given in italics.

Ordinary Members

FIELD, DONALD CEDRIC, B.SC., 46 St. Paul Street, Randwick, New South Wales, Australia. *(New South Wales)*
GAMON, MICHAEL HUGH, 30 St. Peter's Grove, Laceby, Grimsby, Lincs. *(Hull)*
MORTON, STANLEY, "Millfield," Darlington Road, Eaglescliffe, Co. Durham. *(Newcastle)*
PAWSEY, DERYK RAYMOND, British America Paint Co. Ltd., P.O. Box 70, 201 Belleville St., Victoria, B.C., Canada *(Overseas)*

Associate Members

BUTCHART, BILL ERSKINE, 9 Commonwealth Street, Sydney, New South Wales, Australia. *(New South Wales)*
BYRNE, ROBERT CHARLES, 1a Marguerette Street, Ermington, New South Wales Australia. *(New South Wales)*
DARKE, RICHARD MICHAEL, Flat 1, 37-39, Eastfield Road, Burnham, Bucks. *(London—Thames Valley Branch)*
ENGERT, PETER RAYMOND, Robert Bryce & Co. Ltd., 183 Botany Road, Waterloo, New South Wales, Australia. *(New South Wales)*
MATTHEWS, JACK VINCENT, H. G. Oakley & Co. Ltd., The Maltings, Barnet Road, London Colney, Herts. *(London)*

Junior Members

CHESWORTH, BRYAN JOHN, 82 Orchard Road, Wednesfield, Wolverhampton, Staffs. *(Midlands)*
INSCOE, DAVID BARRY, 15 Lea Road, Penn Fields, Wolverhampton, Staffs. *(Midlands)*
PULLEN, DAVID EMERTON, 36 Binalong Road, Wentworthville, New South Wales, Australia. *(New South Wales)*

Forthcoming Events

(Details are given of meetings in the United Kingdom up to the end of the month following publication, and in Sout Africa and the Commonwealth up to the end of the second month after publication).

1964

Monday 2 November

Hull Section. Joint meeting with Hull NFMP entitled "Floor and Wall Finishes with special reference to Vinyl" at the Royal Station Hotel at 7.15 p.m.

Monday 9 November

London Section (Southern Branch). "Durability Testing of Titanium Oxide Pigments" by Mr. E. Oakley at the Queen's Hotel, Southsea at 7.30 p.m.

Tuesday 10 November

West Riding Section. " Theory and Practice on the Use of Colour " by Miss A. Rathbone.

Wednesday 11 November

Scottish Section (Eastern Branch). " Paper/Printing Ink Relationships " by A. T. Franklin at the North British Hotel, Princes Street, Edinburgh at 7.30 p.m.

Thursday 12 November

London Section. " Mould Resistance of Paints in the Tropics " by P. Whiteley (Building Research Station) at Manson House, Portland Place, W.1 at 7 p.m.

Midlands Section (Trent Valley Branch). " Colour Consciousness " by Dr. F. M. Smith at the British Railways School of Transport Lecture Theatre at 7.30 p.m.

Newcastle Section. " Industrial Finishes in the Appliance Field " by Dr. H. J. Sharp at the Royal Turks Head Hotel, Newcastle at 6.30 p.m.

Scottish Section. " The Development of Water Soluble Resins " by A. G. North, at Mores Hotel, Glasgow at 7.30 p.m.

Saturday 14 November

Scottish Section. Student Group. Tutorials : (1) Pigments—P. Birrell, (2) Two Pot Systems—J. Miller, (3) Introduction to Plastics—Speaker from Shell Chemicals Ltd. To be held at Mores Hotel, Glasgow at 10 a.m.

Tuesday 17 November

London Section (Thames Valley Branch). " Antimony Oxide in Flame Retardant Paints " by A. G. Walker at the Royal White Hart, Beaconsfield at 7 p.m. Refreshments at 6.30 p.m.

Thursday 19 November

New South Wales Section. " Modern Extenders for Paint " by W. Murphy at the Theatrette M.L.C. Building, Muller Street, North Sydney at 8 p.m.

Queensland Section. " Recent Developments in Polyurethane Raw Materials " by J. Samios.

Friday 20 November

Council Meeting at 10.45 a.m.

London Section. Ladies' Night at Criterion in Piccadilly, London, W.1 at 7 p.m. for 7.45 p.m.

Manchester Section. "Dispersion Stabilisation Mechanisms in Paint Systems " by W. Black, Esq. at the Manchester Literary and Philosophical Society, George Street, Manchester at 6.30 p.m.

Midlands Section. " What is Pigment Dispersion ? " by Dr. F. M. Smith at the Birmingham Chamber of Commerce, Edgbaston at 6.30 p.m.

Friday 27 November

Bristol Section. " Painting of Plasters " Film Show and Discussion. Joint meeting with Birmingham P.V.L. Clubs at the Hawthorn Hotel, Bristol at 6.30 p.m.

Bristol Section—Irish Branch. " Mature Irish Timber " by T. Ferguson (Irish Inst. for Indust. Res. and Standards) at the Dolphin Hotel, Essex Street, Dublin at 8 p.m.

South Australia Section. Annual Dinner at the Buckingham Arms Hotel, Gilberton.

West Riding Section. Annual Dinner Dance at the Granby Hotel, Harrogate.

Thursday 3 December

Newcastle Section. " The Formulation and Testing of Paints for use in Radioactive Areas " by P. Walker (A.W.R.E. Aldermaston) at the Royal Turks Head Hotel, Newcastle at 6.30 p.m.

Friday 4 December

Midlands Section. Ladies' Night at the Belfry Hotel, Moxhull Park at 6.30 p.m.

Monday 7 December

Hull Section. " Fish Oils, Composition, Processing and Some Industrial Applications " by S. A. Reed. Joint meeting with the SCI Oil and Fats Group, at the Royal Station Hotel, Hull at 7.15 p.m.

Tuesday 8 December

London Section (Thames Valley Branch). " Management Techniques in Research " by S. P. Rose at the Royal White Hart, Beaconsfield at 7 p.m. Refreshments at 6.30 p.m.

Wednesday 9 December

London Section. " The Use of Furoic Acid in Alkyds " by V. Jenkins at Manson House, Portland Place, W.1 at 7 p.m.

Scottish Section (Eastern Branch). Lecture to be arranged " Driers 1965 " by J. H. N. Turner and A. T. Royle, at the North British Hotel, Princes Street, Edinburgh at 7.30 p.m.

Thursday 10 December

Scottish Section. " The Function and Place of the Stock Exchange in Everyday Life " by A. O. Spiers. Followed by the film " My Word is my Bond " at the Mores Hotel, Glasgow at 7.30 p.m.

Friday 11 December

Manchester Section. " Cybernetics " by Dr. F. H. George at the Textile Institute, 10, Blackfriars Street, Manchester, 13, at 6.30 p.m.

Saturday 12 December

Scottish Section. Student Group, film show at the Mores Hotel, Glasgow at 10 a.m.

Monday 14 December

London Section (Southern Branch). " Fluorescent Pigments and Coating " by Mr. H. H. Lavell at the Royal Hotel, Cumberland Place, Southampton at 7.30 p.m.

Thursday 17 December

Queensland Section. Annual Christmas Party.

LONDON SECTION SYMPOSIUM

" Paint versus Corrosion "

to be held at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7, at 3 p.m. on Thursday 7 January 1965.

Forms of application are being sent this month to all Members attached to London Section and others may obtain further details and forms from the Honorary Secretary of London Section, Mr. R. N. Wheeler, Shell Chemical Company Ltd., P.O. Box 11, Egham, Surrey.

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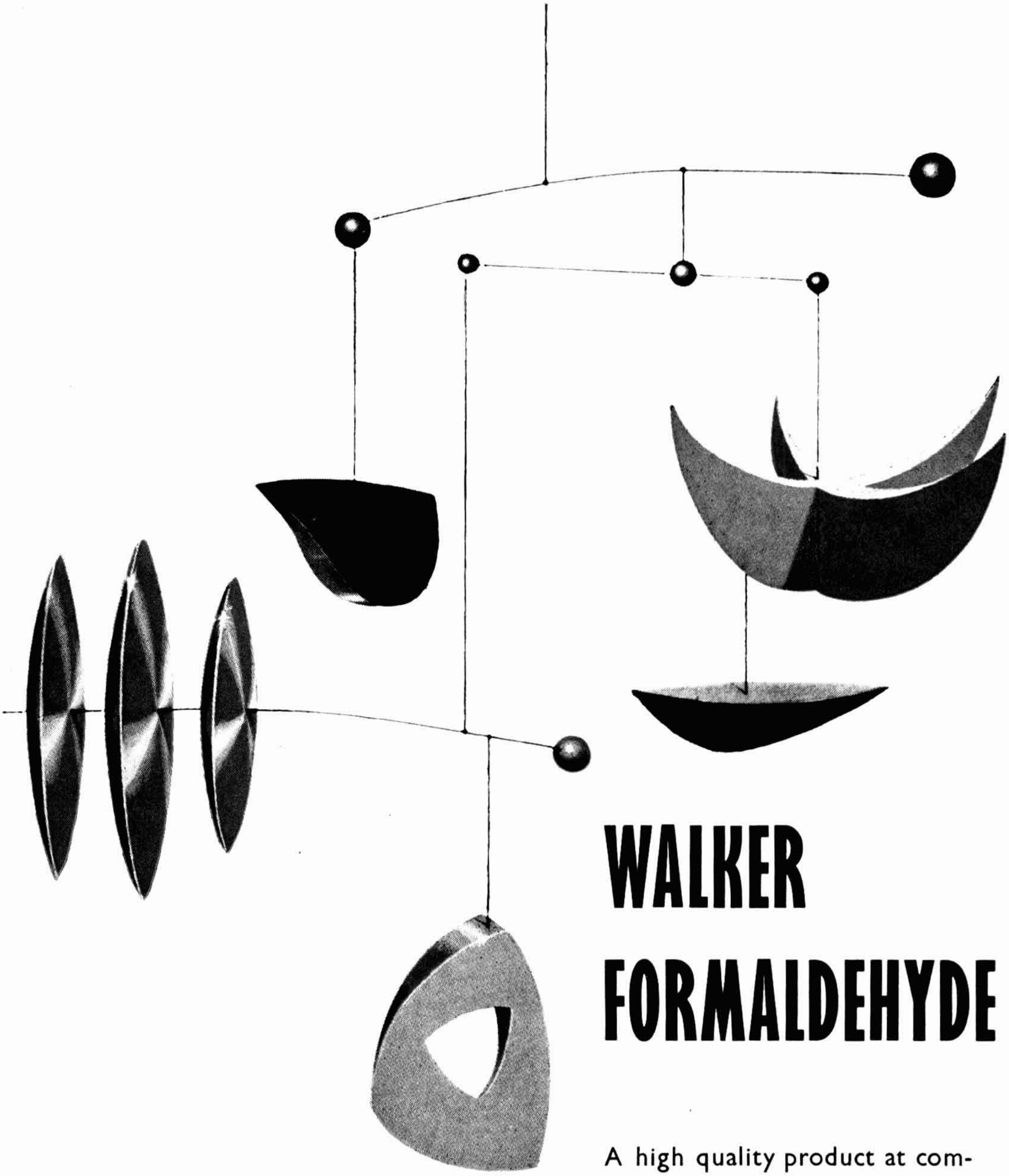

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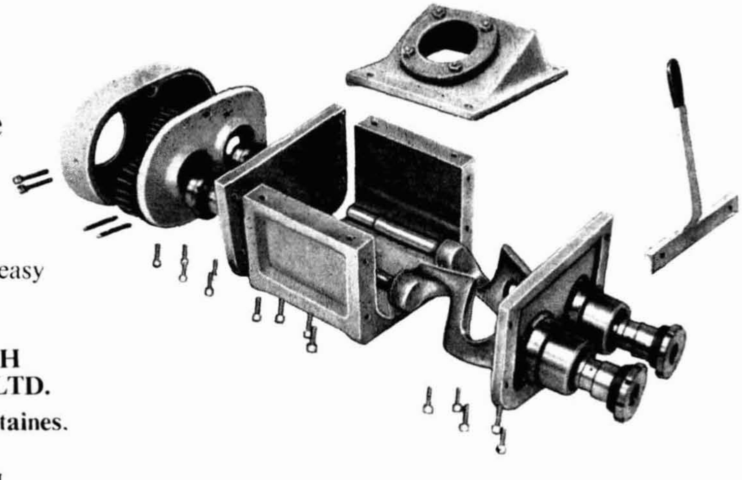

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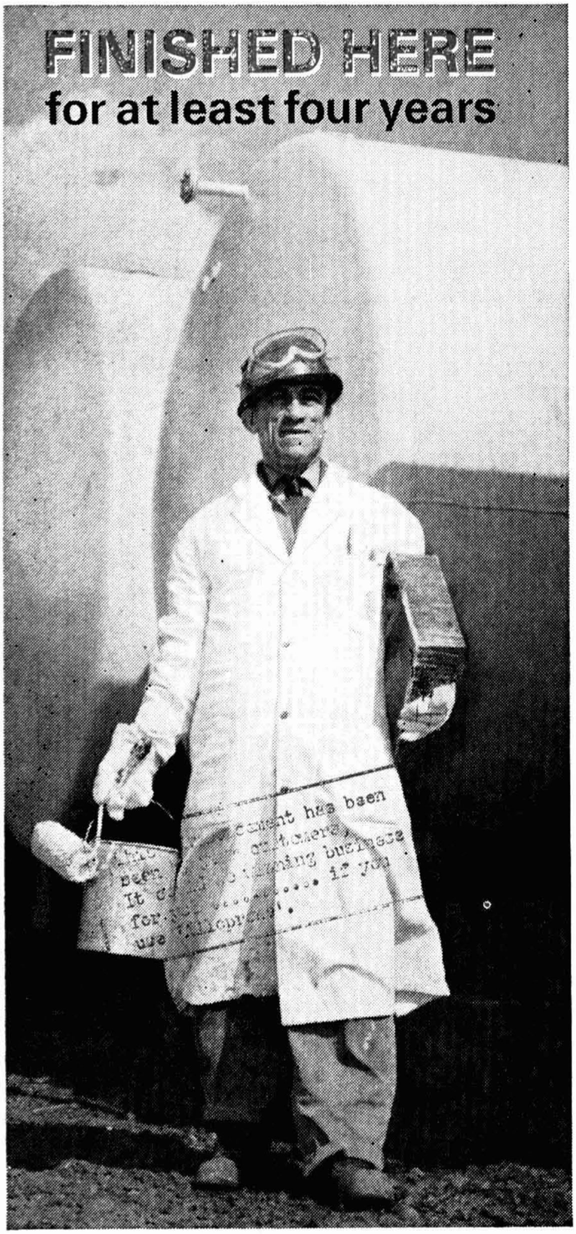

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**estimate based on ICI's experience with 'Alloprene thick coatings on other plant.*

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Operation	Cost/yd² (Labour at 7/5d per hour) pence
Preparation	
Descaling, scaffolding etc.	46·25
Washing down	4·25
Drying off	6·25
	56·75
Painting	
Primer, two thick coatings, finish filling and cleaning trays	31·50
Cost of materials for dry film thickness of 9·4 mil.	49·75
Total	138.00

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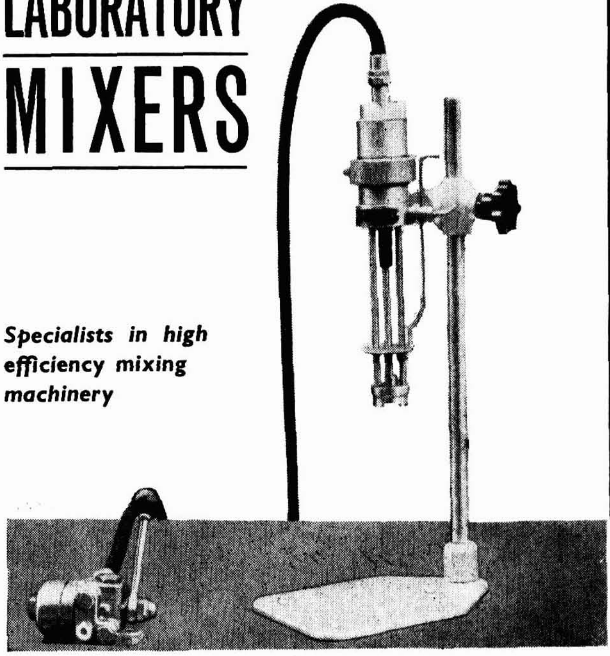

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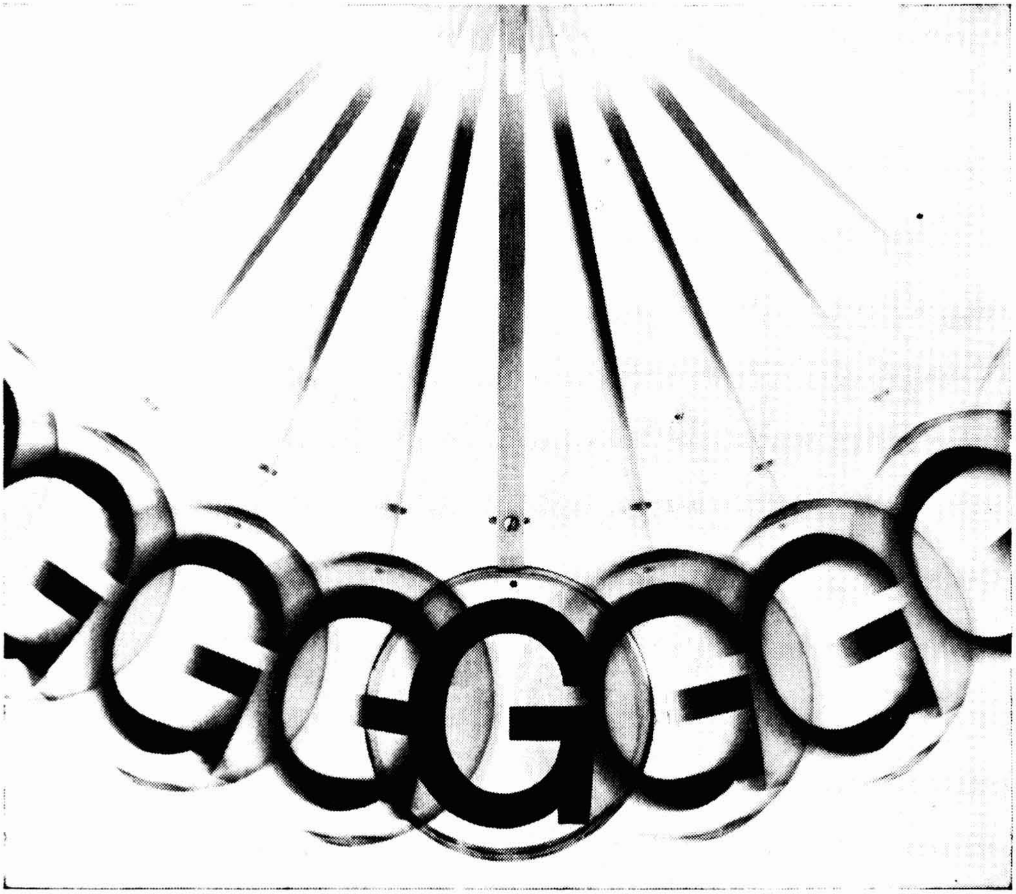

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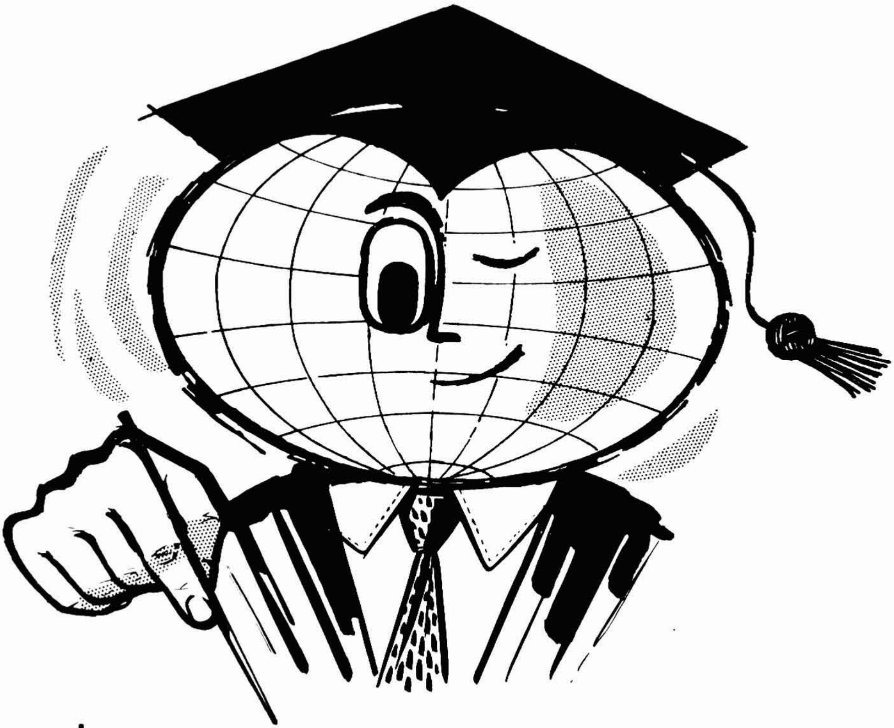

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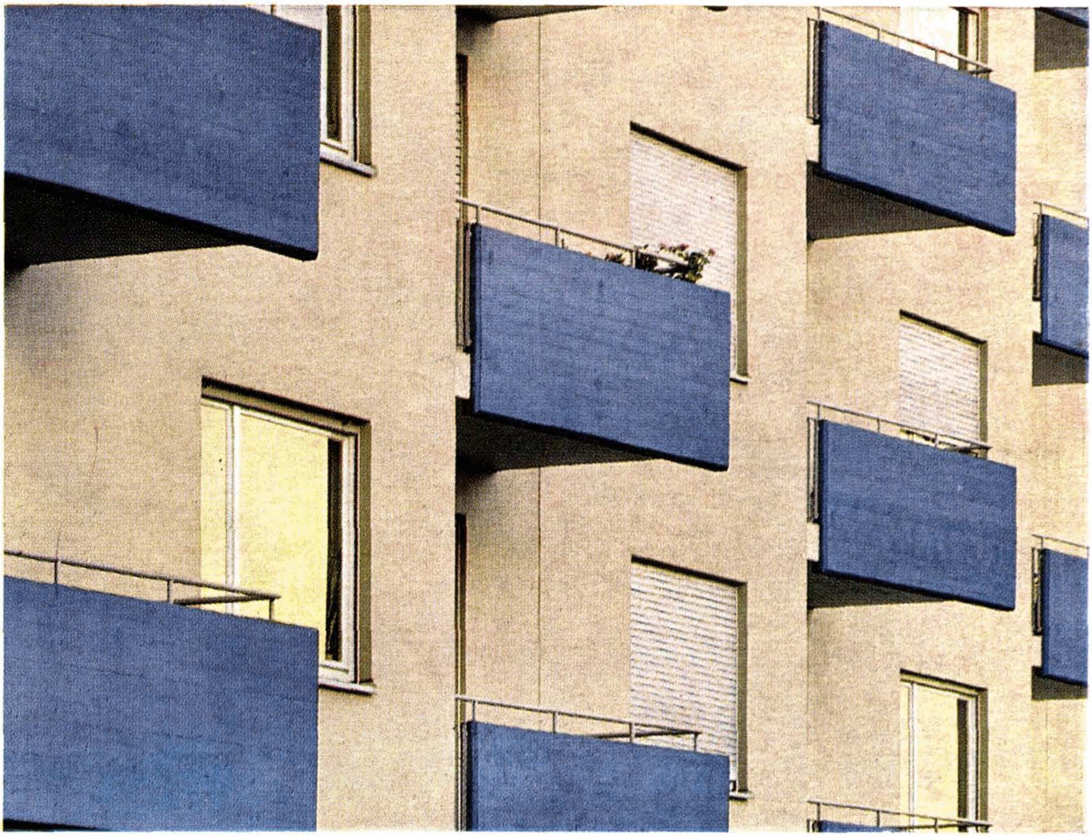

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