

JOURNAL

OF THE

OIL AND COLOUR CHEMISTS' ASSOCIATION



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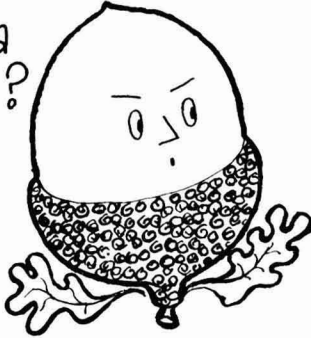
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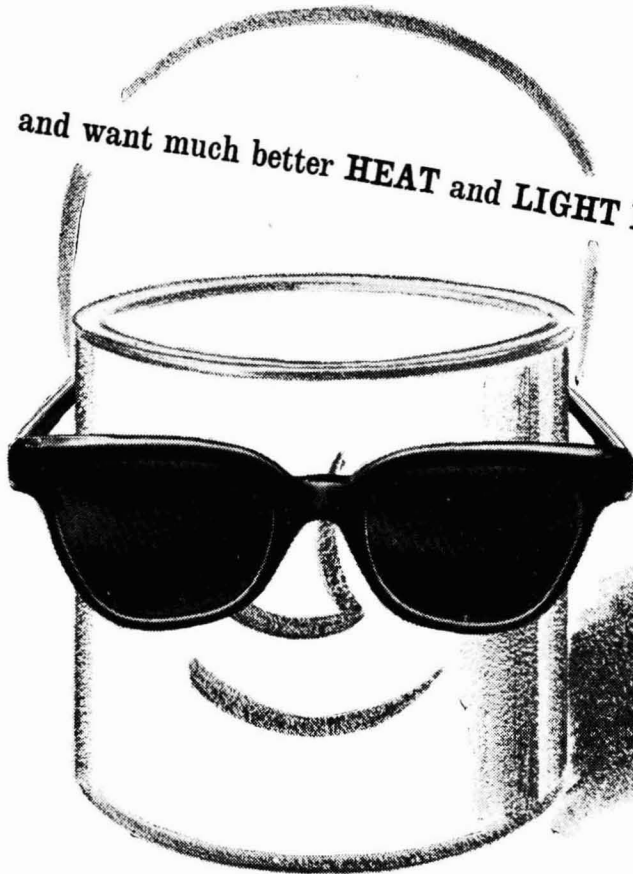
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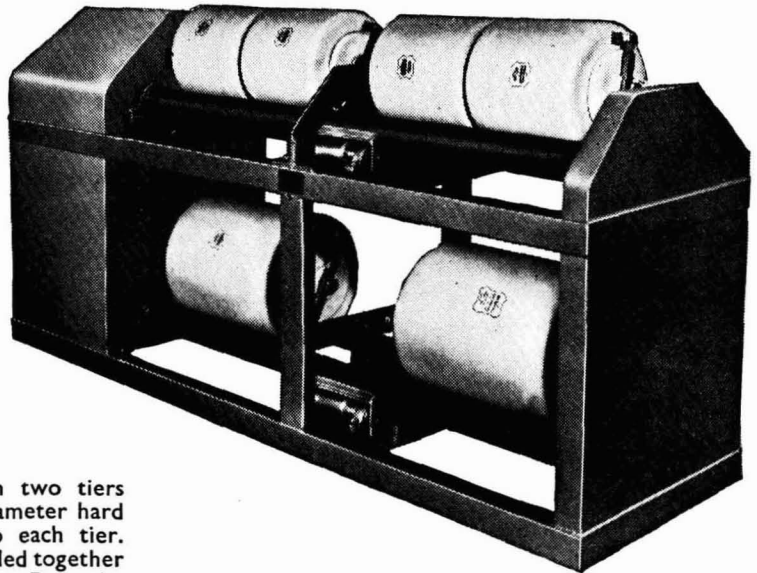
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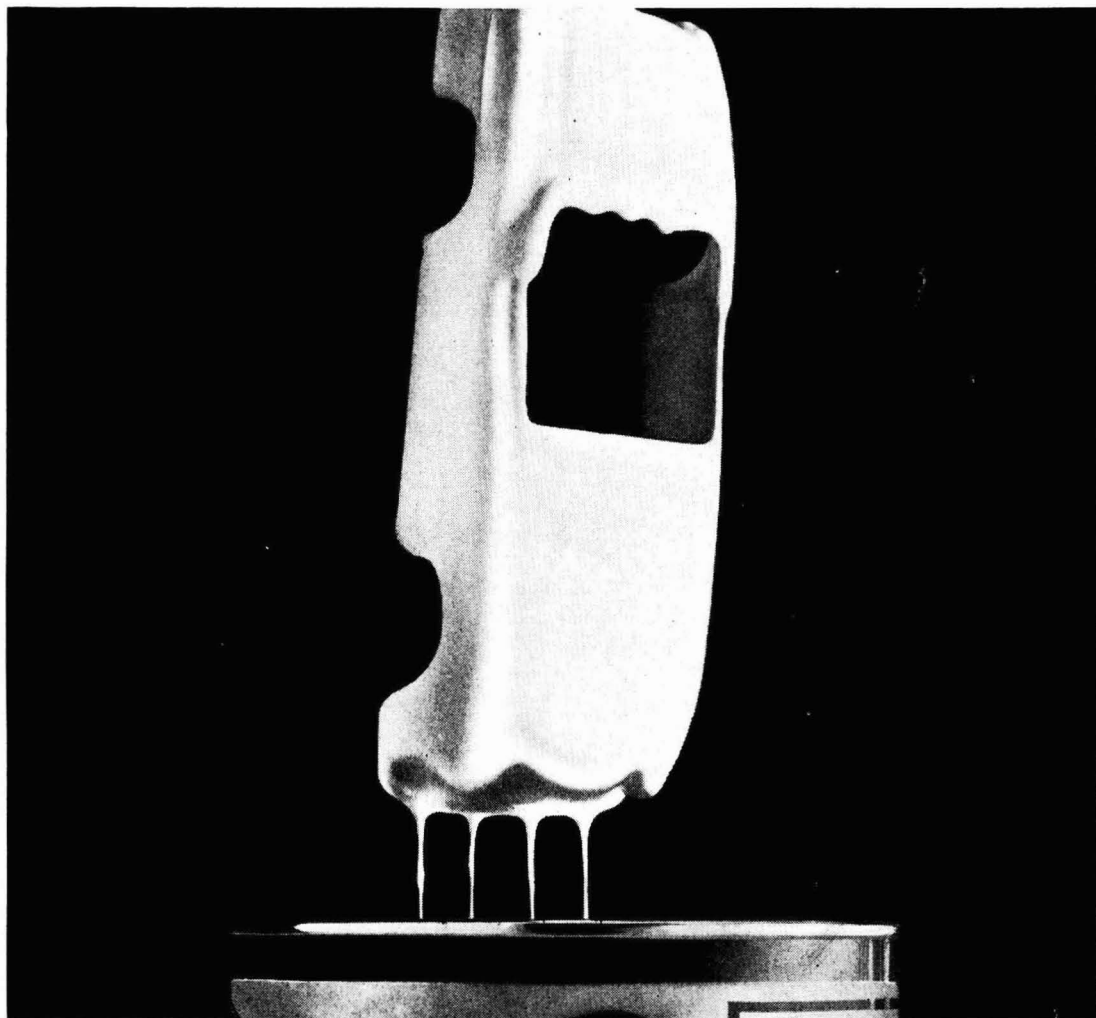
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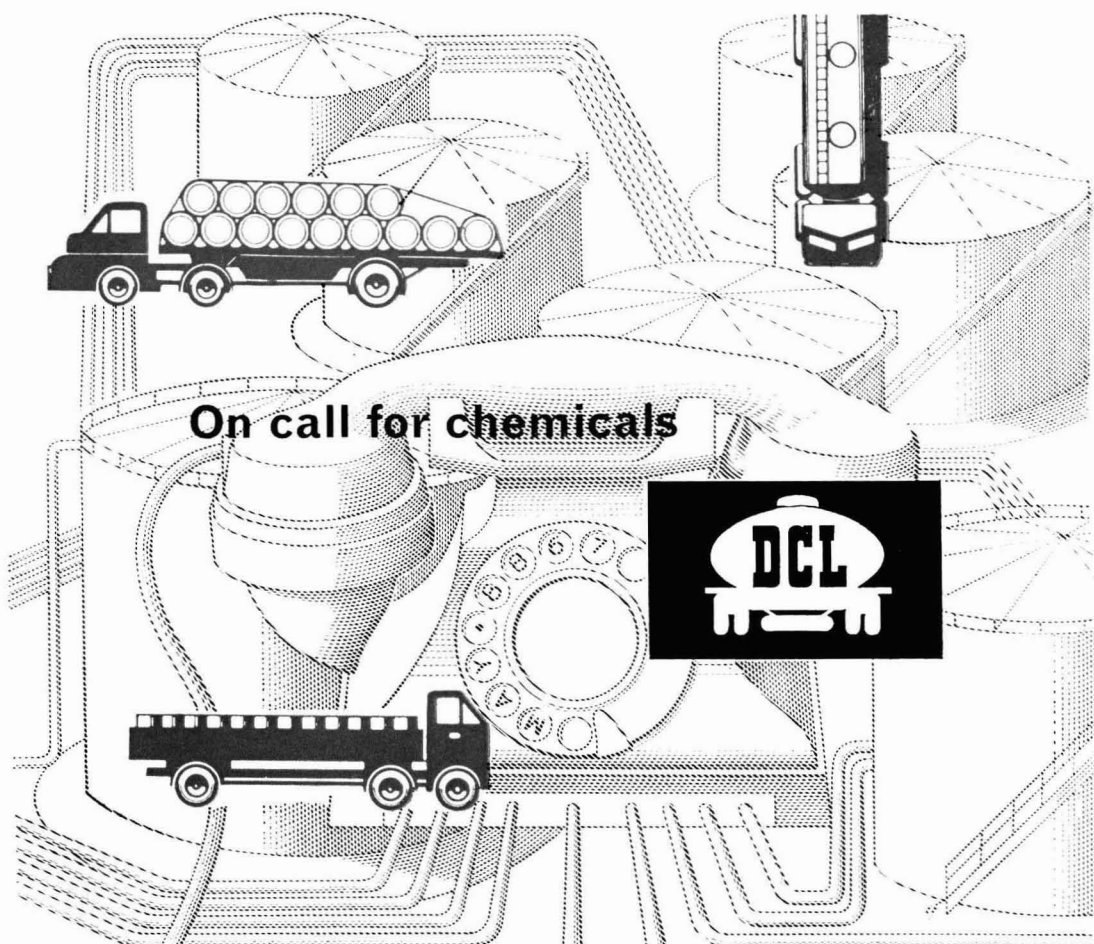
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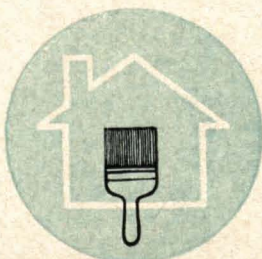
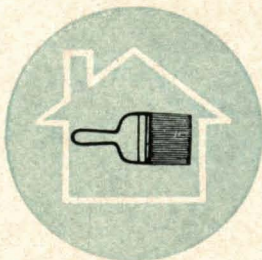
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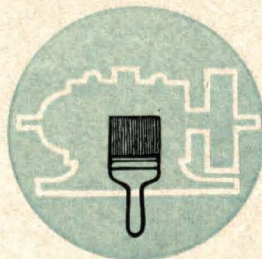
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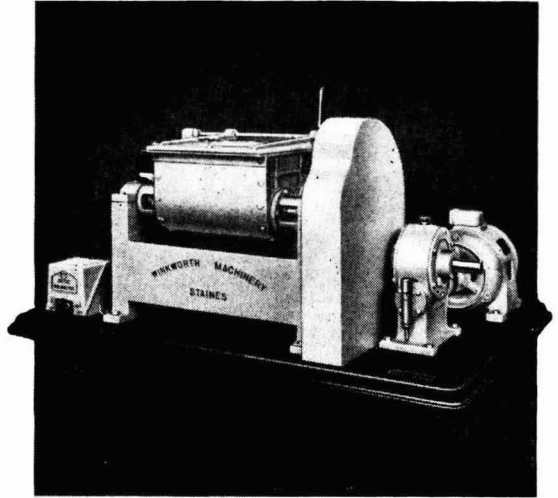
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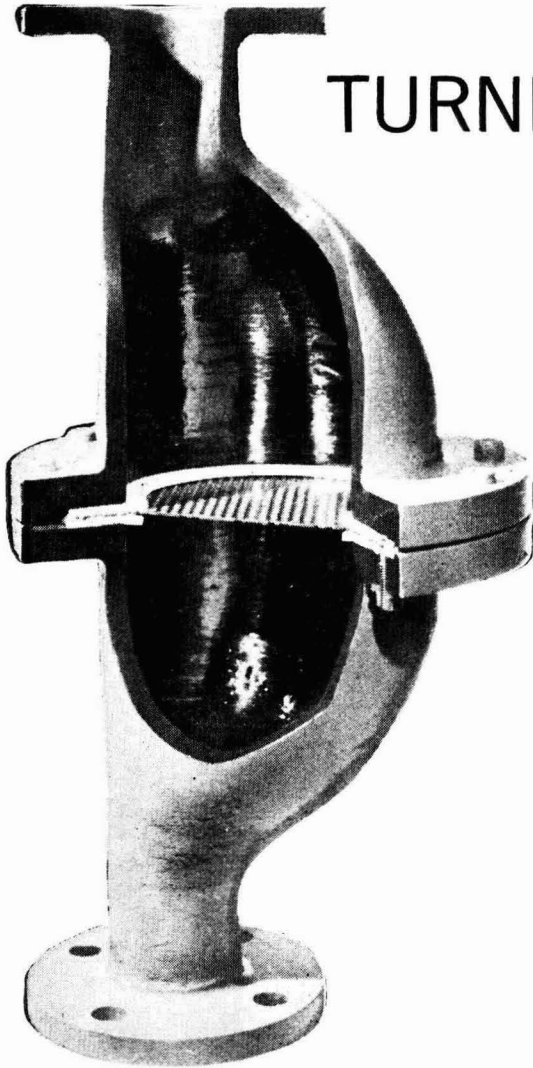
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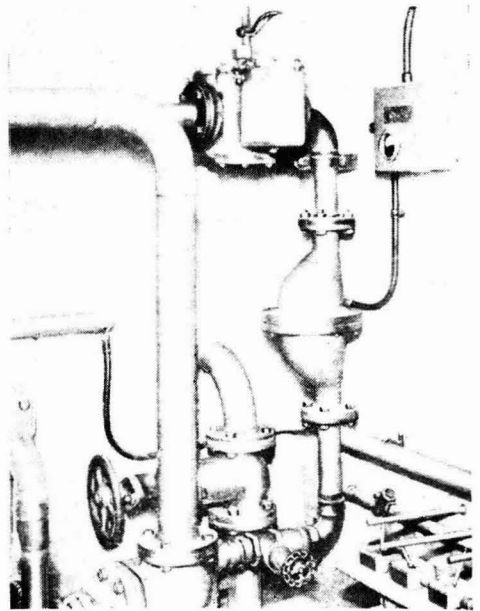
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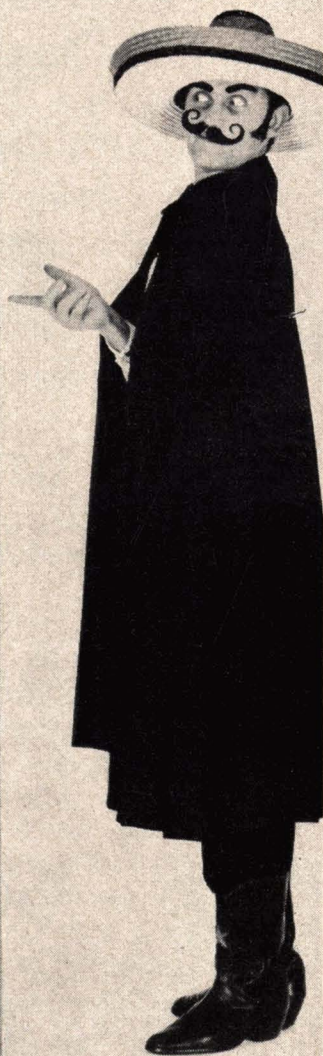
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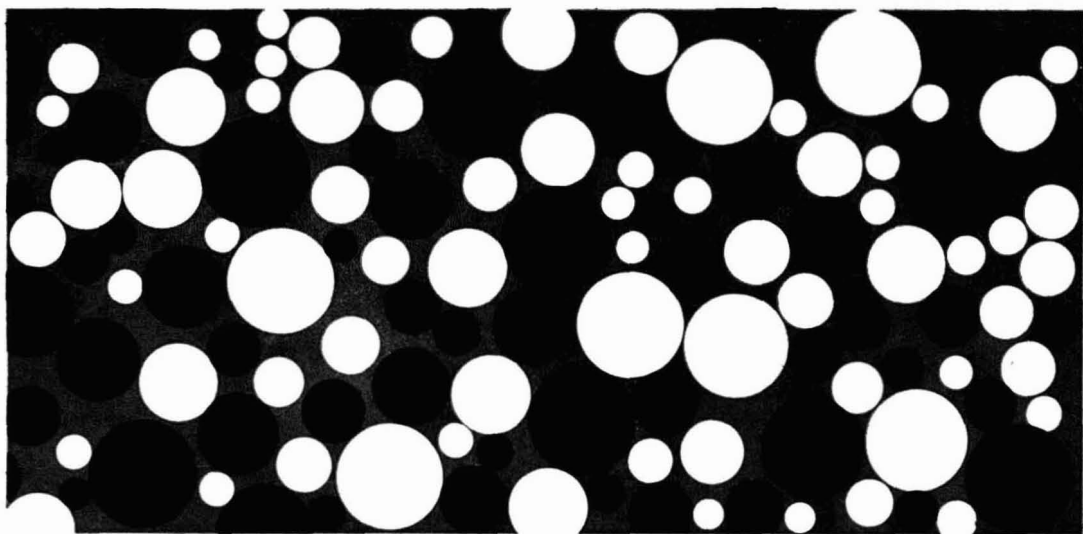
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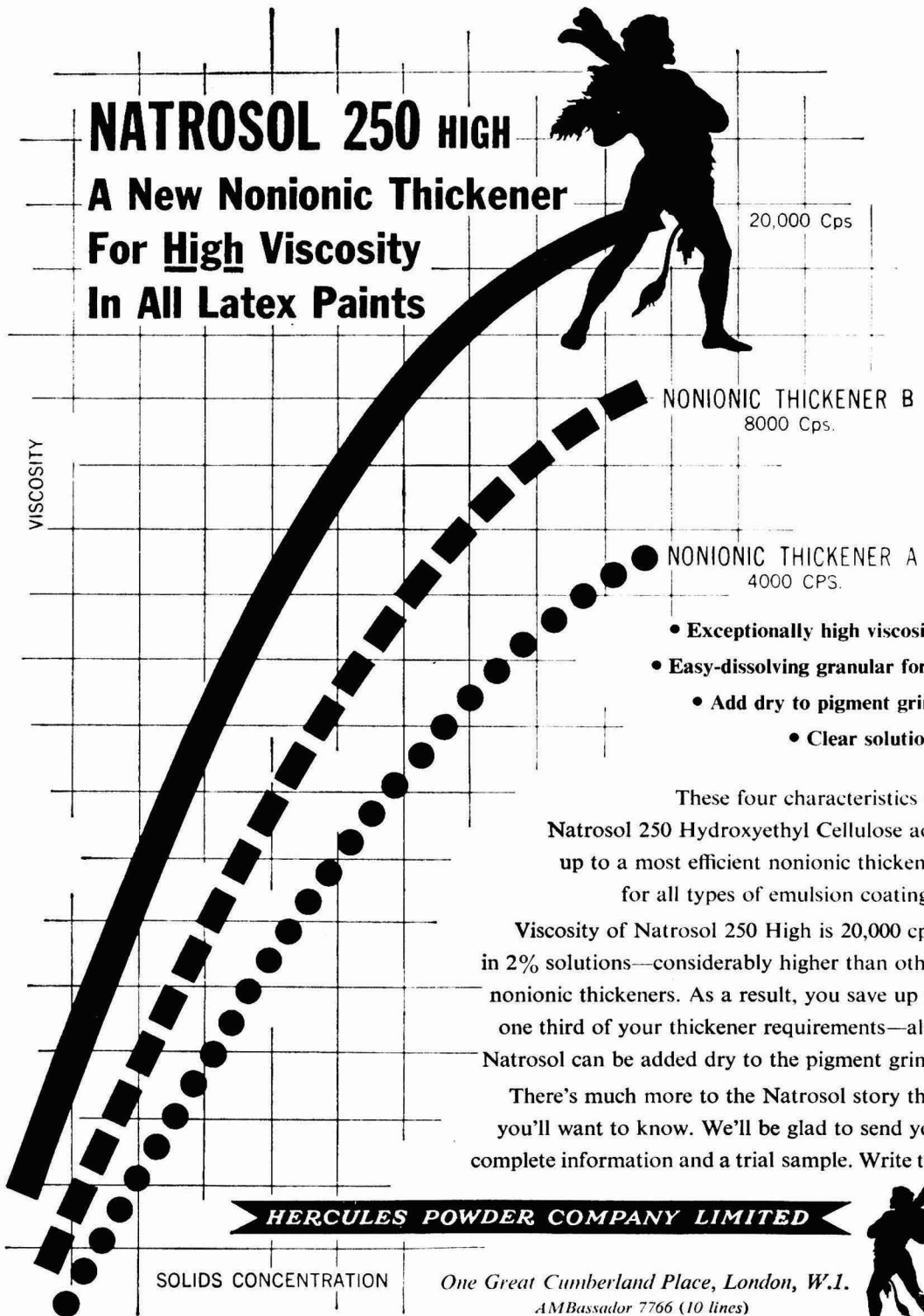
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TRANSACTIONS AND COMMUNICATIONS

Climatic Effects on the Rusting of Painted Steel

By J. R. RISCHBIETH and K. R. BUSSELL

Australian Defence Scientific Service, Defence Standards Laboratories, Department of Supply, Maribyrnong, Victoria, Australia

Summary

The effect of climate in different parts of Australia and at Momote, Admiralty Islands, on the rate at which primed steel rusts has been studied by exposing sets of painted panels in eight localities for up to thirty-eight months. The exposure sites included temperate marine, temperate semi-industrial, temperate rural, hot dry, tropical rural and equatorial oceanic climates. In general, the severity of a site increases with increasing total rainfall, but there are indications that the frequency of wetting and the duration of wetness are important factors. The effect of a top-coat in reducing the rate of development of rusting increases with the severity of the exposure site and is also more marked with decreasing effectiveness of the primer itself.

INTRODUCTION

Earlier work¹ by the authors showed that the climatic conditions in various parts of Australia have an important effect on both the appearance and integrity of exposed paint films. It was found that chalking and erosion were more pronounced where the rainfall is high, and that temperate marine, and hot dry continental interior climates cause the least degradation, and tropical and equatorial the greatest. A related aspect of importance is the effect of climate on the rate at which steel protected by paint will rust. A series of metal primers selected for their known differences in efficiency were applied to mild steel panels and exposed at eight exposure sites to all the elements other than direct sunlight for up to thirty-eight months. Other sets of panels on which primers were covered with top-coats were fully exposed to the weather. As much meteorological data as practicable were collected with a view to relating these to the observed rates of rusting.

EXPERIMENTAL

Exposure Sites

The locations of the exposure sites described below are shown in Fig. 1, and average meteorological data for the areas are given in Appendix A.

Maribyrnong, Victoria—The site is in a semi-industrial suburb of Melbourne, in the temperate coastal zone, having a relatively uniform rainfall throughout the year.

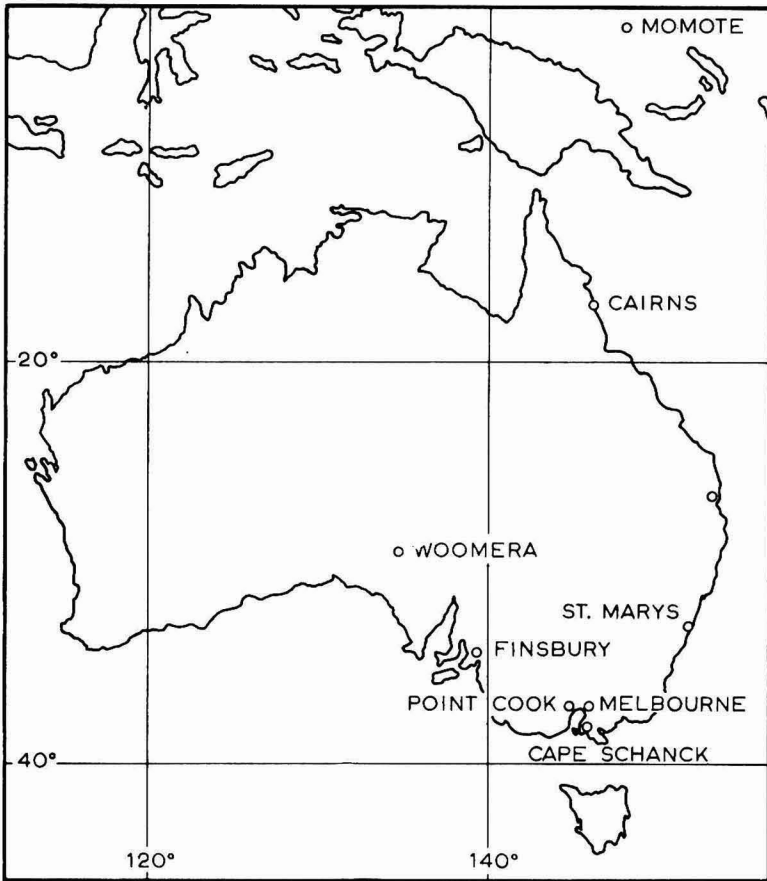


FIG. 1. LOCATION OF EXPOSURE SITES IN AUSTRALIA

Point Cook, Victoria—A rural marine area on Port Phillip Bay, approximately 15 miles from Melbourne, in the temperate coastal zone. The area has a rainfall similar to that at Maribyrnong. The site was on a pier about two hundred yards from the shore and six to eight feet above normal tide level.

Cape Schanck, Victoria—A rural marine area at the entrance to Westernport Bay, in the temperate coastal zone. The site is approximately two hundred feet above sea-level and one hundred and fifty yards inland. There is a relatively uniform rainfall during the year.

Finsbury, South Australia—The site is in a semi-industrial suburb of Adelaide, approximately three miles from the sea in the temperate coastal zone. Maximum rainfall is in winter with a relatively dry summer.

Woomera, South Australia—A hot rural area in the dry continental interior zone. The rainfall is low and spasmodic.

St. Marys, New South Wales—The site is in a rural outer suburb approximately thirty miles from Sydney, in the temperate coastal zone. Average rainfall is lower than that of Sydney, and is higher in summer than in winter, but falls are spread over the whole year.

Cairns, Queensland—The site is at Gordonvale, a rural area twelve miles from Cairns in the sub-equatorial coastal zone, subject to very heavy summer and autumn rainfall and relatively light winter rainfall.

Momote, Admiralty Islands—The site is on Los Negros Island, 2° south of the equator, and has an oceanic climate not subject to severe monsoonal effects. The racks are three hundred yards from the sea and the area has heavy rainfall spread uniformly throughout the year.

Paints

Sixteen primers giving a range of performance from poor to good, as judged by preliminary laboratory corrosion tests, were selected.

Number	Primer description
1.	Red lead/iron oxide, oil base, complying with Specification SAA/Int. 3A.
2.	Red lead/zinc chrome, alkyd base, complying with U.S. Specification Buships, Formula 116.
3.	Red oxide/zinc chrome, alkyd base, complying with U.S. Federal Specification TT-P-636.
4.	Pretreatment primer, complying with U.S. Specification MIL-P-15328.
5.	Zinc chrome, alkyd base, submitted to comply with Specification R.A.A.F.2K7.
6.	Zinc dust/zinc oxide, oil base, complying with U.S. Federal Specification TT-P-641.
7.	Zinc chrome/zinc oxide, alkyd base, complying with U.S. Specification JAN-P-735.
8.	Red lead, alkyd base, complying with Specification SAA/Int. 5A.
9.	Red lead/lead chrome/iron oxide, alkyd base, submitted to comply with Specification SAA/Int. 5A.
10.	Lead chrome/iron oxide, synthetic base, submitted to comply with Specification SAA/Int. 5A.
11.	Zinc chrome/zinc oxide, alkyd base.
12.	Red oxide/zinc chrome, synthetic base, submitted to comply with Specification SAA/Int. 5A.
13.	Red oxide/white lead, oil base, British Admiralty formulation.
14.	Pretreatment primer, similar to U.S. Specification MIL-P-15328.
15.	Zinc chrome, vinyl base, complying with U.S. Specification MIL-P-15930.
16.	Zinc chrome/lead chrome, alkyd base, submitted to comply with Specification SAA/Int. 5A.

Two oil base finishing paints, one pigmented with white lead and the other with rutile and anatase titania, both formulated to exhibit only fair durability, were prepared. Further information on all the paints is given in Appendix B.

Test Panels

The test panels were of satin-finish cold rolled mild steel, 12 in. \times 6 in. \times 18 B.G. They were degreased and roughened with No. 0 emery paper prior to painting, and the backs suitably protected.

Application of Paints

The paints were applied uniformly at pre-determined film thicknesses by either brushing or spraying, as appropriate. Primers 4, 5, and 14 were applied at 0.36—0.44 mil dry film; all other paints were applied at 0.9—1.1 mil dry film. Half the total number of panels were primed only; the remaining panels were primed and, after a suitable indoor drying period, were coated with one coat of the finishing paints. Each finish was applied to half of the panel, divided vertically.

Exposure

Sets of primed panels were exposed in shaded positions at 30° to the vertical facing South at all sites except Maribyrrnong and Point Cook. The nature of the rack construction necessitated vertical exposure facing South at Maribyrrnong and exposure at 85° to the vertical facing North at Point Cook, both in shaded positions. In order to enable progressive rusting ratings to be cross-checked in the one laboratory replica panels were exposed at some of the sites, and periodically one panel from each set was returned to Defence Standards Laboratories, Maribyrrnong, for evaluation. The exposure was continued for thirty-eight months at all sites except Cape Schanck and Point Cook; exposure at these sites was terminated at twelve and six months respectively because of the rapid rate of deterioration.

The primers were exposed without top-coats so as to obtain comparative results in a reasonably short time, but it was felt that the results might be unrealistic with some types of primers, *e.g.* those containing zinc chromate, due to excessive leaching of soluble pigments in the absence of a protective top-coat. This aspect was examined by exposing sets of primed panels coated with the two finishing paints mentioned earlier; they were fully exposed to the weather at the various sites. The finishing paints were formulated to provide a degree of protection against leaching and actinic degradation of the primers but, in order not to prolong unduly the exposure period, they were not made very durable. These sets of primed and finished panels were exposed facing North at 45° at all sites except Point Cook and Momote where they were vertical and at 80° to the vertical respectively. They were exposed for thirty-eight months except at Cape Schanck and Point Cook where the periods were twenty-four and twelve months respectively. As with the primers, panels were withdrawn from replica sets and returned to Defence Standards Laboratories, Maribyrrnong periodically. A total of five hundred and seventy-six panels were exposed at the sites commencing in the period August-October, 1955.

Inspection and Ratings

The panels were rated periodically for visible rusting by the method² given in D.S.L. Circular 10. Briefly, each panel is rated on a numerical scale from 10 to 0 against photographic reference standards identical with those of the

American Society of Testing Materials. A rating of 10 denotes no failure and 0 complete failure for the particular property concerned.

RESULTS AND DISCUSSION

The natives of Momote showed a predilection for the brightly coloured primed panels; some of these were lost and the period of exposure of others is uncertain. No results on the primed panels at this site have, therefore, been included. The average rusting ratings for the primers over the whole of the exposure period at all sites except Momote are shown in Appendix C, which also gives the average ratings for the primers coated with the white lead and titania paints respectively.

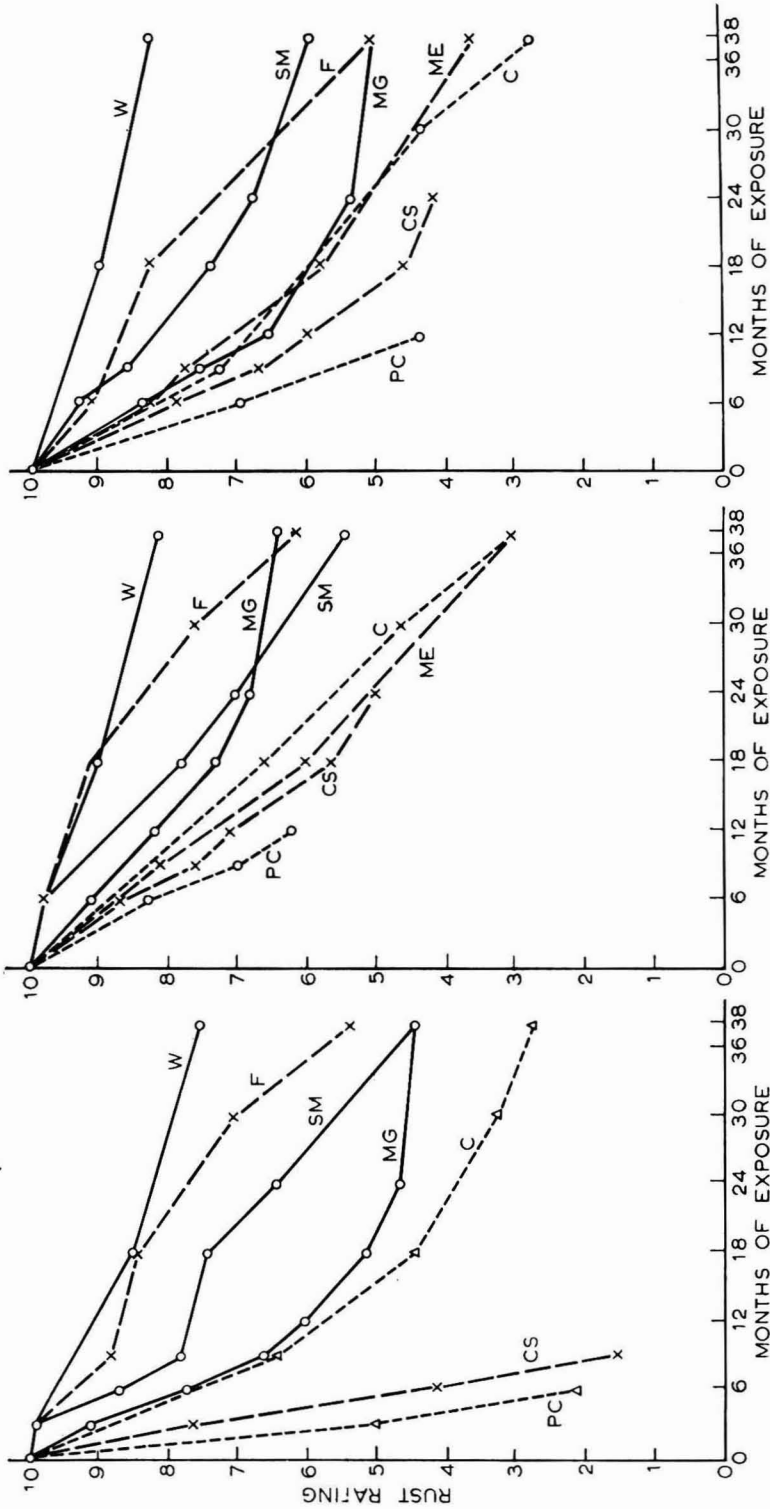
Relative Severity of Sites

The results obtained on the sixteen primers at each exposure site have been averaged and are shown in Fig. 2 for the primers alone, and in Figs. 3 and 4 for the primers coated with the white lead and titania paints respectively. They have been examined both from the view-point of the length of time required for the rusting rating to drop to 7, at which stage the protective value is considered to have seriously diminished, and also from the extent of rusting at the time of withdrawal. The first aspect is of importance when maximum protection and maintenance of appearance is desired and the second is relevant when regular maintenance cannot be effected. Statistical methods have been used to establish whether differences between sites are significant. The relative severity of the sites from each of these aspects is shown in Table I. The relative orders of severity of the sites are much the same for the primed panels and both sets of primed and finished panels.

TABLE I. RELATIVE SEVERITY OF SITES

Period in months to drop to rating of 7				Based on rusting at time of withdrawal		
Area	Primed only	With white lead	With titania	Primed only	With white lead	With titania
<i>Least Severe</i>				<i>Least Severe</i>		
Woomera	>38	>38	>38	Woomera	Woomera	Woomera
Finsbury	30	33	26	Finsbury	Finsbury	St. Marys
St. Marys	20	24	23	St. Marys	Maribyrnong	
Maribyrnong	7	21	11	Maribyrnong	St. Marys	Maribyrnong
Cairns	7	16	11	Cairns	Cairns	Momote
Momote	—	13	12		Momote	Cairns
Cape Schanck	4	12	8	Cape Schanck	Cape Schanck	Cape Schanck
<i>Most Severe</i>				<i>Most Severe</i>		
Point Cook	2	9	6	Point Cook	Point Cook	Point Cook

Considered overall, the sites are in the following order of severity, from least severe to most severe: Woomera, Finsbury, St. Marys, Maribyrnong, Cairns and Momote, Cape Schanck, Point Cook.



CURVES SHOWING THE RELATIVE SEVERITY OF THE EXPOSURE SITES

FIG. 2. PANELS PRIMED ONLY FIG. 3. PANELS PRIMED, WHITE LEAD FINISHED FIG. 4. PANELS PRIMED, TITANIA FINISHED
 W Woomera MG Maribyrnong C Cairns CS Cape Schanck F Finsbury SM St. Marys ME Memotomote PC Point Cook

The Effect of Climate on Severity

The rainfall in a locality would be expected to have an important bearing upon the rate at which painted steel rusts and in Appendix A is shown the rainfall at the various sites during the exposure periods. The frequency of wetting and duration of wetness, however, are probably also important. The incidence of rain, dew and frost will determine the former, and in Appendix A are shown the actual number of wet days during the exposure periods, *i.e.* days in which a dew or frost occurred or more than one point of rain was registered. The duration of wetness will be dependent upon the frequency of wetting, but it will also be influenced by temperature, relative humidity, hours of sunshine, and wind. The evaporation rates at the various sites are probably the best comparative indication of the rates at which wet panels will dry off. The average evaporation rates over the periods of exposure are given in Appendix A for those sites for which recordings were available. Although this meteorological data does not give the full picture it is interesting to discuss the observed order of severity of the sites in relation to them.

Woomera, the driest site, is the least severe, as expected. Finsbury is next and, apart from the marine site of Point Cook, had the second lowest rainfall. Finsbury is less severe than Maribyrnong, which had only slightly more rainfall over the period of exposure although it also had fewer wet days. The evaporation rate at Finsbury is relatively high and that at Maribyrnong is low. It is reasonable to conclude that panels were wet for a longer period at the latter site and that this is the main reason for its greater severity. The rainfall at Maribyrnong during the first year of exposure was much above average and the evaporation rate was below average whereas in the third year rainfall was below average and the evaporation rate was higher; this appears to account for the relatively rapid initial development of rusting and the reduced rate subsequently. The rainfall at St. Marys was abnormally high in the first year although it was much below average in the following two years. This site is less severe than Maribyrnong due probably to the fact that it has fewer wet days and a higher evaporation rate.

Cairns and Momote are more severe than the sites discussed above owing to high rainfall and a high proportion of wet days, high relative humidity may also play a part. These factors evidently outweigh the effect of an appreciable evaporation rate. Momote might be expected to be more severe than Cairns since it is close to the sea and has a higher rainfall and a greater number of wet days. It rains heavily on two out of three days at Momote so that the effect of salt would probably be negligible. Its similarity to Cairns suggests that wetness beyond a certain degree has little further effect.

The marine sites of Cape Schanck and Point Cook were the most severe. At Point Cook the test panels were just above the water and, in fact, were sometimes submerged by high seas whereas at Cape Schanck they were on high cliffs so that the relative order of severity of these two sites is not unexpected.

Performance of Primers

The results obtained over the whole of the exposure period show that the order of merit of the primers, with or without finishing coats, in affording protection to the steel appears to be independent of the exposure site. The

exceptions that occur show no association with particular primers or sites. The order of merit of primers without finishing coats is shown in Table II.

TABLE II
ORDER OF MERIT OF PRIMERS WITHOUT FINISHING COATS

Classification	Primer No.	Primer
Best protection	3	Red oxide/zinc chrome, alkyd base Zinc chrome/zinc oxide, alkyd base Zinc chrome, vinyl base Red lead, alkyd base
	7	
	15	
	8	
Group 2	13	Red oxide/white lead, oil base Red lead/iron oxide, oil base Lead chrome/iron oxide, synthetic base
	1	
	10	
Group 3	4	Pretreatment primer Zinc chrome/lead chrome, alkyd base Red lead/zinc chrome, alkyd base Zinc dust/zinc oxide, oil base
	16	
	2	
	6	
Group 4	9	Red lead/lead chrome/iron oxide, alkyd base Red oxide/zinc chrome, synthetic base Zinc oxide/zinc chrome, alkyd base
	12	
	11	
Worst protection	5	Zinc chrome, alkyd base Pretreatment primer
	14	

(complying with Spec. TT-P-636)
(complying with Spec. JAN-P-735)
(complying with Spec. MIL-P-15930)
(Proprietary product complying with Spec. SAA/Int. 5A)

(British Admiralty Formulation)
(complying with Spec. SAA/Int. 3A)
(Proprietary product submitted to comply with Spec. SAA/Int. 5A)

(complying with Spec. MIL-P-15328)
(Proprietary product submitted to comply with Spec. SAA/Int. 5A)
(complying with Spec. Buships Formula 116)
(complying with Spec. TT-P-641)

(Proprietary product submitted to comply with Spec. SAA/Int. 5A)
(Proprietary product submitted to comply with Spec. SAA/Int. 5A)

(Proprietary product submitted to comply with Spec. R.A.A.F.2K7)
(Proprietary product similar to U.S. Spec. MIL-P-15328)

A study of primer formulation in relation to performance was not the object of the investigation, but several points of interest emerge. Earlier workers have reported big differences in the relative merits of different types of media depending upon whether the primers made from them are applied to clean or rusted steel, oil base being generally superior to synthetic base on the latter. In considering the results given in Table II it should be remembered that the primers were applied to clean steel. The oil base primers fall into Groups 2 and 3, inferior to some alkyd resin based primers and superior to others. Primers containing zinc chromate have given varying performances and there is no relationship between their order of merit and their zinc chromate content. There was a big difference in the performance of the two pretreatment primers which, with the proprietary zinc chromate/alkyd base primer were applied at similar, but lower, film thicknesses than other primers.

Effect of Finishing Paints

The order of merit of primers with finishing coats is similar to that of the primers alone. Three primers containing zinc chrome showed considerable improvement in performance when top-coated, but others containing zinc chrome showed no change in their relative order of merit. Comparison of Figs. 3 and 4 with Fig. 2 and an examination of Table I shows that, in general, the application of a finish markedly reduces the rate of development of rusting at severe sites and that this effect becomes less as the severity of the site diminishes. With the white lead finish at Point Cook, therefore, the average period required for the rusting rating to drop to 7 was four and a half times that of the primers alone, but at Finsbury it was only slightly greater.

Comparison of the primed with the corresponding primed and finished panels shows that there is little difference between the two sets with those primers that, in themselves, afford good protection. In general, as the effectiveness of the primer diminishes, the improvement in rust resistance due to the finish increases. These effects were, in general, more pronounced with the white lead paint than with the less durable anatase/rutile titania paint.

CONCLUSIONS

The exposure sites examined are in the following increasing order of severity: Woomera, Finsbury, St. Marys, Maribyrnong, Cairns and Momote, Cape Schanck, Point Cook. In general the severity of a site increases with increasing total rainfall, but it is felt that the frequency of wetting and the duration of wetness, which in practice are partly dependent upon total rainfall, are more important factors. For example, the rainfall totals for Finsbury and Maribyrnong were similar, but the former is less severe, probably owing to the fact that the higher rate of evaporation at this site leads to lower total duration of wetness. Again, while St. Marys had a higher total rainfall than Maribyrnong, it had fewer wet days and a high evaporation rate, and it was therefore less severe. The rainfall at Momote was more than half as much again as Cairns, but it was very high at both sites. They are similar in severity, from which it appears that wetness beyond a certain degree has little further effect.

Temperate marine sites are much more severe than inland sites having comparable climatic conditions. The site at Momote, while close to the sea, is

not truly a marine site owing to the very high and frequent rainfall which minimises the effects of the salt. The effect of a finish in reducing the rate of development of rusting increases with the severity of the exposure site and also increases with the decreasing effectiveness of the primer, itself.

ACKNOWLEDGEMENTS

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[Received 6 March, 1961

APPENDIX A

1. AVERAGE METEOROLOGICAL DATA FOR EXPOSURE AREAS

Exposure area	Average daily extremes of temperature		Average relative humidity		Rainfall-average per year (in.)	Sunshine-average per year (hr.)
	Maximum (°F)	Minimum (°F)	9 a.m. (%)	3 p.m. (%)		
Maribrnong ..	69	50	70	54	19.6	2036*
Cape Schanck ..	64	51	82	81	29.2	2036*
Point Cook ..	66	50	74	63	§	2036*
Finsbury ..	71	53	56	45	21.0	2514
Woomera ..	78	53	§	§	ca. 6.7	ca. 3400
St. Marys ..	72	53	70	58	27.0	2476
Cairns ..	86	65	82	§	71.0	ca. 2700
Momote ..	86	76	88†	78	147.0	ca. 1680

*Melbourne figures §Not available †Taken at 6 a.m.

Note : The tabulated averages give only a general indication of climate.

More details on daily and seasonal fluctuations could be made available on request.

2. DATA ON DURATION AND FREQUENCY OF WETNESS DURING EXPOSURE (Exposure period 38 months unless otherwise noted)

Exposure area	Total rainfall (in.)	Total number of wet days	Percentage of wet days	Evaporation rate (in./month)
Maribrnong ..	78	331	28.6	3.30
Cape Schanck†	58	442	60.5	§
Point Cook‡	20.5	183	50.0	4.0
Finsbury ..	65.5	417	36.1	5.66
Woomera ..	24.5	171	14.8	§
St. Marys ..	110.5	210	18.3	3.74
Cairns ..	226	500	43.3	4.33
Momote ..	381	743	64.3	§

‡24 months exposure

†12 months exposure

§Data unavailable.

APPENDIX B

DETAILS OF FORMULATIONS

Priming paints

1. *Red lead, oil base, extended with red oxide, complying with performance requirements of Specification SAA/Int. 3A.*

(Pigment : vehicle ratio 35.7% by volume)

Composition	% by wt.
Red lead	63.3
Red iron oxide	15.5
Raw linseed oil	19.3
Mineral turpentine	1.9

2. *Red lead/zinc chrome, alkyd base, complying with U.S. Bureau of Ships—Formula 116*

(Pigment : vehicle ratio 35% by volume)

Composition	% by wt.
Red lead	28.7
Zinc chrome	5.3
Mica	4.9
Red iron oxide	0.8
Asbestine	12.1
Aluminium stearate	0.5
Soya/phthalic alkyd, 60% solids	31.4
Dipentene #	1.9
Mineral turpentine and driers	14.4

3. *Red oxide/zinc chrome, alkyd base, complying with U.S. Fed. Specification TT-P-636*

(Pigment : vehicle ratio 38% by volume)

Composition	% by wt.
Red iron oxide	26.4
Zinc chrome	4.8
Zinc oxide, non-chalking	4.8
Asbestine	4.8
China clay	6.2
Soya/phthalic alkyd, 60% solids	37.0
Mineral turpentine and driers	16.0

8. *Red lead, alkyd base*

No formulation available. Proprietary product complying with performance requirements of specification SAA/Int. 5A.

9. *Red lead/iron oxide/lead chrome, oil modified D.C.O./pentaerythritol base.*

No formulation available. Proprietary product, submitted to comply with performance requirements of specification SAA/Int. 5A.

10. *Lead chrome/iron oxide, synthetic base.*

No formulation available. Proprietary product, submitted to comply with performance requirements of specification SAA/Int. 5A.

11. *Zinc chrome/zinc oxide, alkyd base.*

(Pigment : vehicle ratio 39.6% by volume)

Composition	% by wt.
Zinc chrome	27.8
Zinc oxide, non-chalking	9.5
Asbestine	12.1
Aluminium stearate	0.5
Soya/phthalic alkyd, 70% solids.. .. .	30.4
Dipentene	2.0
Mineral turpentine and driers	17.7

12. *Red oxide/zinc chrome, synthetic base.*

No formulation available. Proprietary product submitted to comply with performance requirements of specification SAA/Int. 5A.

13. *Red oxide/white lead, oil base, British Admiralty formulation.*

(Pigment : vehicle ratio 43.2% by volume)

Composition	% by wt.
Red iron oxide	35.2
White lead	13.2
Asbestine	11.8
Linseed stand oil: alkali refined linseed oil (50 : 50)	19.5
Mineral turpentine and driers	20.3

14. *Pretreatment primer.*

Proprietary product stated to be similar in formulation to U.S. Specification MIL-P-15328.

15. *Zinc tetroxy chromate, vinyl based, complying with U.S. Specification MIL-P-15930 Formula 120.*

(Pigment : vehicle ratio 20.6% by volume)

Composition							% by wt.
Zinc tetroxy chromate	..	..	..	..	..	..	7.6
Asbestine	..	..	..	..	..	..	4.7
Carbon black	..	..	..	..	..	..	0.2
Aluminium stearate	..	..	..	..	..	..	0.1
Vinyl resin (90% vinyl chloride, 5% vinyl alcohol, 5% vinyl acetate)	..	..	..	..	..	..	13.5
Tricresyl phosphate	..	..	..	..	..	..	1.3
Methyl isobutyl ketone	..	..	..	..	..	..	43.8
Toluene	..	..	..	..	..	..	28.8

16. *Zinc chrome/lead chrome, alkyd base*

No formulation available. Proprietary product submitted to comply with performance requirements of specification SAA/Int. 5A.

Finishing Paints

(Both finishing paints 28% pigment : vehicle ratio)

Composition							% by wt.
A	White lead	..	..	..	..	..	71.3
	Raw linseed oil	..	..	..	..	..	19.0
	Linseed stand oil (50 poise)	..	..	..	..	..	6.4
	Mineral turpentine and driers	..	..	..	..	..	3.3
B	r-titania	..	..	..	..	..	17.5
	a-titania	..	..	..	..	..	32.4
	Asbestine	..	..	..	..	..	3.2
	Barytes	..	..	..	..	..	5.9
	Raw linseed oil	..	..	..	..	..	26.6
	Linseed stand oil (50 poise)	..	..	..	..	..	9.0
Mineral turpentine and driers	..	..	..	..	..	5.4	

APPENDIX C

OUTDOOR RUSTING RATINGS—AVERAGE FIGURES OVER EXPOSURE PERIOD

1. *Primered panels*

Exposure area	Primer No.																Average for each site
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Cape Schanck ..	6.3	2.0	3.3	3.3	1.7	4.7	7.3	7.0	3.7	5.3	3.0	4.0	6.0	2.0	6.3	2.3	4.3
Point Cook ..	5.5	2.5	8.0	5.0	1.5	2.5	7.0	4.5	2.0	2.0	2.0	2.0	2.0	0	6.0	5.0	3.6
Cairns ..	5.5	2.5	7.5	4.2	0.3	1.8	8.5	6.0	2.0	5.8	2.3	4.2	8.2	0	7.0	2.0	4.2
Maribyrnong ..	7.8	5.5	9.4	5.0	1.5	4.9	9.4	8.6	4.5	7.1	2.5	3.4	8.0	1.5	10	5.3	5.9
St. Marys ..	8.8	8.3	9.8	8.2	2.8	7.0	10	9.0	7.2	8.7	4.5	7.3	9.8	1.7	7.3	6.8	7.3
Finsbury ..	9.0	6.8	9.8	7.2	4.0	6.0	9.2	9.0	6.5	8.8	5.5	3.5	9.5	5.2	9.8	7.5	7.4
Woomera ..	10	9.5	10	7.5	2.0	10	9.5	10	6.0	9.5	5.0	7.0	9.5	3.5	9.5	9.5	8.0
Average over all sites	7.6	5.3	8.3	5.8	2.0	5.3	8.7	7.7	4.6	6.7	3.5	4.5	7.6	2.0	8.0	5.5	5.8

OUTDOOR RUSTING RATINGS—AVERAGE FIGURES OVER EXPOSURE PERIOD

2. *Primered and White Lead finished panels*

Exposure area	Primer No.																Average for each site
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Cape Schanck ..	9.0	8.6	8.8	5.8	1.0	6.0	9.8	6.0	3.6	5.0	9.2	9.0	9.0	4.2	8.2	5.2	6.8
Point Cook ..	8.0	6.6	8.1	8.1	2.7	6.0	9.7	8.0	2.3	8.0	9.9	8.3	9.0	8.3	7.3	3.7	7.1
Cairns ..	5.5	7.5	9.3	4.0	2.5	6.0	9.3	4.8	2.3	6.5	5.0	6.8	8.5	3.0	9.0	4.0	5.9
Momote ..	9.7	9.3	9.7	7.0	4.3	5.5	8.5	6.5	3.0	6.7	8.3	8.3	9.3	4.8	9.0	4.5	7.2
Maribyrnong ..	8.8	9.3	8.7	7.0	3.0	5.0	9.3	8.7	5.3	8.2	9.2	9.0	9.2	6.8	9.2	6.5	7.7
St. Marys ..	10	9.7	10	8.2	4.8	7.3	10	8.2	6.5	8.8	9.7	9.5	9.8	5.7	9.7	7.0	8.4
Finsbury ..	8.8	9.5	9.8	8.5	4.8	6.3	9.8	8.8	5.8	7.5	8.8	9.0	9.3	6.3	9.5	7.3	8.1
Woomera ..	10	10	10	7.5	6.0	7.5	10	8.0	5.0	7.5	10	10	10	8.0	10	9.0	8.7
Average over all sites	8.7	8.8	9.3	7.0	3.6	6.2	9.6	7.4	4.2	7.3	8.8	8.7	9.3	5.9	9.0	5.9	7.5

OUTDOOR RUSTING RATINGS—AVERAGE FIGURES OVER EXPOSURE PERIOD
 3. *Primed and Titania finished panels*

Exposure area	Primer No.																Average for each site
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Cape Schanck ..	5.2	8.0	6.0	3.2	1.8	7.6	9.0	7.6	1.8	5.8	8.4	8.2	7.0	2.6	6.6	5.0	5.9
Point Cook ..	4.0	3.7	7.0	5.0	5.7	3.0	9.3	7.0	0.7	5.0	8.0	7.0	7.0	6.0	7.7	2.0	5.5
Cairns ..	4.0	7.8	8.0	4.5	4.5	5.5	8.5	5.8	0.5	5.3	3.3	4.3	5.5	2.5	9.0	2.8	5.1
Momote ..	7.7	8.7	8.0	6.0	4.8	7.3	8.5	7.0	1.0	7.3	7.3	8.7	8.0	4.0	8.8	3.8	6.7
Marlbyrnong ..	6.2	8.5	8.2	4.7	4.7	6.0	9.0	7.7	1.5	6.7	8.3	8.3	8.3	3.2	7.8	6.0	6.6
St. Marys ..	9.0	9.2	8.7	7.3	8.3	8.3	10	9.3	4.0	7.8	9.0	8.7	9.2	4.2	8.8	6.5	8.0
Finsbury ..	7.8	9.3	8.3	7.3	4.5	7.0	9.5	8.8	3.3	6.3	9.0	8.5	8.8	4.5	9.3	6.0	7.4
Woomera ..	9.5	10	10	7.5	6.5	9.5	10	9.5	5.0	7.5	9.5	10	10	6.5	10	9.0	8.8
Average over all sites	6.7	8.2	8.0	5.7	5.1	6.8	9.2	7.8	2.2	6.5	7.9	8.0	8.0	4.2	8.5	5.1	6.8

The Evaluation of Priming Paints by Corrosion Tests

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Summary

A study has been made of the reproducibility and relative severity of four laboratory corrosion tests for evaluating priming paints and of their correlation with outdoor exposure tests. The tests comprised the Humidity Test described in Method No. 25 of the United Kingdom Defence Specification DEF.1053, the A.S.T.M. Salt Fog Test, Method No. B117-54T, a test similar to the A.R.E. Salt Droplet Test described in B.S.1391-1952 and a Salt Spray Test similar to that described in Method No. 24 of DEF.1053. Each test was conducted for ninety-six and two hundred and forty hours.

The Salt Droplet Tests for both periods of time are more reproducible than the others. The 240-hour Salt Droplet Test, and the 240-hour Salt Spray Test, which are between the Salt Fog Test and the Humidity Test in severity, grade primers more in accordance with the results obtained outdoors than do the other tests. The severe 240-hour A.S.T.M. Salt Fog Test and the relatively mild Humidity Tests lack correlation with outdoor exposure trials. As pass-fail tests the 240-hour Salt Droplet Test and the 96-hour Salt Spray Test predict the performance of a primer, satisfactory or unsatisfactory, with more certainty than the other tests.

INTRODUCTION

Primers for steel have for many years been evaluated for their protective properties against rusting by exposing them under conditions of continuous condensation at a temperature cycling between 42° and 48°C, as described in Method No. 25 of the United Kingdom Defence Specification 1053 and Method No. 452.1 of Australian Standard No. K41-1957. There is no published information on the relationship between the results obtained on paints in this test and their service performance, but observations over a considerable period indicated that the correlation might be poor.

Corrosion tests described in the literature are many and varied, but only with a few has any systematic attempt been made to correlate results with service performance. The four tests considered in the paper are the Humidity Test (A.S. K41-1957), the A.R.E. Salt Droplet Test (B.S. 1391-1952), the D.E.F. Continuous Salt Spray Test (Method No. 24 of DEF. 1053) and the A.S.T.M. Salt Fog Test (B117-54T).

The reproducibility and relative severity of these four corrosion tests and their relationship to the results of outdoor rusting trials are examined. Test periods of ninety-six and two hundred and forty hours for each method were selected, to conform with those appearing in United Kingdom or Australian Specifications. The merits of the tests, both for grading and as criteria for acceptance or rejection of primers, have also been examined.

EXPERIMENTAL

Corrosion Tests

Humidity Test: The relative humidity in the cabinet was 100 per cent. The air temperature rose from 42° to 48°C and returned to 42°C over a period of

between forty-five and seventy-five minutes, the heating and cooling periods being approximately equal. These conditions produced continuous condensation of moisture on the test panels.

Salt Droplet Test: The apparatus was as specified, but the procedure differed in respect of the composition of the salt solution and the temperature, which was 20°-25°C. The composition of the salt solution was similar to that of sea water, being as shown below. The test panels were suspended vertically 2-3 in. above dishes of water. Once every twenty-four hours the panels were sprayed with the salt solution from an atomiser, so that the surfaces were evenly covered with discrete droplets. They were then returned to their positions on the rack above the water and the rack covered to prevent the immediate drying of the droplets.

COMPOSITION OF SALT SOLUTION

Constituent	Content (g./l.)
NaCl	27
MgCl ₂ .6H ₂ O	8.5
MgSO ₄ .7H ₂ O	4.1
CaSO ₄ .2H ₂ O	1.9
KCl	0.5

Salt Spray Test: The apparatus was as specified, but the salt solution and temperature of test were the same as for the Salt Droplet Test. Panels were supported in a wooden holder with the test surfaces upwards at approximately 15° to the vertical in a salt mist, so that their surfaces were evenly coated with droplets of solution. The salt spray was prevented by a baffle from impinging directly on the surfaces of the panels.

A.S.T.M. Salt Fog Test: The test was performed as specified; the salt solution contained 20 per cent sodium chloride by weight and the temperature was 95^{+2°}_{-3°} F.

Paints, Test Panels and Application

The same sixteen primers were used as in determining¹ the climatic effects on the rusting of primed steel. They were applied to the same type of test panel by the same methods and at the same film thicknesses. Because of their ready availability, primers Nos. 1, 3, 6, 7 and 11 were used in determining the reproducibility of the test methods.

Testing Procedure

Quadruplicate panels of each primer were submitted to each of the corrosion tests, one pair for ninety-six hours and the other for two hundred and forty hours. After every twenty-four hours' exposure the test panels were redistributed randomly in the test chambers. In order to determine reproducibility, additional duplicate panels of each of the five primers mentioned above were submitted

to each of the tests for both ninety-six and two hundred and forty hours four times.

Inspection and Rating

On completion of the test periods the panels were rated for visible rusting as described earlier¹; the results of three independent operators were averaged.

RESULTS AND DISCUSSION: LABORATORY CORROSION TESTS

Reproducibility

When more than two of the results in a set of four were either 10 or 0, the set was excluded from the calculations for precision in order to obtain a truer estimate. The 95 per cent confidence range about the mean for a single panel subjected to the respective tests at any given time is shown in Table I. Using the Student "t" test of significance, the Salt Droplet Test is more reproducible than the other tests and its precision is considered quite good, having regard to the subjective nature of the rusting assessment.

TABLE I
PRECISION OF TEST METHODS

Test (A — 96 hr. B — 240 hr.)	Precision (\pm)
Humidity	A 3.0
	B 3.3
Salt Droplet	A 1.7
	B 1.6
Salt Spray	A 3.1
	B 3.0
A.S.T.M. Salt Fog	A 3.4
	B 3.8

The sources of error in each method were not of major concern and therefore an analysis of variance was not undertaken. However, the limits of precision taking average results for duplicate panels prepared and exposed at the same time do not differ significantly from those for the same panels taken singly, indicating that a substantial proportion of the error in each method derives from conducting any one test at different times. With several panels, therefore, it is preferable to prepare and test them at different times rather than as replicas. Such a procedure with the 96-hour Salt Droplet Test improves the precision from ± 1.7 for one panel to ± 1.2 for two panels and ± 0.8 for four panels.

Relative Severity

The average rust ratings of duplicate panels of each primer in the eight corrosion tests are shown in Table II. Also shown are the average ratings

for each primer over the eight tests and the average rating of all primers for each test.

TABLE II
RESULTS OF LABORATORY CORROSION TESTS
A — 96 hr. B — 240 hr.

Primer No.	Humidity cabinet		Salt droplet test		Salt spray test		A.S.T.M. salt fog test		Average over all tests
	A	B	A	B	A	B	A	B	
1	10	10	10	6	10	3	4	0	6.6
2	7	7	2	0	7	5	3	0	3.9
3	10	10	10	9	9	5	7	1	7.6
4	5	5	3	2	5	3	3	4	3.8
5	10	9	9	4	6	3	3	4	6.0
6	6	4	5	2	2	1	5	2	3.4
7	8	8	9	8	8	8	5	4	7.3
8	10	10	10	9	10	6	6	2	7.9
9	8	7	7	0	6	0	0	0	3.5
10	10	10	8	6	7	4	5	2	6.5
11	4	6	2	0	0	0	2	2	2.0
12	3	2	3	1	1	0	8	3	2.6
13	10	10	10	10	10	9	8	7	9.3
14	9	7	7	6	5	4	6	6	6.3
15	10	10	10	10	10	8	7	3	8.5
16	10	10	10	8	10	5	1	0	6.8
Average for each test	7.9	7.7	7.2	5.1	6.6	4.0	4.6	2.5	5.7

The results show that the tests may be grouped in the following order of severity. The tests within any one group are not significantly different in severity from each other, but the indications are that they are in the order shown.

Rating	Test (A — 96 hr.) (B — 240 hr.)	Average for all primers
Most severe	A.S.T.M. salt fog — B	2.5
Intermediate	(1) Salt Spray — B	4.0
	(2) A.S.T.M. Salt Fog — A	4.6
	(3) Salt Droplet — B	5.1
Least severe	(1) Salt Spray — A	6.6
	(2) Salt Droplet — A	7.2
	(3) Humidity — B	7.7
	(4) Humidity — A	7.9
Average		5.7

OUTDOOR RUSTING TESTS

The results of outdoor rusting tests on primed steel at seven sites in Australia, using the same sixteen primers as for the laboratory tests, have been reported¹ earlier. In selecting outdoor exposure results for comparison with those from

laboratory tests, it is desirable to choose a period of exposure which gives good differentiation between the primers. At Point Cook, Cape Schanck, Cairns and Maribyrnong the greatest differentiation between the primers occurred at three, six, eighteen and twenty-four months respectively, and the results after these periods of exposure were compared with the laboratory results. At St. Marys, Finsbury and Woomera, the greatest differentiation was shown at thirty-eight months, when the exposure trials were terminated. It seems unlikely that longer exposure at the first two of these sites would have increased the differentiation, but at Woomera the exposure was too short as ten of the primers were still rated 10 or 9.

The rust ratings of the primers at the seven sites after the periods mentioned above are shown in Table III. Also shown are the average ratings for each primer over all seven sites and the average rating of all primers at each site.

TABLE III
RESULTS OF OUTDOOR RUSTING TESTS

Primer No.	Sites and periods (months) of exposure							Average over all sites
	Cape Schanck 6 m.	Point Cook 3 m.	Cairns 18 m.	Maribyrnong 24 m.	St. Marys 38 m.	Finsbury 38 m.	Woomera 38 m.	
1	6	9	6	6	5	7	10	7.0
2	0	3	3	3	5	1	9	3.4
3	4	9	8	9	9	9	10	8.3
4	5	7	4	3	5	5	6	5.0
5	0	3	0	0	0	3	1	1.0
6	5	5	2	3	5	4	10	4.9
7	8	8	8	9	10	9	9	8.7
8	7	5	7	7	6	7	10	7.0
9	2	4	2	3	2	2	4	2.7
10	6	4	6	5	5	7	9	6.0
11	3	4	3	1	1	3	5	2.9
12	6	4	3	1	4	3	6	3.9
13	6	4	9	7	9	8	9	7.4
14	0	0	0	0	0	4	3	1.0
15	7	6	7	10	10	9	10	8.4
16	1	6	2	2	0	3	9	3.3
Average for each site	4.1	5.1	4.4	4.3	4.8	5.3	7.5	5.1

RELATIONSHIP BETWEEN LABORATORY AND OUTDOOR TESTS

Correlation

The degree of agreement in the grading of the primers depends on the correlation between the results of the laboratory tests and the average results for each primer over all sites. The correlation coefficients and their significance are shown in Table IV. The tests that show the best correlation with the respective exposure sites are shown in Table V.

TABLE IV
CORRELATION BETWEEN LABORATORY TESTS
AND AVERAGE OUTDOOR RESULTS

Laboratory test (A — 96 hr. B — 240 hr.)		Correlation coefficient	Level of significance (%)
Salt Droplet	B	0.61	< 2
Salt Spray	B	0.59	< 2
	A	0.52	< 5
A.S.T.M. Salt Fog	A	0.50	< 5
Salt Droplet	A	0.46	< 10
Humidity	B	0.39	Not significant
	A	0.11	Not significant
A.S.T.M. Salt Fog	B	0.01	Not significant

TABLE V
BEST TESTS FOR EACH EXPOSURE SITE

Exposure site	Period of Exposure (months)	Best laboratory test		
		Test (A — 96 hr. B — 240 hr.)	Correlation coefficient	Level of (%) significance
Cape Schanck	6	A.S.T.M. Salt Fog — A	0.55	< 5
		Salt Droplet — B	0.42	< 10
Point Cook	3	None	—	—
Cairns	18	Salt Droplet — B	0.71	< 1
		Salt Spray — B	0.67	< 1
		Salt Spray — A	0.57	< 2
Maribyrnong	24	Salt Spray — B	0.71	< 1
		Salt Droplet — B	0.70	< 1
		Salt Spray — A	0.67	< 1
St. Marys	38	Salt Spray — B	0.65	< 1
		A.S.T.M. Salt Fog — B	0.62	< 2
		Salt Droplet — A	0.53	< 5
Finsbury	38	Salt Droplet — B	0.82	< 0.1
		Humidity — B	0.79	< 0.1
		Salt Spray — B	0.68	< 1
Woomera	38	Salt Spray — A	0.51	< 5
		Salt Droplet — B	0.49	< 10
		Salt Spray — B	0.49	< 10

It was originally thought that salt spray tests might correlate well with marine sites and the humidity test with inland sites, but the results clearly show this is not so. A study of the results shows that the 96-hour A.S.T.M. Salt Fog Test does not correlate particularly well because it is too severe. Extension to two hundred and forty hours makes the test even more severe, but less reliable; it approximates in severity to the two marine sites after 6-9 months' exposure, but the correlation of results is poor.

The reason why most of the tests in the least severe group do not correlate well is that they fail to differentiate sufficiently between the primers; too many primers give good results. It is of interest, however, that the 96-hour Salt Spray Test gives the best correlation of any test with the least severe site (Woomera). There is little difference between the 96- and 240-hour Humidity Tests, so that extending the time of this test beyond two hundred and forty hours does not appear to be a fruitful avenue for improvement.

The two most worthy of consideration are the 240-hour Salt Droplet and the 240-hour Salt Spray Tests. The degree of correlation of these two tests with the outdoor tests at the seven sites is shown in Table VI. The correlation

TABLE VI
CORRELATION OF 240-HOUR SALT DROPLET
AND 240-HOUR SALT SPRAY TESTS WITH OUTDOOR EXPOSURE SITES

Exposure site	Period of exposure (months)	Salt Droplet (240 hr.)		Salt Spray (240 hr.)	
		Correlation coefficient	Level of (%) significance	Correlation coefficient	Level of (%) significance
Cape Schanck	6	0.42	< 10	0.33	Not significant
Point Cook	3	0.35	Not significant	0.22	„
Cairns	18	0.71	< 1	0.67	< 1
Maribyrong	24	0.70	< 1	0.71	< 1
St. Marys	38	0.53	< 5	0.65	< 1
Finsbury	38	0.82	< 0.1	0.68	< 1
Woomera	38	0.49	< 10	0.49	< 10

between these two tests and outdoor exposure is good for the sites of intermediate severity. It is only fair for Woomera, probably because the primers were not well differentiated there. Correlation with the two marine sites is not good.

The laboratory results were also compared with the outdoor results at the time of withdrawal of the panels, *i.e.* six months at Point Cook, twelve months at Cape Schanck and thirty-eight months at the other sites. Correlation with average outdoor results over all sites is generally somewhat better than has been reported above. For reasons not evident, the correlations between the 240-hour Salt Droplet and the 240-hour Salt Spray Tests, and the two marine sites at the times of withdrawal (which are shown in Table VII), are much better than those shown in Table VI.

TABLE VII
CORRELATION OF 240-HOUR SALT DROPLET AND
240-HOUR SALT SPRAY TESTS WITH MARINE SITES
AT TIME OF WITHDRAWAL

Exposure site	240 hr. Salt Droplet		240 hr. Salt Spray	
	Correlation coefficient	Degree of (%) significance	Correlation coefficient	Level of (%) significance
Cape Schanck	0.60	< 2	0.56	< 5
Point Cook	0.59	< 2	0.58	< 2

Both laboratory and outdoor tests were rated by the same procedure so that direct comparison of the rusting ratings is permissible. Based on the average of all primers, the results of the two best laboratory tests correspond very approximately to the following periods of exposure of primed steel panels in the shade at the various sites.

PERIODS OF EXPOSURE AT VARIOUS SITES EQUIVALENT TO 240-HOUR SALT DROPLET AND 240-HOUR SALT SPRAY TESTS

Exposure site	Equivalent exposure period (month)	
	Salt Droplet	Salt Spray
Point Cook	3	4
Cape Schanck	5	6
Cairns	15	22
Maribyrnong	18	> 38
St. Marys	33	> 38
Finsbury	39	> 38
Woomera	> 38	> 38

Pass or Fail Tests

The foregoing discussion has been concerned with the grading of primers on merit by means of laboratory corrosion tests. However, such tests are frequently employed in specifications as a criterion of acceptance or rejection of primers for steel. It is of interest, therefore, to examine the results from this point of view. The primers chosen for these tests covered a wide range of performance and the average was below the standard normally considered acceptable. Specifications having corrosion tests usually require the test panel to show little or no corrosion, and therefore a rating of 8 was taken as a pass and the sixteen primers classified accordingly. In the outdoor tests the limit of acceptance was arbitrarily chosen as 6.4, being 25 per cent greater than the average rating for all primers over all sites. Six of the sixteen primers were classified as satisfactory outdoors when this procedure was used. The comparison of these classifications is shown in Table VIII.

TABLE VIII
COMPARISON OF LABORATORY AND OUTDOOR CLASSIFICATIONS

Test (A — 96 hr. B — 240 hr.)		No. of times lab. test and out- door test agree	Lab. test passes; outdoor test fails	Lab. test fails; outdoor test passes
A.S.T.M. Salt Fog	— B	10	0	6
Salt Spray	— B	13	0	3
A.S.T.M. Salt Fog	— A	10	1	5
Salt Droplet	— B	14	1	1
Salt Spray	— A	15	1	0
Salt Droplet	— A	13	3	0
Humidity	{ — B	13	3	0
	{ — A	11	5	0

The 240-hour A.S.T.M. Salt Fog Test failed all six primers considered satisfactory outdoors and the 96-hour test failed five of them. At the other extreme, the 96-hour Humidity Test passed five of the ten primers that gave an unsatisfactory performance outdoors, including the two worst. The 240-hour Humidity Test and the 96-hour Salt Droplet Test also passed one of these bad primers.

The 240-hour Salt Droplet Test and the 96-hour Salt Spray Test were the best as pass/fail tests. However, they both passed one primer which was below average outdoors. The satisfactory primer failed by the Salt Droplet Test had an average rating of 7.0 over all sites, only 0.6 above the arbitrary minimum limit. The agreement obtained with these two tests is somewhat better than had been expected, but it is evident that serious errors can still occur. If time permits, it is wise to evaluate primers by an outdoor test such as the one described, but these two laboratory tests are obviously of great value if a quick decision has to be made. In this respect, from the viewpoint of a purchaser of primers, the 240-hour Salt Spray Test might well be favoured; while it gave the wrong result with about 20 per cent of the primers, in no case did it accept an unsatisfactory primer.

CONCLUSIONS

The 96- and 240-hour Salt Droplet Tests are the most reproducible of the eight tests examined. The 240-hour Salt Droplet and the 240-hour Salt Spray Tests, which are of intermediate severity, grade primers more in accordance with the results obtained outdoors than do the other tests. The 240-hour Salt Droplet Test requires only relatively inexpensive apparatus, but the procedure is time-consuming; with the latter test the reverse applies. The selection between these two tests should be based on these points, and having regard to the superior reproducibility of the Salt Droplet Test. The severe A.S.T.M. 240-hour Salt Fog Test and the relatively mild Humidity Tests lacked correlation with outdoor results.

As pass/fail tests the 240-hour Salt Droplet and the 96-hour Salt Spray Tests predict the category, satisfactory or unsatisfactory, into which a primer

falls with more certainty than the other tests. Even so, both tests incorrectly pass a proportion (about 6 per cent) of primers. A safer test for a purchaser to apply would be the 240-hour Salt Spray Test which, while it incorrectly failed about 20 per cent of primers, did not pass any that were unsatisfactory when exposed outdoors.

ACKNOWLEDGEMENTS

This paper is published with the permission of the Chief Scientist, Australian Defence Scientific Service, Department of Supply, Melbourne, Australia.

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Determination of Thixotropic Coefficient

By A. DE WAELE

221 Chase Side, Southgate, London, N.14

INTRODUCTION

The reversible loss in consistency which some materials undergo when sheared is designated as thixotropy, but the term is often applied to materials which merely exhibit curvature of their rheological diagrams. It must be pointed out that the line obtained by plotting the results accruing from non-Newtonian bodies in both capillary and also with rotary instruments, does not indicate rigidity-thixotropy falling within its original definition. The diminishing curvature of the line with increasing shear rate merely indicates a change in *apparent* viscosity¹. This property is not realisable in quasi-fluids by ordinary subjective observations, except when present in extreme cases, and only assumes practical significance in certain special applications. A large degree of viscosity-thixotropy, therefore, would be useful in a material intended for use in spraying, by ensuring a high degree of fluidity at the spray nozzle combined with a slow flow on the sprayed surface, thereby minimising runs and sag.

The classic definition of thixotropy in a plastic material is the reversible change from a semi-solid paste or gel to a freely flowing fluid, when a sufficiently high rate of shear is maintained within it. Such property, superimposed as it invariably is on a viscosity-thixotropy, forms the basis of the flow characteristics of so-called thixotropic paints.

TEST METHODS

Rotary Viscometer

It is sometimes the practice to explore the thixotropic behaviour of a plastic material by a special technique in a coplanar rotary viscometer. The material under test is first subjected to rotary shear at a rate sufficient to attain linearity of the shear rate/stress curve. When the stress deflection (θ_1) is steady, shear is arrested for given intervals of time, the rotation restarted at the same rate and the immediate, but temporary, deflection (θ_2) noted. A curve is plotted of ($\theta_2 - \theta_1$) against the different intervals of rest. The resulting curves, however, whilst indicating the existence of thixotropy, only give a qualitative picture which is still more obscure in meaning if curves from different materials cross.

Conductimetric Method

The author has established that the rate of growth of rigidity on resting between shear operations can be determined by a conductimetric method in cases where the material to be tested consists of an electrically conductive phase

in a medium of low conductance². However, many pigments used in paints exhibit little conductance, *e.g.* zinc oxide, organic pigments, *etc.*, and some materials owe their rigidity, not to flocculation of disperse phase, but to a lyophilic gel formed by adsorption of some fraction of the medium on to the disperse phase. Thixotropic lithographic printing inks, therefore, do not easily respond to such means of investigation unless a special and elaborate technique is adopted. It is again obvious that water paints are excluded from examination by this method since low conductivity of the continuous phase is essential.

An analogy between the equation connecting growth of electrical conductivity with time of rest after shear²

$$dC/C.dt = K.t^n$$

and that derived from the rheological method cited

$$\frac{d(\theta_2 - \theta_1)}{(\theta_2 - \theta_1).dt} = K.t^n$$

suggests itself, but for reasons which are not definitely established, this analogous equation did not lead to the linearity necessary to establish n , the coefficient of thixotropy. The empirical equation

$$\frac{d(\theta_2 - \theta_1)}{dt^n} = K$$

results in linearity when the logarithms of the numerator are plotted against logarithms of times of rest, n then being the required thixotropy coefficient of regain of rigidity and K the residual rigidity at unit time of rest. Writing θ_r in place of the more cumbersome $(\theta_2 - \theta_1)$, the empirical equation becomes

$$d\theta_r/dt^n = K$$

Since $\log \theta_r - n \log t = \log K$

The rate of build-up at any given time of rest (t) is

$$\frac{d\theta_r}{dt} = n \frac{\theta_r}{t}$$

which at unit time simplifies to

$$\frac{d\theta_r}{dt} = n.K$$

RESULTS

In Figs. 1-3 are shown the plots of θ_r against t for three emulsion paints examined twenty-four hours after making and one week later; Figs. 4-6 are plots from three gloss enamels, the logarithmic derivatives of the direct graphs being shown in Figs. 7-12. In Fig. 13 is shown a logarithmic plot interpolated from the curve shown as Fig. 13 in the paper on carbon black suspensions by Mill³.

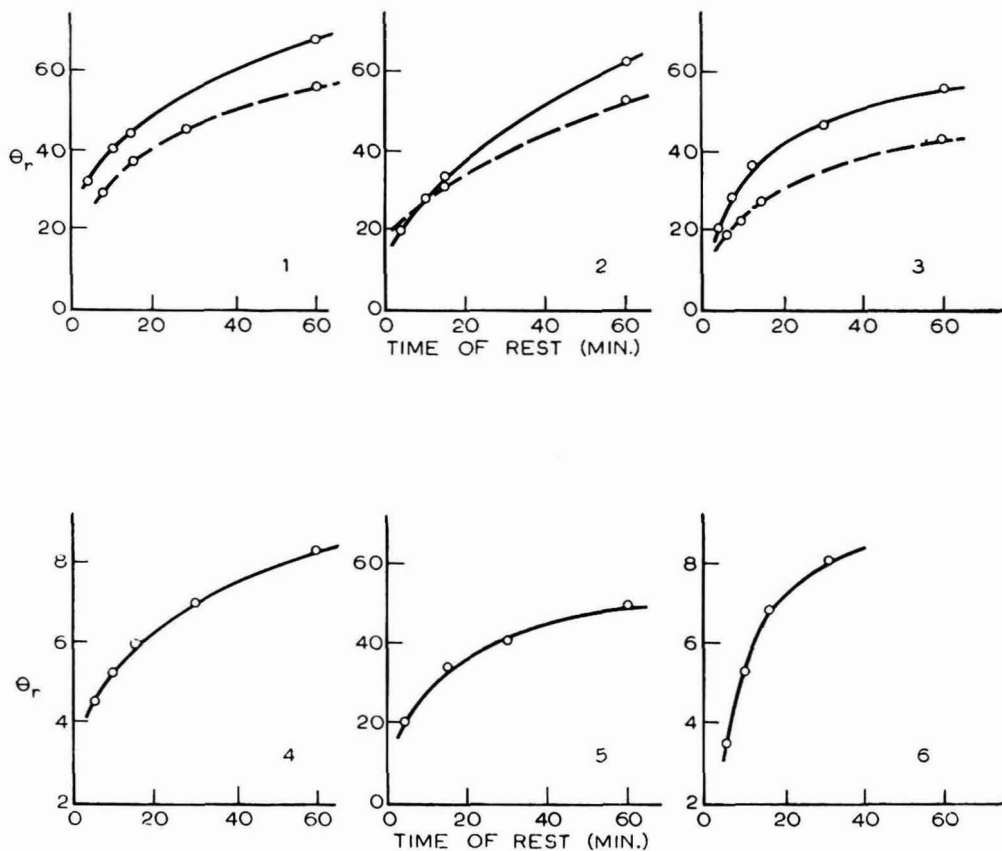


FIG. 1 to 6

PLOTS OF θ_r AGAINST TIME OF REST (t)

Emulsion Paints :

FIG. 1. WHITE

FIG. 2. TINTED OFF-WHITE

FIG. 3. TINTED YELLOW

(— examined after 24 hours, - - - - after 1 week at 40°C)

Gloss White Enamels :

FIG. 4. ALONE

FIG. 5. WITH *Bentone* ADDED

FIG. 6. WITH GELLED ALKYD ADDED

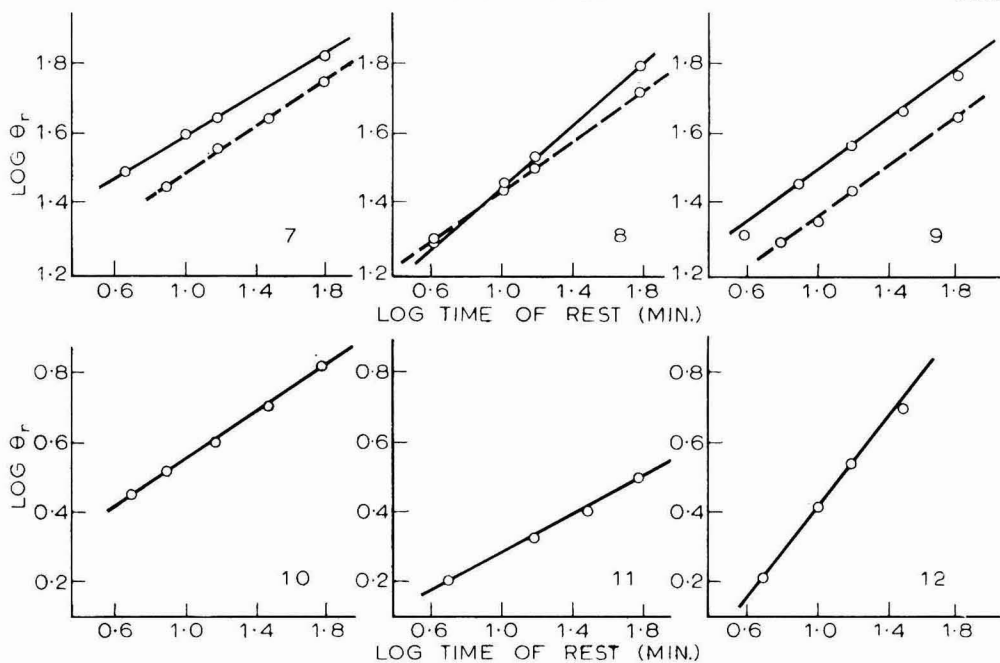


Fig. 7 to 12

PLOTS OF $\text{LOG } \theta_r$ AGAINST LOG TIME OF REST

Emulsion Paints :

FIG. 7. WHITE

FIG. 8. TINTED OFF-WHITE

FIG. 9. TINTED YELLOW

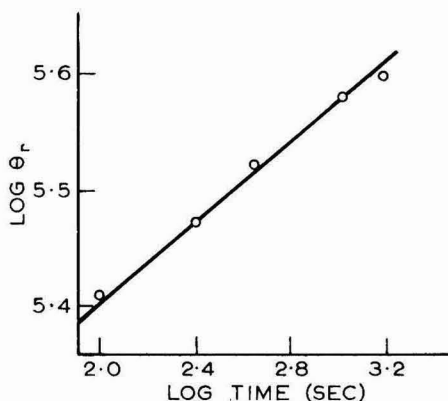
(— examined after 24 hours, - - - - after 1 week at 40°C)

Gloss White Enamels:

FIG. 10. ALONE

FIG. 11. WITH *Bentone* ADDED

FIG. 12. WITH GELLED ALKYD ADDED

FIG. 13. PLOT OF $\text{LOG } \theta_r$ AGAINST LOG TIME OF REST (MILL'S FIG. 13)

The constants obtained by treatment of the several logarithmic curves in dimensional units are given in Table I, whilst Table II shows the effects of some adducts on the constants of the enamel paints, including those from Figs. 10, 11 and 12. Included in the same Table are the constants derived from Fig. 13.

TABLE I
WHITE EMULSION PAINTS. EFFECT OF TINTING AND EFFECT OF STORAGE FOR ONE WEEK

Age	Untinted		Tinted off-white		Tinted yellow	
	24 hr.	1 week	24 hr.	1 week	24 hr.	1 week
n	0.31	0.33	0.35	0.42	0.35	0.36
K	1.23	0.93	0.80	0.69	0.87	0.63
$d\theta_r/dt$ (unit time) ..	0.38	0.31	0.28	0.29	0.30	0.23

TABLE II
GLOSS ENAMELS AND CARBON BLACK IN OIL

	n	$K \times 10^2$	$d\theta_r/dt \times 10^2$
White gloss enamel	0.45	2.3	1.0
„ „ + <i>Bentone</i> ..	0.27	5.6	1.5
„ „ + 15% gelled alkyd	0.67	1.2	0.8
„ „ + 20% „ „	0.67	4.6	3.1
„ „ + 25% „ „	0.66	4.9	8.3
Dark oak gloss enamel	0.40	8.3	3.3
Carbon black in oil	0.17	0.56×10^{-1}	9.5×10^{-2}

DISCUSSION

Whilst the conductimetric method² is performed on material under completely static conditions, this is not the case in the technique adopted in the foregoing. In the first place, during the "rest" period a definite, although decreasingly small stress is maintained by the residual torque in the wire, so that rigidity is not built up to the same extent as it would if the "rest" represented a truly static condition. This could be overcome by releasing the torque of the wire immediately the initial "deflocculating" continuous shear is arrested. Further, it must be noted that the impetus of the stator exercises a disturbing influence. This can be allowed for by employing stators of varying moments of inertia and extrapolating to zero moment.

The foregoing treatment affords a means of classifying plastic materials for their thixotropic properties in a quantitative manner and of predicting their behaviour within those intervals of time during which thixotropy assumes practical significance.

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Reviews

PRINTING INK MANUAL

Society of British Printing Ink Manufacturers, Editor-in-chief, DR. R. F. BOWLES. Cambridge: W. Heffer and Sons Ltd., 1961. Pp. viii+746. Price 70s.

This much-awaited volume, commissioned by the Technical Training Board of the British printing ink industry, has been written by a team of twenty-two British experts, including Dr. R. F. Bowles and four associate editors, with the support of the Society of British Printing Ink Manufacturers. It is a comprehensive text-book covering largely the requirements for the Advanced Technician's Certificate of the City and Guilds of London Institute, but serving equally well as an up-to-date guide for scientists, research workers and others to the technological aspects of printing inks and printing. No more than an elementary knowledge of physics and chemistry is called for to understand most of the text.

Following a Foreword with acknowledgements by the editors, the book has been arranged in two parts. Part I comprises the first nine chapters, beginning with a short history of ink making. Then comes a thirty-page outline of printing processes in which the emphasis is on those factors related to inking, and a good bibliography of wide scope for further reading, though not on xerography, is appended. In Chapter 3 is given a unique account of the manufacture of modern printers' rollers, a section of the industry almost without a literature. There follows an excellent explanation of papermaking, the composition, properties and chief types of paper, with a well-chosen bibliography. Consideration is given in the next three chapters to the other substrates on which ink may be printed, *viz.* cellulose films, plastics, metals and foils. The rheological and other aspects of ink film making and film breaking are lucidly discussed in appreciable detail over forty-nine pages and Chapter 9 consists of a fifty-seven-page discourse on colour and colour vision, including colour reproduction and measurement, together with a selected yet quite comprehensive reading list.

Having thus broadly covered the wide range of printing ink requirements, Part II, consisting of twelve chapters, takes up almost two-thirds of the volume and deals directly with ink manufacture. After an eighty-two-page grouped schedule listing the important chemical and physical properties and applications of most of the very numerous raw materials used in ink formulation, there are separate chapters on news inks, typographic, lithographic, photogravure, flexographic and screen process inks and another on inks for special purposes. In these chapters the specific needs and problems of each process are dealt with, as well as the formulation of the several modifications and varieties of ink required for each. In Chapter 18 a concise account is provided of varnishes in which the chemistry has been limited and probably kept as simple as possible, though, for this reason, more references to the literature might have been included. The mechanical considerations involved in the efficient dispersion of powdered pigments in liquid vehicles, *i.e.* actual ink manufacture, receive attention in Chapter 19, of which there are three pages on works costing as regards plant and labour, ten pages on factory planning and layout and four pages on factory legislation and welfare. The last two chapters deal respectively

in some detail with the testing and control of materials and finished inks (sixty-one pages) and print diagnosis, that is, the recognition of prints and printing defects, the latter being illustrated with twenty-three whole-page photomicrographs. Throughout the text are many line and half-tone illustrations appropriately placed and numbered, and at the end is a fully adequate, combined author and subject index.

The manual certainly gives good value for its cost and will be very useful to senior students of printing and papermaking as well as those engaged in ink manufacture. However, there appear to be two or three overall criticisms. No system has been adopted for the fairly numerous references to literature. Bibliographies, as already mentioned, are given at the ends of Chapters 2, 4 and 9, but elsewhere the literature references are included among the text in some chapters or as footnotes in others, with confusion of both methods in a few cases, *e.g.* p. 419. Initials or abbreviations are used without definition for the names of some institutions and at least one process in the text and frequently among the references for the titles of publications, several of which are not widely known. A list of such abbreviations would have assisted newcomers to the subject.

Being primarily intended to provide a basis for the training of technical personnel, the price is likely to be regarded by students as rather high, and since there are over 750 pages, size 6 in. \times 9 in. the volume is two inches thick so that it is bulky to handle. The size and therefore the price could have been reduced somewhat without the loss to the essential subject matter. There is considerable repetition of technical points, which on the whole may be a good thing and difficult to exclude among a team of authors, but iteration of historical and technical printing developments, particularly between Chapter 2 (Printing Processes) and Chapters 11, 12, 13 and 14 (Inks for the Various Processes) might have been avoided. For the same purpose when a new edition is called for, the extensive chapters on Paper and Colour and Colour Vision could be much reduced with the retention of the excellent bibliographies supplied on these subjects.

There are a number of minor imperfections or omissions. For instance, p. 23 line 15, "offset" for "set-off"; pp. 26 and 215, "brightness" is a less ambiguous word than "lightness" for luminosity; on p. 25 there is no indication of the difference between "aniline" and "pigmented" flexographic inks; on p. 35 is an obscure reference to the Rembrandt Company as the first in the field of rotary photogravure, the location of this firm in Lancaster and its connection with Storey Brothers Ltd. not being mentioned until p. 442; although the serious difficulties arising in printing from dimensional changes in paper are mentioned in Chapter 4, no reference is made to any method under "Printability Tests" for measuring this factor and it is passed over almost casually under "Misregister" on p. 726; Chapter 7 details the manufacture of tinfoil but contains no direct statement of the method of printing on it; since 1961 (the publication year of the Manual) coincides with the centenary of James Clerk Maxwell's famous demonstration of trichromatic colour reproduction, this might have been acknowledged in Chapter 9; on p. 721 it is stated that "strike through" and "show through" should not be confused, yet they are on p. 251 relative to the transparency of paper; static electricity on the paper should have been added

to the factors that increase set-off on p. 366; if the limited use of genuine vermilion justifies its inclusion among the pigments listed in Chapter 10, why not flake white? With regard to the photomicrographs of prints and print defects, it would have been helpful to have stated the kind of paper on which each specimen was produced and Fig. 21.7 is rather misleadingly labelled "Photogravure *half-tone*". In the paragraph on collotype recognition, p. 711, the typical though irregular pattern of this process is not described, yet it is on p. 32.

Notwithstanding the above comments, this modern, authoritative and interestingly readable manual is a most welcome addition, especially in the field of technical education, to the very few text-books on printing inks so far published.

There are few misprints, the most misleading, perhaps, being "filled" for "fitted" p. 616, line 18. In the reviewer's copy Figs. 21.20 and 21 are duplicated. The book is well printed and durably bound.

F. W. CLULOW.

THE MECHANISM OF HETEROGENEOUS CATALYSIS

Edited by J. H. DE BOER. Amsterdam: Elsevier Publishing Co., 1960. Pp. xi +180. Price 15s.

This monograph consists of eight papers presented at a symposium held by Dutch chemists in Amsterdam, together with an introductory lecture by Professor de Boer and a brief discussion on each paper. It provides a review of current work in Holland on catalyst mechanisms, with particular reference to chemisorption, to absolute rate equations for such processes, to mobility on the catalyst surface and its effect on selectivity, and to the order of reactions involving chemisorption.

The titles of the individual papers are (1) *Electronic Structure of Metals and Overvoltage*, (2) *The Decomposition of Formic Acid on Metal Catalysts*, (3) *The Decomposition of Formic Acid on Oxides*, (4) *The Mechanism of Ammonia Synthesis over Iron Catalysts*, (5) *The Influence of the Electrical Double Layer in the Heterogeneous Catalysis of Ionic Processes in Solution*, (6) *The Mechanism of the Ziegler Polymerisation of Ethene*, (7) *The Mechanism of the Selective Hydrogenation of Fatty Oils*, (8) *Bifunctional Catalysts*.

This list of contents will show that, with the exception of the two papers on formic acid decomposition, the subjects covered have no very close relation one to another. However, the monograph provides a valuable summary of contemporary developments in studies of catalyst mechanisms, and the treatment is somewhat more detailed than that now customary in most scientific journals. It is an interesting and stimulating collection which should be in the hands of all those who are working in this field.

R. H. GRIFFITH.

INORGANIC SYNTHESSES VOLUME VI

EUGENE ROCHOW (Editor-in-Chief). New York: McGraw-Hill Book Company, 1960. Pp. 272. Price 60s.

This book follows the well established pattern of style and high standard of presentation set by previous issues in this series. The preparation of sixty-nine

varied compounds is described, and the experimental details provided have been subjected to critical and independent checking. The book is divided into eight chapters with the syntheses grouped according to the Mendeleef periodic classification.

Each preparation is presented in a uniform sequence, which starts with an introduction containing a critical survey of known methods reported in the literature and a brief justification of the choice of the method to be described. Secondly, details of the procedure and the apparatus are given with emphasis on safety. In some cases clear diagrams of the equipment to be used are included. Finally, the physical and chemical properties of the product are described, followed by literature references.

There is also a most useful cumulative index comprising the syntheses from previous volumes, contributors' names and a formula index, thus necessitating only a brief search for the required preparation.

L. J. BELF.

ORGANIC COATING TECHNOLOGY

Volume II—Pigments and Pigmented Coatings

By H. F. PAYNE. New York and London: John Wiley & Sons Inc., 1961. Pp. 1399. Price 140s.

This companion volume to Professor Payne's "Organic Coating Technology": Vol. I:—Oils, Resins, Varnishes and Polymers, with which it is intended to be used, is surely a book not only for the student and technical man new to the industry (as suggested on the dust cover), but also one that the experienced chemist and technologist will welcome. The author is to be congratulated on writing a book that is so readable, and so valuable as a reference work with its concise summaries of up-to-date thinking on the subjects covered. The book is refreshingly new and does not lean on prior textbooks in the field. Six of the twelve chapters are devoted to pigments as such, the other six being concerned with formulation, paint application, and discussion of specialised systems (architectural, industrial and corrosion and chemical resistant paints).

An "up-to-dateness test" applied by the reviewer was based on known publications about surface agents, sand grinding, the *Kady* mill, the *Attritor*, the *Cowles* dissolver, aerosol applications, considerations of bacteria, fungi and algae, acrylic finishes, polyesters, water-soluble resins for industrial finishes, critical pigment volume concentration and light fastness of vat-dyestuffs. The book came through very well on these, but failed to reveal attention to the work of *Dintenfass* nor (surprisingly enough) of *Daniel* on flow point techniques. It might be thought that more space should have been given to such matters as particle size, specific surface of pigments, flooding, dispersion and pre-dispersed pigments.

Although there are classical references covering European journals and many references to *J.O.C.C.A.* in particular, the bibliographical coverage (averaging some fifty to sixty references at the end of each chapter) is weighted on the American side. This applies also to trade names, e.g. *Resydrol* water-soluble resins and *Desmodur* polyurethanes are not mentioned, but only the American products. The book deserves a better Index with separation of "Author" and

"Subject" entries. No initials of authors appear in the index; in certain cases similarity in surname has been considered sufficient justification for only one entry in reference to dissimilar kinds of work by different individuals.

R. J. COLE.

INTRODUCTION TO PETROLEUM CHEMICALS

Edited by H. STEINER. Oxford: Pergamon Press, 1961. Pp. 200. Price 50s.

The petroleum industry, with its abundant supply of simple hydrocarbon products, is an obvious source of heavy chemicals. From making a chemical use of, to deliberately manufacturing, the by-products was a natural, though exacting, step. Most large refineries have now associated chemical operations. Many simple aliphatic and more and more aromatic chemicals are being produced from petroleum. Thermoplastic manufacture is almost entirely, and surface coating manufacture is increasingly becoming, dependent upon petroleum chemicals.

An immense technological effort has been necessary to develop petroleum chemicals and it is now difficult for the chemist in other branches of industry to follow progress. "Introduction to Petroleum Chemicals" attempts to bridge the gap between the complicated petroleum chemical industry and the equally specialised industries which use its products. In this respect the book succeeds. It is a collection of lectures presented at Manchester College of Science and Technology in 1959 with the object of giving an outline of the petroleum chemicals industry to chemists in other industries in the Manchester area. The book now enables these lectures to reach a wider audience. The authors, four from the petroleum and five from the associated chemical industries, are all specialists in their chosen field, many of them being experts recognised outside their industry. The papers are factual, comprehensive and adequately documented. They emphasise the main principles and conclusions of their subject, yet they include detail without losing the interest of the specialist, or non-specialist, from another field.

"The conditions of cracking are simple and brutal" introduces an early section of *Cracking Processes*; the chapter elaborates this theme. There are simple conditions at which to aim, but many factors can affect the precise conditions of brutality. The subsequent chapter on *Separation Processes* emphasises how choice of process depends on available feed stock and utilities. These two chapters deal clearly with the basic reactions and processes on which the whole of the industry depends. In two further chapters on *Products and Polymers from Ethylene and Propylene*, hydrolysis, oxidation and condensation reactions are just examples of the processes discussed. Current problems in producing aromatic chemicals are considered and the chapter on simple olefine polymers is an excellent survey of new polymerisation processes in a rapidly changing field. The *Production and Use of Butadiene and Isobutylene* describes the separation processes and uses for C₄ hydrocarbons. *Aromatics from Petroleum* describes the various catalytic reforming processes, the method of isolation and the more important chemical conversion steps. *Styrene and Polystyrene* covers manufacture of the monomer, the polymer and applications of the latter. The *Acetylene* chapter again emphasises how much the choice

of process, and there are many variations, depends upon the choice of site and available raw materials. Finally, just to remind us that even carbon itself is not without its problems, the manufacture of carbon black and the uses of the various grades is described.

The styles of papers vary, but they all fit neatly into a whole, a credit to the editor and authors. There is an adequate five-page index, numerous diagrams, tables and illustrations, usually one per page. These vary from molecular models and physical data to flowsheets and photographs of plants. The layout and printing are easy to read. It seems a pity the book should cost 50s., which must surely restrict its sale. In 1953 the Society of Chemical Industry published, at a much lower price, a pamphlet covering a symposium on a quite similar range of subjects, again introduced by Sir Robert Robinson. Is not publication by the appropriate scientific society the best way of presenting such useful papers to the widest audience at the least cost? However, to the person who is not directly concerned with petroleum chemicals, yet feels he should know something about them, this book is to be recommended.

D. P. DODGSON.

Auckland Section

INSTRUMENTATION IN THE ASSESSMENT OF PRINTING INK CHARACTERISTICS

The first general meeting of the Section since receiving full Section status was held on 15 March at the premises of Shell Oil (New Zealand) Ltd., following dinner at the Star Hotel. The Chairman, Mr. A. Partridge, welcomed members and friends and expressed the hope that the new Section would have a sound future, with many stimulating instructive lectures and discussions.

The lecturer for the evening was Mr. A. G. Hammond, assistant technical manager of Morrison and Morrison Ltd., who spoke on "Instrumentation in the Assessment of Printing Ink Characteristics". Mr. Hammond introduced his subject by outlining the progress of recorded communication from cuneiform writing to the development of printing from movable type. In the fourteenth century the Flemish painters first developed oil paints by grinding pigments in vegetable drying oils, and this was the basis of early ink formulation. Printing and printing ink manufacture progressed side by side as crafts, until the middle of the nineteenth century, when two important changes took place. The discovery of the coal tar dyestuffs by Perkins greatly extended the range of pigments, and the industrial revolution led to radical changes in printing press design. This received a further impetus as a result of the 1914-18 war. Press speeds and labour costs were now so high that idle machine time had to be reduced to a minimum. Variations in the properties of inks became more critical and the time had come for empirical testing methods to be replaced by instrumental techniques. The purpose of the paper was to describe some of the instruments used today by the printing ink manufacturer to measure the physical properties of his products.

The maximum particle size of dispersed pigments was important and was tested on a fineness-of-grind gauge, by comparison with a graduated channel varying in depth from 0.002 in. cut in a small steel slab. The propensity of a printed film of ink to "set-off" on the back of the succeeding sheet was measured by placing a printed strip and an unprinted sheet in loose contact on a steel bed which moved at a controlled speed below a small trip hammer, which pressed them into close contact. The period of time for the hammer blows to produce zero set-off could be measured. The "skinning time" of an ink could be measured by allowing a steel point to be drawn across a thin film of ink at a known speed. The point at which a permanent scratch mark appeared enabled the skinning time to be calculated. Printed packages which moved against each other in transit could "scuff" unless the ink film was "scuff resistant". This could be measured by rubbing an unprinted surface against a printed one under controlled conditions, and observing the degree of scuff. The Sutherland reciprocating arc, the PATRA rotary and the Hedley hand reciprocating instruments were described.

On the subject of rheology, the difficulty of separating flow, tack and viscosity was discussed. The I.G.T. Printability Tester was described; this enabled an inked roller to print on a strip of paper at gradually increasing speeds until picking of the paper surface occurred. The "tack" values of different inks or different papers could therefore be compared. The Ford Cup, Falling Sphere and Ostwald Tube methods of measuring "viscosity" were mentioned. The torsion type of viscometer was discussed in which the viscosity was measured by torque on a wire; the *Ferranti* model was described. The *Brabender Viscograph*, which gave a direct graphical reading showing changes of viscosity due to mechanical agitation or changes of temperature, was described, together with the bar type of viscometer in which a rod fell through a collar internally coated with ink. The importance of "pH" in lithographic fountain solutions and of paper was stressed, and the glass electrode and *Lovibond Comparator* types of instrument were described. The PATRA method of obtaining a quick guide to the pH of paper surfaces by coloured indicators was also discussed.

The day-to-day method of assessing "colour" by visual comparison was described and the need for instrumentation in compiling colour specifications for standardisation was emphasised. The three British Standards, B.S. 1480 : 1949, B.S. 2650 : 1955 and B.S. 3020 : 1959, for three- and four-colour process printing, were considered. The preparation of spectrophotometric curves using smoked magnesium oxide as a standard and eight-colour filters ranging from about 4,300-6,700 Å units was also described.

Mr. Hammond answered several questions and an interesting discussion followed, after which a vote of thanks to the speaker was proposed by Mr. W. R. Raine.

R. L. T.

Bristol Section

THE DEVELOPMENT OF ORGANIC PIGMENTS FOR PRINTING INKS

On 24 March, the lecture was divided into two parts, Mr. J. Mackinlay dealing with the development of organic pigments from pre-war to the present day, whilst Dr. F. M. Smith dealt with the physical properties of pigments, such as particle size and shape, on their properties in inks.

Mr. Mackinlay opened by detailing the improvements which had been made over the past years, owing to the manufacture of purer raw materials and improvements in plant and manufacturing techniques. He then proceeded to describe modifications which had been made in conventional organic pigments, such as increased light fastness, lower dusting qualities, lower bulking values and better dispersibility. He continued by outlining the development of pigmented chips, and the improvement in flushing properties. The question of cost could not be ignored, but he felt that the increased chemical resistance and light fastness which was being obtained would more than compensate for the inevitable increase in cost.

In the second part of the paper, Dr. Smith demonstrated with the aid of electron micrographs, the shape and size of a number of pigment dyestuffs, and then gave details of some recent work on P.V.C./viscosity relationships. Among the points made was the increase in thixotropy with increasing pigmentation which occurred in some cases, and also the possibility of a relationship between the viscosity at high pigment loadings and the oil absorption. On the subject of surface active agents, different effects obtained by treating the pigment, as against milling the additive into the dispersion in oil, were described in some detail.

A very lively discussion, opened by Mr. Butler, then followed, in which Mr. Wade, Mr. Phillimore, the Chairman, Mr. D. S. Newton, and a number of visitors took part. A vote of thanks to the lecturers was proposed by Mr. Brooke.

D. S. N.

Hull Section

JOINT MEETINGS

During March the Section joined with two other local bodies to hold discussion meetings. On 13 March members of the Hull and District Chapter of the York and East Yorkshire Architectural Society were guests of the Section at a discussion evening. The Chairman, Mr. J. S. Geary, welcoming members of the architectural profession, introduced their Chairman, Mr. C. E. Tooley, who, during a short address, commented on various matters which he said he hoped would be discussed.

Mr. Tooley said that many architects thought paint manufacturers should use the same naming for similar colours. Clients were very happy when surrounded by manufacturers' shade cards, but when their choice was completed the architects'

headache began. Paints were tested under ideal conditions, and the architect would like to see testing also take place under more practical conditions. The use of plastics was becoming more common. These had a number of advantages over paint, not least of which was that plastics could be built into the building as a unit during construction. Mr. Tooley also asked why it was that deep colours in emulsion paints often showed sheariness when used on large areas.

A lively discussion followed during which answers were given to many of the questions posed by the architects. Those taking part included Mr. Tooley and Mr. Linnaker (architects), and Mr. E. A. Brown, Mr. H. M. Cook, Mr. J. J. Cowperthwaite, Mr. J. S. Geary, Mr. N. Lythgoe, Mr. F. Parsons, Mr. W. A. Rutherford and Mr. S. Sharp (chemists). It was perhaps unfortunate that the attendance of the architects was rather small on this occasion.

THE FUTURE TREND OF PAINT TECHNIQUE

On 22 March members were invited to join with the Hull Branch of the National Federation of Master Painters to take part in a discussion entitled "The Future Trend of Paint Technique". The introductory speakers were Mr. J. Pittaway, President of the Hull Branch of the Federation, and Mr. S. Sharp, for the Association.

Mr. Pittaway stated that paints today were complex products and his members were interested to learn more about the materials with which they worked. They were particularly interested to learn from the chemists of newer paints and techniques and of future trends.

Replying for the chemists, Mr. Sharp said that there were three basic components in paint, the pigment, medium and solvent. Titanium dioxide pigment was widely used today, and many more pastel colours were now available which could be used outside. Among the resins, p.v.a. emulsion paints had given a fillip to the use of paint for the decoration and protection of large areas, and acrylic based emulsion paints were now available on the market, representing the latest development in this field.

The speaker then described the popularity of alkyd resins for gloss paints, pointing out their limitation as to drying time. It was now possible to make a faster drying paint than eight hours by using an alkyd modified with vinyl toluene. This would mean exterior painting could be done in the afternoon without the risk of humidity damaging the film, as was likely with a slower drying medium. Finally there was the solvent in the paint, and here work was going on to produce solventless paints. There was also the newer development of airless spraying and the continual striving to produce better paints with water as the only solvent.

The meeting was then opened for discussion. Priming paints for wood in particular were discussed, reference being made to cheap primers, to those containing white lead and to multipurpose primers. Mr. W. A. Rutherford thought that the painter today mainly primed three wood surfaces, namely, softwood, hardwood, such as oak, and gaboon faced plywood on flush doors. Modern building construction was increasingly utilising in the same constructional unit woods and metal which required primers of different kinds suited to these surfaces. What was needed was a multipurpose primer which could be used on both these surfaces. This requirement could be met by a calcium plumbate primer; he did not feel that the primer based on a fairly high proportion of white lead for use on wood was what the painter wanted, owing to its slow drying characteristics. In any case the painter could not always wait until the film was hard enough to take a further paint coat satisfactorily. Mr. S. J. Reed felt that there might be some difficulty in formulating such a primer which was suitable for these surfaces because wood and metal had different absorptions.

In summing up, Mr. Pittaway thought the idea of an all-purpose primer was attractive.

Discussion also took place on the merits of rot-proofing timber before erection and painting. It was suggested that, provided that the treatment was not detrimental to subsequent painting, it was of value in combating dry rot and mould growth, particularly during very wet winter building as experienced recently. The frequent failure of alkyd paint systems on glazing putty was mentioned by one speaker for the painters, and, in reply, Mr. Sharp thought that there was scope for the use of mastics incorporating copolymers, not only for this country, but also for overseas. He suggested that the same materials might also be used as fillers.

For the painters, Mr. Waddington was interested in the claims made for the whiteness and stability of colour of some white gloss paints available today. He exhibited to the meeting a cupboard door painted twelve months previously with a well-known white gloss paint and which had been in service in his kitchen during this period. He also exhibited a panel showing the same paint freshly applied. The degree of yellowing of the aged paint was very obvious when compared with the freshly applied film. In addition he had paid extra for this particular white and this was the result. He said he would like an explanation for this yellowing from the chemists.

Mr. N. Lythgoe replied that yellowing on ageing was bound to occur as long as unsaturated vegetable oils were present in the medium of the paint. Yellowing could be reduced or eliminated by using stoving paints incorporating special resins which did not contain unsaturation, but these paints were naturally not suitable for use as brush applied decorative paints in the normal way.

It was pointed out by Mr. Cowperthwaite (chemist) that when linseed oil was used as a component of the medium, yellowing took place on ageing, and in the presence of gases, such as ammonia. However, the use of oils, such as soya bean or tobacco seed oil, reduced yellowing considerably, especially when these oils were used to modify alkyd resins. Mr. W. A. Rutherford observed that the use of a soya bean oil-modified alkyd in a modern gloss finish reduced yellowing considerably, and also produced a paint more tolerant to lower temperature drying conditions.

Other subjects discussed included mottled coatings, emulsion paints, airless spraying, plastic paints and fillers. In closing the meeting, Mr. Pittaway thanked the chemists for attending and answering the questions so frankly. Mr. Geary, the Hull Section Chairman, said in reply that he felt that the discussion had been extremely valuable to the members of both bodies and looked forward to further joint meetings in the future.

W. A. R.

London Section

CAN THE CLIMATOLOGIST HELP YOU?

The seventh technical meeting of the twenty-third session was held on 23 March, at Manson House. With Mr. A. T. S. Rudram, Vice-Chairman, in the chair, Mr. H. C. Shellard of the Meteorological Office, Bracknell, presented a paper entitled "Can the Climatologist help you?" Mr. Shellard described the history, organisation and services offered by the Meteorological Office and illustrated his talk with photographs of some of the equipment used. He described how the use of computers assisted in the collation of data on climatological behaviour at stations distributed throughout the country. The lecturer concluded his paper with a survey of some of the collated results of average weather conditions in various parts of the country particularising rainfall, wind direction and strength, and direct sunlight. He showed how certain of these factors could vary, depending on the angle of exposure of the surface being studied.

Following the lecture, a discussion was held in which Mr. T. R. Bullett, Mr. A. H. Soane, Mr. J. F. Stanners, and Mr. N. R. Fisk participated. During the course of the

discussion the question of the correct angle of exposure of panels for durability tests was raised and it was indicated that 45° facing South was not necessarily the optimum condition. The meeting was brought to a conclusion by the proposal of a vote of thanks to the lecturer by Mr. P. Whiteley.

C. R. P.

ANALYSIS OF PAINT MATERIALS

The last technical meeting of the 1960-61 session took the form of a joint meeting with the Society for Analytical Chemistry and was held at the Wellcome Institute on 12 April, and proved to be one of the most successful meetings of the session. The President of the Society for Analytical Chemistry, Dr. A. J. Amos, took the chair and was joined on the dais by the Chairman of the London Section, Mr. J. A. L. Hawkey. The estimated total attendance was two hundred and the evening's proceedings consisted of three papers under the general heading "Analysis of Paint Materials".

The first of these papers was of a general introductory nature entitled "Some Problems in the Analysis of Surface Coating Materials", and was presented by Mr. C. Whalley, of Laporte Chemicals Ltd. He suggested that there were six prime reasons for the analysis of surface coatings, namely, control of raw materials, control of finished products, investigation as to why coatings went "wrong", *e.g.* lack of drying power, *etc.*, breakdown of competitors' products, investigation of failures, and research projects to give a better understanding of the basic chemistry of coatings. Most work was concentrated on the third, fourth and sixth of these items. He then proceeded to survey the types of material to be analysed, oleoresinous coatings of all types, emulsion based materials and lacquers. The lecturer deplored the lack of any standard text book on systematic methods of analysis, but mentioned the publications of Kappelmeier and Hanson as going some way towards that end. A survey was then made of the methods available for analytical investigations into the pigment system, including emission spectroscopy, which would determine the elements present very rapidly, X-ray fluorescence spectroscopy, which had the advantage of being applicable to the complete dry film and which he considered could be a very useful tool in the future, and X-ray diffraction, which was useful both for the identification of different crystalline forms of the same basic chemical, *e.g.* anatase and rutile titanium dioxides, and for particle size measurement. Complexone titrations were mentioned as a useful tool when the elements present had been isolated. In solvent analysis the use of gas-liquid chromatography had now become standard practice and displaced all other methods. The real problems arose in the analysis of the medium because the products being analysed were usually not in the form in which they were originally found. This problem was much more difficult today than ten or fifteen years ago owing to the large scale developments in film forming systems. No composite scheme for chemical analysis was available at present, and it was necessary to proceed in stages. Infra-red spectroscopy and gas chromatography could give useful information, but it was necessary for the analyst to know the types of material which would be encountered so that satisfactory deductions could be made from the information obtained. The possibilities of the use of nuclear magnetic resonance spectra in this connection was also suggested. Mr. Whalley concluded by asking whether paint companies really made the most efficient use of the analysts they employed.

The second paper, entitled "The Examination of Mixed Solvents Obtained from Plastic Adhesives, Lacquers and Surface Coating Preparations", was presented by Mr. A. R. Jeffs with Dr. J. Haslam and Mr. H. A. Willis (all of I.C.I. Ltd., Plastics Division) as co-authors. Mr. Jeffs described a technique which involved a combination of gas-liquid chromatography and infra-red spectroscopy. In all cases the solvents were isolated from the composition since direct examination involved difficulties in

relation to the trapping of solvent or contamination with depolymerisation products from the medium. Isolation was accomplished by a micro-vacuum distillation technique which was described in detail. Initial information was then obtained by gas-liquid chromatography on a 30 per cent dinonyl phthalate/120 mesh *Celite* column of 6 ft. length and $\frac{1}{4}$ in. diameter at 100°C using a catharometer detector. This gave an identification of hydrocarbon solvents of such precision that the solvents could be attributed to their manufacturers by the characteristic chromatograms obtained. Chromatography on different static phases, *e.g.* paraffin wax, tritolyl phosphate, served to identify some other solvents by an examination of the relative retention times, 12 ft./ $\frac{1}{4}$ in. columns being used in this case. The final refinement in identification was by the use of a heated gas cell or liquid cell and infra-red spectroscopy. The details of this technique were fully described and the equipment used was displayed for examination. When quantitative determination was required, it was usual first to obtain an approximate estimate from the chromatograms, then to make up such a mixture and carry out a chromatographic examination of this known mixture. By comparing the chromatograms of the known and unknown mixtures, estimates of sufficient accuracy could usually be obtained.

The third paper, by Dr. D. R. Duncan, of the Paint Research Station, was entitled "The Identification and Estimation of Pigments in Pigmented Compositions by Reflectance Spectrophotometry", and described the possibilities of the use of this technique in the identification of specific pigments by plotting spectrophotometric curves using the θ value ($=\frac{1-R}{2R}$) as described in the author's paper in *J.O.C.C.A.*, 1949, 32, 296. Mixtures of an unknown pigment at various concentrations with a white pigment, plotted as described, were shown to give a family of curves which, by selection of a suitable reduction factor, could produce a curve characteristic of the coloured pigment. This could then be compared with similar curves for known pigments and the pigment thus identified. In the case of unknown pigment mixtures, a very good estimate of the proportions of pigments required to produce a non-metameric match could be obtained because the θ function is an additive function of the coefficients of absorption of the individual pigments used. The important point of this method was that the colour match would be obtained from the pigments available in the analyst's organisation rather than a perfect identification of the pigments used in the original composition. Examples of the use of the method were shown and differences between the curves of a metameric pair were clearly illustrated in addition.

At the conclusion of the three papers, the meeting was thrown open for discussion, in which Mr. K. J. Salmon, Dr. G. L. Fuchs, Mr. H. B. Smith, Mr. R. R. Coupe, Mr. B. W. Stannard, Mr. C. Jackson, Mr. C. P. Cole, Mr. G. H. Thomas, Mr. E. B. Bunker, Mr. R. G. Kinsman and Mr. N. R. Fisk participated. Most of the questions were directed towards Dr. Duncan, who amplified some of the points of the technique he had described. The meeting was concluded by the proposal of a vote of thanks to the lecturers by Mr. J. A. L. Hawkey. The large attendance and extent of the discussion bore evidence to the quality of the papers.

C. R. P.

Manchester Section

JOINT MEETING

On 10 March, the Section held a joint meeting with The Royal Statistical Society (Merseyside Branch) at the Bradford Hotel, Liverpool.

Mr. J. P. L. Truesdale gave the first paper in which he discussed the concept of statistical error. Taking as his illustration the results of batch analyses of glass, he showed the nature of the normal distribution coupled with the probability of obtaining results showing departures from the mean. He demonstrated this effect by drawing

results from a sample of two thousand, which further led to the fact that standard deviation of means of a group of results was lower than that for individual samples.

The properties of the standard deviation were then elucidated by Dr. C. F. A. Roberts. Using two painted panels, he showed that a population of results were defined by the two parameters, mean and standard deviation. The standard deviation was the only measure of spread which gave due weight to every observation in the population. He pointed out that the variance which was the square of the standard deviation had the important property of being additive. He also illustrated that, provided that the observations were random, the frequency diagram or histogram approximated to the normal curve.

Mr. W. J. Jennett, taking the basis so far discussed, showed that a distribution of results followed from the effect of uncontrolled, but natural, disturbances brought to bear on the event being studied. This he demonstrated most effectively with the aid of the Galton Apparatus. He then described the results of a work study on the production time for a new process. The isolation of various contributory factors, such as variations arising from each operator and the type of product, was illustrated by frequency diagrams. As a result, he stated that production planning had been made possible by using lesser skilled labour for the general operation and confining the final adjustment to the skilled man. Thereby they had obtained a standard time for the process irrespective of the factors originally studied.

Finally, Mr. R. L. Plackett briefly indicated the power of statistics for studying several factors simultaneously, using dispersion matrices and also concomitant variations in more than one effect by multivariate analysis.

I. S. M.

Midlands Section

WALLPAPER TODAY

The February meeting of the Section was a Ladies' Invitation meeting held at Permo-glaze Ltd. The Chairman, Mr. N. H. Seymour, expressed his pleasure at seeing so many Members and their ladies present, and gave a special welcome to Mr. E. H. Ott, President of the Federation of Societies for Paint Technology. The subject "Wallpaper Today", discussed by Mr. R. E. Grime and Mr. K. H. Maidens, covered the history of wallpaper, the manufacturing processes involved, the design and application to interior decoration.

At the present time 120-140 million rolls of wallpaper were made in the United Kingdom each year, 30 per cent of them being exported. Britain was the largest user, and also had the widest range of patterns from which to choose. This represented an enormous development from the seventeenth century, when designs were block printed and the wallpaper was sold in large sheets which had to be matched in two dimensions.

The first process in printing was the grounding of the paper with a china clay casein dispersion, giving a suitable surface for printing. It was possible to print colour on a wet ground coat, but the dispersion produced was not usually sharp. This could be improved considerably by drying the ground coat, but as it involved an extra process, the paper was more expensive. The majority (70 per cent) of wallpapers were in white, grey and beige, plain textured or embossed, as these neutral colours created few problems in home decoration.

Mr. Grimes dealt with printing of coloured papers, and also with more special types, such as washable papers, and showed some excellent examples of hand-printed papers where screen printing was adopted. Mr. Maiden explained the processes involved in the manufacture of paper, giving many illustrations of the plant and techniques involved. The lectures were concluded with many suggestions on the use of wallpaper

in interior decoration. The discussion covered the technical problems in manufacture and the practical problems experienced by the amateur decorator, and showed that the evening was thoroughly enjoyed by everyone.

R. D. C.

Newcastle Section

FINISHING IN THE MOTOR INDUSTRY

The third meeting of the present session was held in the Royal Turks Head Hotel, Newcastle upon Tyne, when Mr. H. L. Quick read a paper entitled "Finishing in the Motor Industry".

After briefly surveying the scale of dependency of the motor industry upon the paint industry, and summarising the wide range of service conditions which the motor-car finish must withstand, Mr. Quick classified the paint used in motor vehicle production into three main groups, *i.e.* body finishing paints, chassis paints and engine paints, and gave the characteristics required of each class. The automatic processes employed in paint application were then considered in detail and illustrated by slides. Methods were described for pretreatment and priming by the *Rotodip* plant, wherein the body is both dipped and sprayed with phosphating solution before being dip primed, and by the rather more simple spray phosphate plant, incorporating the dip priming of the lower part of the body only. The surface preparation was considered to be the keystone to the whole system of body painting, and the requirements of surfacers and application methods were detailed. Then the techniques by which colour coats were applied and stoved were described, the necessity for the elimination of airborne dirt in the plant being emphasised. Finally, the lecturer discussed the reasons why the motor industry carried out an extensive programme of paint testing, and listed the methods of test which were in operation in the industry, and those which were under review.

The paper given by Mr. Quick occupied the ideal time of somewhat under an hour, but such was the interest shown by members that the discussion which followed lasted for a much longer period. The meeting was closed by the acting Chairman, Mr. A. A. Duell, who proposed the vote of thanks.

G. W. D.

Scottish Section

WATER-THINNABLE STOVING FINISHES

The sixth meeting of the current session was held on 23 February at the North British Hotel, Edinburgh. Mr. E. A. Bullions, Chairman, presided over a large gathering of Members and after the preliminary business he introduced their guest and lecturer, Mr. A. G. North.

Mr. North introduced his lecture on "Water-Thinnable Stoving Finishes" by comparing water-soluble and emulsion-based systems for the production of water-dilutable stoving finishes, and by examining the general properties of water. He said that emulsion resins had a number of advantages, one, in particular, being the fact that virtually any resin could be produced in emulsion form; there was no restriction, therefore, on the type or molecular weight of the resin. The resin could often be water-insoluble without any thermosetting reaction taking place since, once the water left the film and resin coalescence occurred, the coating would be reasonably water resistant. A great disadvantage of emulsion systems was that it was difficult to produce gloss finishes with normal pigment loadings, because the pigment had to change phase during the film forming operation. Further, the presence of colloids and wetting agents tended to decrease the film water resistance and could also cause gloss troubles, as they were not

truly compatible with the polymer. In practice, problems were also found with emulsion systems, because of excessive foaming and the tendency of the coatings to coalesce on the surface, and for water to be entrapped in the film during the early flash off stage. This entrapped water subsequently could cause blistering of the coating during the high temperature stoving. Solution systems, on the other hand, did not suffer from problems of obtaining good gloss and were generally easier to handle in paint formulation. The requirements of solubility, of course, posed certain restrictions on the type of resin that could be used and the lecture would deal with water-soluble melamine alkyd and phenolic alkyd systems, which in their cured state, were comparable in composition to the surface coatings generally used.

The lecturer went on to describe the general formulation of paints using water-soluble resins of the type considered. He pointed out that, in general, pigmentation could be accomplished by quite normal methods and that most pigments could satisfactorily be used. Exceptional types were strongly basic pigments, or those with an excessive degree of water-solubility. Recent work had been carried out, particularly on the use of anti-corrosive pigments, and it had been found that two of the most effective types were strontium chromate and lead chromate. Added in quite small percentages, these had a marked effect on the corrosion resistance of coatings; this was particularly interesting in view of the fact that lead chromate was not normally considered as an anti-corrosive pigment. Of the two types, strontium chromate was slightly more effective in the melamine alkyd system, and lead chromate in the phenolic alkyd system. The total level of pigmentation was important in determining the degree of corrosion resistance in coatings, and in general a pigment volume concentration around 30 per cent was suggested. At this point, a number of slides were shown illustrating the superiority of water-based systems of this type over conventional solvent-based systems in anti-corrosive properties both on steel and on zinc-coated metal.

In the application of water-based finishes, it had often been considered that electrostatic methods were not satisfactory. Quite recently, however, electrostatic spraying in volume had been started in Sweden and an illustration was shown of the apparatus that was being used. It was important in all water-thinned stoving finishes to ensure that adequate flash-off time was given to allow evaporation of most of the water. It was also necessary to ensure stoving to the recommended schedule, since undercuring was relatively more harmful than with conventional finishes.

Cleanliness of metal surfaces to which these systems were being applied was very important, but recent developments had indicated that modifications in the resins could make these systems more tolerant of slight traces of surface contamination. The lecture concluded with a number of lantern slides, illustrating some of the commercial applications of these resins. It was mentioned, in particular, that in many of these cases, the paint had some specific advantage, quite apart from the general benefit of replacing an expensive and hazardous solvent with water. Typical of such advantages was a very high degree of flow and levelling on porous metal castings used for adding machines, and the absence of solvent washing effects on the inside of petrol tanks coated by a filling and draining technique.

Mr. Bullions, Dr. Atherton, Mr. Jeffries and Mr. McKay were foremost amongst those who participated in the discussion following the lecture. At the request of the Chairman, Mr. Colin Cochrane proposed the vote of thanks.

H. G.

THE SURFACE PREPARATION OF STEEL BEFORE PAINTING

The seventh and last ordinary meeting of the current session was held on 16 March at More's Hotel, Glasgow, with Mr. E. A. Bullions in the chair. Mr. E. E. White delivered a paper entitled "The Surface Preparation of Steel Before Painting".

The life of a steel structure depended on several factors, one of the most important being surface preparation. The duration of protection afforded by any painting

scheme on a well prepared surface would be much greater than that of a similar scheme on a poorly prepared surface. Comparative figures illustrating the effect of surface preparation on paint durability were quoted. Sand blasting (10.4 years) was more effective than both pickling (9.5) and wire brushing (2.3). If it were possible to keep mill-scale perfectly intact and firmly adherent, it would itself protect steel from rusting and form a good basis for the paint. Unfortunately, however, under industrial conditions this solution of the problem was impracticable. There were two main groups of methods, mechanical and chemical, used for removing mill-scale from steel. One of the commonest mechanical methods was by exposure to weather, followed by wire brushing. Prolonged exposure to the weather caused all the scale to be undermined and to flake off. Wire brushing should then remove any remaining mill-scale, although it was certain to leave a considerable amount (up to 2 oz./ft.²) of rust. One way of improving the efficiency of removal was by the use of power tools. Power-driven wire brushes, chippers, scrapers and similar mechanical aids could reduce the quantity of scale and rust remaining, although they can never be completely removed.

An improved technique was by flame cleaning, consisting of the application of an intensely hot oxyacetylene flame to the surface of the steel. The sudden heating caused loose mill-scale to flake off and it also dehydrated any rust present. After the removal of the flame the surface was immediately wire brushed. It was then dusted down and painted while still warm and dry. The two principal methods for producing the most suitable surface for painting were pickling and blasting. The former involved the immersion of the steel in acid, and, provided that the pickling baths were not allowed to become spent, little difference results from the use of different acids, whether sulphuric, hydrochloric or phosphoric. The best process was probably the *Duplex* method, which employed hot 5 per cent sulphuric acid, followed by a hot water rinse and a final dip in 2 per cent phosphoric acid containing up to 0.5 per cent of iron, all at 80°C. A thin protective phosphate film was deposited on the steel surface which retarded to some extent the development of rusting. The phosphate film was not intended to protect the steel indefinitely, and painting should be done on the same day as pickling.

Mill-scale and rust could also be removed mechanically by the abrasion of flying grit, consisting of broken steel shot or sand, which was usually projected at the surface by compressed air or from the edge of a wheel. The choice of blasting conditions, e.g. the type of abrasive, the blasting pressure and the distance of the nozzle from the work, was important. A good key for painting must be obtained without excessive surface roughness. The durability of painting schemes on steel which had been rusted before being grit blasted was liable to be less than that of similar schemes on unrusted and grit blasted steel. Failure was probably stimulated by rust entrapped below the paint film, since blasting had a tendency to span the mouths of pits in the corroded surface and hammer in the rust. In the blasting techniques it was important to prevent the dust formed from being injurious to health or damaging to the paint film which might be applied over it. A vacuum technique had been now developed which overcame these hazards.

Steel could be pretreated by immersion in phosphating baths, which produced a layer of zinc, manganese or iron phosphates closely integrated with the metal substrate. This layer not only provided an excellent key for painting but also greatly reduced the outward spread beneath the paint film from rust spots. Phosphoric acid washes might also be used, being sprayed, brushed or sponged over the surface, but while they were useful for the removal of superficial rust, they were not as effective in removing old or heavy rust deposits. Pretreatment primers, otherwise known as wash primers or etch primers, were also of use. They consisted of phosphoric acid, a chromate pigment and a film-forming synthetic resin, polyvinyl butyral.

Finally, the preparation of ship plate was discussed. As a result of tests, the following method was recommended for new construction. The plates were descaled by grit blasting or pickling and allowed to weather for one or two months. Although this was essential for pickled plates, it might not be critical for those that had been grit blasted. The plates were then wire brushed thoroughly, and a pretreatment primer was applied followed finally by the bottom painting scheme.

After the lecture a lively discussion period ensued, and finally, at the request of the Chairman, Mr. George Anderson, the Honorary Secretary proposed the vote of thanks to the lecturer.

H. G.

SCOTTISH SECTION—STUDENT GROUP

BRAINS TRUST

The final meeting of the session was held on 15 April at More's Hotel, Glasgow, with Mr. J. Miller, Student Group Liaison Officer, presiding. By well-established precedent, the final meeting of each session takes the form of a "Brains Trust", an event always eagerly anticipated by the students. The panel on this occasion was formed by Mr. Ian Hutchison, Mr. W. W. Horsburgh, Mr. W. McDermaid and Mr. A. Pisacane. The questions submitted were many and varied, ranging from queries on "technical service by local paint manufacturers to customers" to "a comparison of one-can and two-can systems of polyurethane finishes". It can be said that the members of the panel rose to the challenge and each and every question was dealt with at length and to the satisfaction of the audience.

A vote of thanks to the members of the panel was ably proposed by Mr. Miller and heartily endorsed by all present. It is recorded with regret that Mr. Miller is relinquishing the post of Student Group Liaison Officer. His retirement has been necessitated only by increasing business commitments. In the departure of Mr. Miller the students have lost an earnest mentor and friend, who directed all their affairs with complete understanding and to the entire satisfaction of all concerned. Mr. D. M. Stewart succeeds Mr. Miller as Student Group Liaison Officer. Mr. Stewart brings to his task a wealth of experience and there is no doubt that the affairs of the student group will continue to flourish under his guidance.

H. G.

London Section

ANNUAL GENERAL MEETING

The Annual General Meeting of the Section was held on 26 April at the Criterion Restaurant, Piccadilly, W.1. The meeting was preceded by a dinner which was attended by about forty-five members. The Honorary Secretary, Mr. M. R. Mills, proposed the adoption of the Annual Report and made mention of the variation of meeting nights during the session. The average attendance for Tuesdays was sixty-eight, for Wednesdays was one hundred and forty-six and for Thursdays was one hundred. He also commented on the formation of the Southern Branch of the Section and the transfer of responsibility for the Annual Technical Exhibitions to a Committee of Council. Mr. B. F. Rolls seconded the adoption of the report and suggested that attractive television programmes might have accounted for the low attendance on Tuesdays. He thought that the adoption of the Exhibition by Council was a logical move in view of the contribution made by the function to the income of the Association. The report was adopted without dissent.

Mr. A. H. Soane, Honorary Treasurer, proposed the adoption of the financial report and mentioned the loss on the Ladies' Night. Mr. R. A. Brown, Chairman of the Southern Branch, seconded the adoption and outlined the history of the formation of the Southern Branch. Mr. G. F. Jones queried the loss on the Ladies' Night and a discussion developed on methods to avoid a possible deficit in the future. Mr. J. A. L. Hawkey, Mr. M. R. Mills, Mr. N. R. Fisk, Mr. H. A. Newnham and Mr. C. Kersey all spoke on this point and Mr. R. A. Brown finally suggested that the points raised should be referred back to the Committee for detailed consideration.

The Chairman proposed the election of the following Honorary Officers:

<i>Hon. Secretary</i>	..	Mr. M. R. Mills
<i>Hon. Treasurer</i>	..	Mr. A. H. Soane
<i>Hon. Publications Secretary</i>	..	Mr. C. R. Pye

Hon. Programmes

<i>Officer</i>	..	Mr. A. R. H. Tawn
<i>Hon. Auditor</i>	..	Mr. W. H. Campbell

Mr. J. A. L. Hawkey then proposed the election of Mr. A. T. S. Rudram as Chairman for the forthcoming session and commented on his qualities both as a Committee Member and Programmes Officer. In seconding this election, Mr. H. A. Newnham, reviewed Mr. Rudram's career to date and pointing out Mr. Rudram was the first member of the staff of the Paint Research Station to be elected Chairman of the Section, despite the close ties between the two bodies. The election was approved unanimously with acclamation. In acknowledgement, Mr. Rudram paid tribute to the help he had received from the past Chairmen of the Section under whom he had served, and also his colleagues at the Paint Research Station. A vote of thanks to the retiring Chairman, Mr. J. A. L. Hawkey, was proposed by Mr. N. R. Fisk, who spoke of the long service Mr. Hawkey had given to the Section and of the patience, good humour and wisdom he had shown as Chairman.

The three elective members of committee were announced as Mr. K. H. Arbuckle, Mr. F. Armitage and Mr. D. E. Eddowes. Mr. B. F. Rolls raised a question concerning the lantern in use at Manson House and this was discussed by Mr. Rudram, Mr. Hawkey and Mr. P. J. Whitaker.

CITY LIVERY COMPANIES

At the conclusion of the meeting Mr. C. G. Todd, a Past Master and the present Clerk of the Wax Chandlers' Company, gave a talk on the City Livery Companies. He described the constitution of the companies, the various ranks within that constitution and the recognised means of entry. Before taking the livery, it was necessary to be a Freeman of the City of London for one year and he showed his own certificate of Freedom, but he said that this had little authority. Mr. Todd traced the origins and development of the livery companies from the time when Charlemagne in 779 and

821 A.D. forbade them, and in 1150 Wardens were appointed to check abuses in their various trades. In 1328 Edward III became a liveryman and gave to the livery companies the power and privilege of electing the Lord Mayor, and Sheriffs of the City of London, which power is still in force to-day.

The speaker then outlined the particular history of the Wax Chandlers' Company, which was eighth in seniority of the minor companies, and therefore, twentieth of the eighty-two now in existence. The earliest document dated from 1199, but recorded activities dated from 1343. The vicissitudes of the company throughout the ages were described, and the fare at a banquet to the Lord Mayor in 1478 was recorded as costing the magnificent total sum of 7s. for what appeared to be a most sumptuous menu. The first Royal Charter and grant of Arms dated from Richard III and both were reviewed from time to time by succeeding monarchs until James II withdrew the Charter and lost it. In the light of this loss and after a law suit, the Company was permitted to use the previous Charter, which is still valid to-day and accounts for the fact that the Company is allowed unlimited Livery, whilst most of the later companies are limited in the number of their liverymen.

The site of the Hall at Gresham Street (originally Maiden Lane)/Gutter Lane junction has been occupied since 1487. Mr. Todd concluded by describing the position of the City Livery Companies to-day. Far from being anachronisms, they were a feature of the City, and dis-

pensed considerable hospitality. In 1880 a total income of some £700,000 derived from "quarterage" (subscriptions from members) and property ownership, about two-thirds was spent on benevolent activities. Many well-known public schools were supported by individual companies of which St. Paul's, Tonbridge, and Merchant Taylors' were good examples. Eleven hundred charities including five hundred almshouses and institutions for the poor were also maintained, in addition to grants-in-aid to sons, and widows of liverymen and Freemen.

At the conclusion of the talk Mr. F. Armitage said that the Paynters-Stainers Company had some claim to fame, being probably one of the first to be involved in a case of patent infringement. The case, brought by Sir Francis Howard, was recorded in Pepys' diary. Mr. Todd said that these two companies were amalgamated about three hundred years ago and were still quite active, but like many other companies had no hall of their own.

Mr. J. A. L. Hawkey proposed a vote of thanks to Mr. Todd for what had proved to be an extremely fascinating talk, which could be said to be almost a part of the history of the country. After the meeting Members had the pleasure of inspecting exhibits brought by Mr. Todd, including a copy of the Charter of the Wax Chandlers' Company and the book of Ordinances and Search Book, recording the investigations of the Company into the quality of production of wax candles, both of which dated back to the sixteenth century.

C. R. P.

Manchester Section

ANNUAL GENERAL MEETING

The thirty-seventh Annual General Meeting of the Section was held at the Nag's Head Hotel, Manchester, on 14 April, with Mr. H. Smith in the chair, and eighty members present. The minutes of the thirty-sixth Annual General Meeting were read and accepted. The Annual Report of the Committee and the Treasurer's Report were presented and adopted unanimously, whence the meeting proceeded to the election of Officers.

The following Members were elected as the Officers of the Section for the 1961-62 Session.

<i>Vice-Chairman</i>	..	Mr. J. Smethurst
<i>Hon. Secretary</i>	..	Mr. R. McDowell
<i>Hon. Treasurer</i>	..	Mr. H. F. Clay
<i>Hon. Publications Officer</i>	.. ..	Mr. J. S. Moll
<i>Hon. Research and Liaison Officer</i>	..	Mr. N. Ashworth
<i>Hon. Social Secretary</i>		Mr. M. J. Heavers

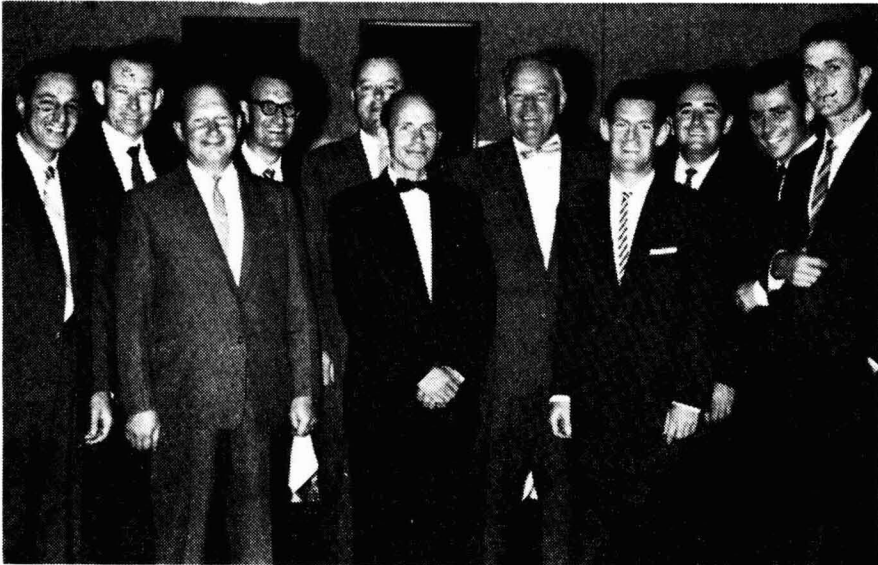
Mr. H. Smith thanked all those officers who had served over the past year for their efforts in all the activities of the Section. In accordance with Rule No. 8, Mr. S. L. Mole had retired from the Committee this year and Mr. M. J. Heavers had become the Honorary Social Secretary. There were, therefore, two vacancies on the Committee, for which three nominations had been received. As a result of a ballot, Mr. H. Archer and Mr. A. W. R. Thomas were

elected. The two Honorary Auditors, Mr. R. Bowden and Mr. E. L. Tweedie, who have both given long service in this capacity to the Section, were unanimously re-elected for the following year.

After the Annual General Meeting had been declared closed, Members sat down to an excellent hot-pot supper with liquid refreshment and spent a convivial evening being entertained by Mr. L. Adams.

I. S. M.

Queensland Section



Members of the Queensland Section Committee at their Annual Dinner Dance

ANNUAL DINNER DANCE

On 7 December 1960, about eighty Members and guests wended their way to "The Chinese Club", Auchenflower, Brisbane, where the Section held its Annual Dinner Dance. The Chairman, Mr. H. A. McDonald, and Mrs. McDonald received and welcomed the Members, guests and their ladies.

After an excellent meal at which vast quantities of Chinese food and spring chickens were consumed, the loyal toast was proposed by Mr. McDonald, who also spoke briefly on the valuable work carried out during the year by members of the Committee. Later, the energetic among the company enjoyed themselves dancing and the not so energetic by conferring with their

many friends. They were assisted by the plentitude and excellent quality of the Queensland beer, while those dancing were helped by an excellent seven piece dance band, which showed amazing flexibility in playing music to suit all tastes. Featured in this band were some very talented artists who included in their repertoire some stimulating performances of traditional jazz. Dancing continued late into the night when the evening was brought to a close with the usual traditional ceremonies. The smooth running of the function was largely due to Mr. H. C. Wulff, who was Master of Ceremonies, and to Mr. B. Porter who spent many long hours over the organisation.

D. W.

Newcastle Section

ANNUAL DINNER DANCE

The Section Annual Dinner Dance was held in the Crown Hotel on 21 March. Among the principal guests were the President, Mr. P. J. Gay, and Mrs. Gay, the Chairman of the Scottish Section, Mr. E. A. Bullions, and Mrs. Bullions, the Chairman of the Hull Section, Mr. J. S. Geary, and Mrs. Geary, the Chairman of the Manchester Section, Mr. H. Smith, and Mrs. Smith, and Mr. and Mrs. Reay represented the Midlands Section.

There were ninety-one members and guests present to hear the President propose the toast to the Section, mentioning

the continued growth of the Section and commenting with pleasure on the number of younger members in attendance. The Chairman of the Section, Mr. A. D. Hibberd, who proposed the toast to the guests, explained how it came about that he was presiding for the third time at this function and, as it was his swan-song, he expressed his thanks to the various officers who had given their support during his two years of office. After the dinner, dancing continued until 1 a.m., when an enjoyable evening had to be brought to a close.

G. W. D.

Scottish Section

ANNUAL GENERAL MEETING

The Annual General Meeting of the Scottish Section was held on 21 April, at St. Enoch Station Hotel, Glasgow. With Mr. E. A. Bullions in the chair, and in the presence of a fair attendance of Members, the business on hand was efficiently and harmoniously accomplished. The Chairman, Honorary Officers, Committee Members and Honorary Auditors were nominated and elected to their respective appointments.

<i>Chairman</i>	..	Mr. E. A. Bullions
<i>Vice-Chairman</i>	..	Mr. A. S. Fraser
<i>Hon. Secretary</i>	..	Mr. G. Anderson
<i>Hon. Treasurer</i>	..	Mr. J. S. Hutchison
<i>Hon. Publications Officer</i>	..	Mr. H. Gibson
<i>Representative on Council</i>	..	Mr. H. Gibson
<i>Hon. Research Liaison Officer</i>		Mr. T. B. Hannah
<i>Hon. Education Officer</i>	..	Mr. A. Mclean
<i>Student Group Liaison Officer</i>		Mr. D. M. Stewart
<i>Hon. Auditors</i>	..	Mr. L. Hopwood Mr. J. D. W. Davidson
<i>Committee</i>	..	Mr. W. W. Horsburgh, Mr. A. Mawer, Mr. J. Miller, Mr. W. K. MacCallum, Mr. J. F. McVey, Mr. W. Peden.

When the business of the meeting was concluded, the Chairman thanked all Members for their unstinted support during the session just ending, and he felt sure they would all continue to work for the common good in the future. In reply, Dr. D. Stead, Immediate Past Chairman, thanked Mr. Bullions on behalf of the Members and assured him that much of the success attending the work of the Section during the year under review was in no small measure due to Mr. Bullions's own efficiency and zeal.

H. G.

A. H. WHITAKER

A well-known and much respected personage is missing from the list of Honorary Officers and Committee Members for the 1961-62 session. The name, A. H. Whitaker, is indelibly written in the annals of the Scottish Section. A Founder Member and Past Chairman, Mr. Whitaker has filled with distinction and acceptance many offices. In recent years he has been the Section's Representative on Council and occupied the role of elder statesman in the affairs and deliberations of the Section, where his counsel was invariably sought on all matters of protocol. For his years of unremitting effort on behalf of the Scottish Section, all Members now record their grateful thanks to Mr. Whitaker and hope that it may be possible for him to be present at some future meetings of the Section.

Mr. Whitaker was made an Honorary Member of the Association in 1956.

H. G.

ANNUAL SMOKING CONCERT

Following the Annual General Meeting, Members and friends foregathered at the Stuart Hotel, East Kilbride, for the Annual Smoking Concert. After a meal served in pleasant surroundings, the remainder of the evening was devoted to song and story. The harmony was sustained by two well-

known professional artists, but if the Section's own musicians and songsters maintain their present form, the Section might well be able to dispense with outside help on future occasions. It can be recorded that this was another successful "Smoker" and thanks are due to those responsible, especially to Mr. Ian Hutchison, who at very short notice made the final arrangements when it became necessary to find a new venue for this function.

H. G.

Register of Members

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

Ordinary Members

- BROWN, BERNARD CLARK, 151 Summerhouse Drive, Wilmington, Nr. Dartford, Kent. (London)
- BROWNLIE, JAMES POVEY, 11 Faskally Avenue, Bishopbriggs, Glasgow, Scotland. (Scottish)
- BUTTERS, DEREK FRANCIS, 16 Hartington Court, Lansdowne Way, London, S.W.8. (London)
- CHARMAN, PAUL EDWARD HENRY, Silver Birches, Connaught Road, Brookwood, Surrey. (London)
- EASTON, JAMES DOUGLAS, 19 Craiglawn Avenue, Eaglesham, Glasgow, Scotland. (Scottish)
- FILSON, ARTHUR COLE, 57 Newsham Drive, Newsham Park, Liverpool, 6. (Manchester)
- FORESTIER, Mlle. H., 161 rue de la Republique, Puteaux (Seine), France. (Overseas)
- FRANIC, BORIS, Colorificio Italiano Max Meyer S.P.A., Via Comasina, 121, Milan, Italy. (Overseas)
- HARRIS, LESLIE CYRIL, 10 Home Close, Pound Hill, Crawley, Sussex. (Overseas)
- HICKMAN, VIVIAN, c/o Styrene Co-Polymers Ltd., 1 Roebuck Lane, Sale, Cheshire. (Manchester)
- HOWARTH-WILLIAMS, JAMES, Swale Chemicals Ltd., 53 Park Hill Road, Croydon, Surrey. (London)
- INGHAM, MICHAEL PETER, 11B Oxford and Cambridge Mansions, Marylebone Road, London, N.W.1. (London)
- JONES, PETER RONALD CHARLES, 40 Mill Lane, Bilbrook, Wolverhampton, Staffs. (Midlands)
- JONES, THOMAS MAXWELL, 82 King Street, Southport, Lancs. (Manchester)
- KENNEDY, THOMAS, "Greenlands", 30 Hillington Road, Sale, Cheshire. (Manchester)
- RING, PETER NORMAN, 22 Park Court, Abbeville Road, Clapham, London, S.W.4. (London)
- ROBINSON, ANTHONY, 25 Ferndale Road, Thurmaston, Leics. (Midlands)
- ROOME, KENNETH, Shell International Chemical Co., St. Helens Court, Great St. Helens, London, E.C.3. (London)
- SREEVES, JOHN ERNEST, 34 Yoxall Road, Shirley, Solihull, Warwicks. (Midlands)
- THORNHILL, ARTHUR EDWARD, 7 Baguley Road, Sale, Cheshire. (Manchester)
- THOMAS, GRAHAM CHRISTOPHER, "Calverton", Britwell Road, Burnham, Bucks. (London)
- TORRE, HUMBERTO, 18 Ventnor Gardens, Barking, Essex. (London)

Associate Members

- BROWN, ALEXANDER DURHAM CHIRNSIDE, 16 Craiglea Crescent, Milngavie, Nr. Glasgow, Scotland. (Scottish)
- BURTON, PETER, 30 Sylvan Avenue, Emerson Park, Hornchurch, Essex. (London)
- GILBERT, KENNETH, 59 Avondale Avenue, Hazelgrove, Stockport, Cheshire. (Manchester)
- HARVEY, JOHN ALOYSIUS, Drinagh, Heathbridge Green, Cobham, Surrey. (London)
- TREGASKIS, CHARLES GEORGE, 23 Dunstone Road, Higher St. Budeaux, Plymouth, Devon. (London)

Junior Members

- CRAIG, ROBERT, Law House, 14 Haddricks Mill Road, Newcastle upon Tyne, 3. (Newcastle)
- FERRIS, ANTHONY GEORGE, 7 Common Road, Inkpen, Nr. Newbury, Berks. (London)
- GENT, MALCOLM APPELBY, Taylors Cellulose Lacquer Co., Victoria Works, Garside Street, Bolton, Lancs. (Manchester)
- HUGHES, KENNETH PETER, Taylors Cellulose Lacquer Co., Victoria Works, Garside Street, Bolton, Lancs. (Manchester)
- LYON, JOHN RUSSELL, 4 Maxwell Place, Liverpool, 13. (Manchester)
- MCLEAN, ANGUS McDONALD, 930 Argyle Street, Glasgow, C.3. (Scottish)
- PELLOW, NEIL MCINNES, 443 Broomfield Road, Balornock, Glasgow, N.1. (Scottish)

NEWS OF MEMBERS

Mr. W. G. Wade, an Ordinary Member attached to the Bristol Section, is now visiting Australia. He has been travelling through the Near and Far East and intends to visit New Zealand and the United States before returning home. Mr. Wade is also intending to deliver a paper to the Association in Melbourne on 5 June.

Mr. P. E. H. Charman, an Ordinary Member attached to the London Section, has been appointed Technical Representative of Croxton & Garry Ltd.

Mr. J. M. Maughan, an Ordinary Member attached to the Hull Section, has been appointed Works Director of the Humber Oil Company Ltd.

Mr. M. G. Bassett Smith, an Associate Member attached to the London Section, is to become General Manager of the Dunlop Footwear Company at Walton, Liverpool, on 1 August.

Mr. W. H. Stevens, an Ordinary Member attached to the London Section, has been

elected Honorary Secretary of the Association of Consulting Engineers.

Mr. B. N. Reavell, an Ordinary Member attached to the London Section, and Chairman of the Kestner Evaporator and Engineering Company, has been elected to the Council of the British Chemical Paint Manufacturers' Association.

It is regretted that an error occurred in this Section in the April issue of the *Journal*. Mr. K. Reiser was reported to have joined Lewis Berger (Great Britain) Ltd. in 1934 and to have been general works manager in 1959. In fact, Mr. Reiser joined Lewis Berger as a management trainee in 1954, becoming technical liaison officer in 1956, and technical and economic planning officer in 1958. He is combining his directorship with the post of research and development manager.

PRINTING INK MANUAL

On 23 March a reception was held in the Connaught Rooms to celebrate the publication of "The Printing Ink Manual". The Manual deals with the history, theory

and practice of printing ink manufacture in a manner suitable for the instruction of technicians entering the industry. It is also designed to be a valuable guide to graduates, research workers and others connected with or otherwise interested in the industry.

The Manual was prepared by a panel of British experts in the printing ink industry, with the support of the Society of British Printing Ink Manufacturers. The Technical Training Board of the Printing Ink and Roller Making Industry, under whose guidance the Manual was prepared, operates under the direction of the Society of British Printing Ink Manufacturers and the Oil and Colour Chemists' Association.

At the reception, Mr. N. E. Ward, the President of the Society, welcomed representatives of the Press and introduced Dr. F. W. Stoyale, who played a prominent part in the setting up of the Technical Training Board and who was also its first Chairman. Dr. Stoyale dealt briefly with the history of the Manual before handing over to Dr. R. F. Bowles, the present Editor-in-Chief. Dr. Bowles gave details of the work involved in the production of the Manuals and paid special tribute to the work of the first Editor-in-Chief, Mr. H. A. Idle, who had borne so much of the initial hard labour.

A review of the "Printing Ink Manual" by Dr. F. W. Clulow, Director of the Department of Printing and Photographic Technology at the Manchester College of Science and Technology, appears on page 382.

It is interesting to note that this Manual preceded by one month Part One (Non-convertible Coatings) of the Paint Technology Manuals, being published by this Association. Both are primarily intended to serve the same purpose—the training of technical personnel within the industries concerned. Members will be interested to learn that Part Two of the Manuals, entitled "Solvents, Oils, Resins and Driers", is well advanced and that publication is expected in the autumn.

BATTERSEA COLLEGE OF TECHNOLOGY

The Spectroscopy Section of the Battersea College of Technology has announced a course on Colour Technology (II) (19-23 June, 1961). The course is intended to meet the needs of those who are concerned with colour control in industry. It will be arranged to add to and to extend the first course given last year.

Enrolment forms may be obtained from the Secretary (Spectroscopy Courses), Battersea College of Technology, London, S.W.11. Early application is advisable.

SLF THIRD CONGRESS

The Federation of Scandinavian Paint and Varnish Technicians (SLF) will be holding its Third Congress in Oslo from 12-14 October, 1961, with the Association of Norwegian Paint and Varnish Chemists as organisers. The Federation is a union of the associations of paint and varnish technicians in Denmark, Finland, Sweden and Norway. The first Congress took place in Stockholm in 1955 and the second in Copenhagen in 1958. The programme will include lectures and discussions of paint technology problems, and the last day will be reserved for excursions. The majority of the lectures will be given in Scandinavian languages, although some will be in English or German.

Further information can be obtained from the Secretary of the Third SLF Congress, Mrs. Inger Carl, Alf Bjercke, Skippergt, 29, Oslo, Norway.

WAVERLEY GOLD MEDAL

The annual essay competition, with the first prize of the Waverley Gold Medal and £100, is sponsored by *Research* to encourage scientists to write clearly and comprehensively about their work. There is a second prize of £50, and also a special prize of £50 for competitors under thirty years of age. Full details and entry forms can be obtained from The Editor, *Research*, 88 Kingsway, London, W.C.2.

Forthcoming Events

(Note: Details are given of meetings arranged in the U.K. up to the 15th of the month following publication, and in the Commonwealth up to the 15th of the second month after publication.)

Thursday, 1 June

Biennial Conference. "Physics in Surface Coatings", at Palace Hotel, Torquay, Devon.

Thursday, 1 June

New South Wales Section. Factory Inspection, B.O.R.A.L. Refinery.

Friday, 2 June

Biennial Conference. Palace Hotel, Torquay.

Annual General Meeting at the Palace Hotel, Torquay, at 2.15 p.m.

Association Dinner and Dance at the Palace Hotel at 7.30 p.m.

Saturday, 3 June

Biennial Conference. Conference disperses.

Monday, 5 June

Victorian Section. "Micronised Pigments for Paint and Ink Manufacture" by W. G. Wade, Technical Director, Golden Valley Colours Ltd., Bristol.

Friday, 9 June

Bristol Section. The Annual Skittles Match with the Birmingham Paint, Varnish and Lacquer Club at "Ye Olde Hobnails", Little Washbourne.

Thursday, 15 June, to Sunday, 18 June

New South Wales Section. Third Annual Convention at the "Ritz", Leura.

Monday, 3 July

Victorian Section. "Anti-Fouling Systems" by F. Marson, M.Sc., Defence Standards Laboratories.

Thursday, 13 July

New South Wales Section. "Emulsions in Paints" by B. McGuinness.

Friday, 28 July

New South Wales Section. Annual Ball.

Monday, 7 August

Victorian Section. "Scientific Library Methods" by P. Russell, Librarian in Charge, C.S.I.R.O., Library, Canberra.

Thursday, 10 August

New South Wales Section. "Unsaturated Polyesters" by J. Samios.



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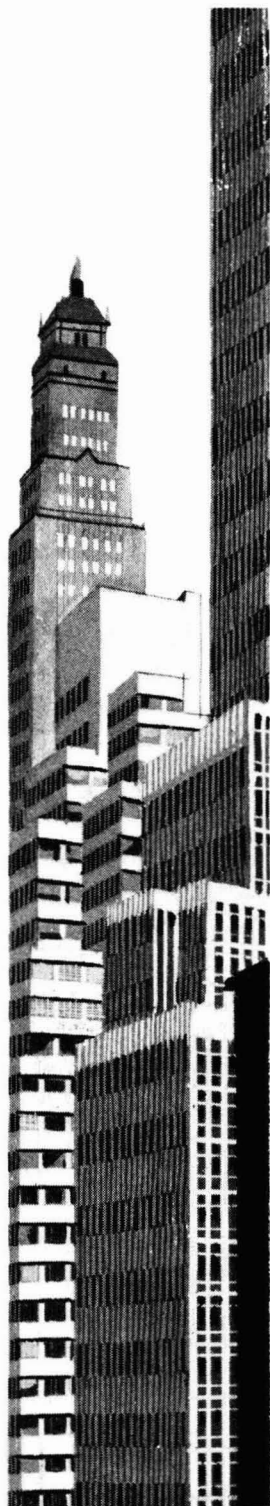
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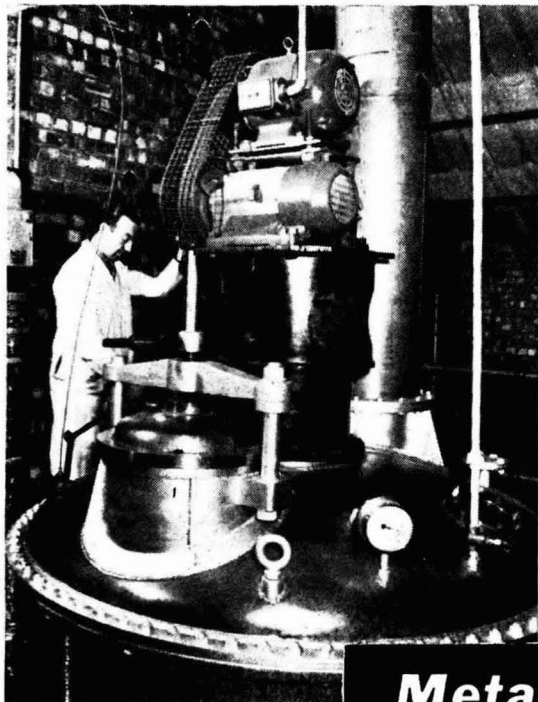
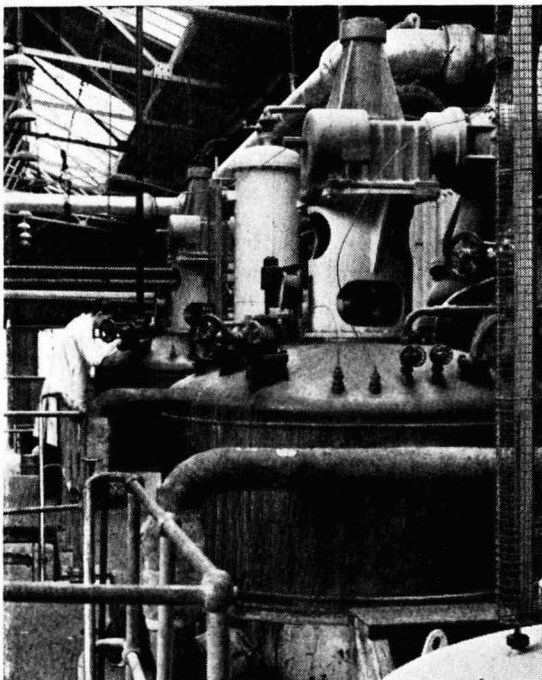
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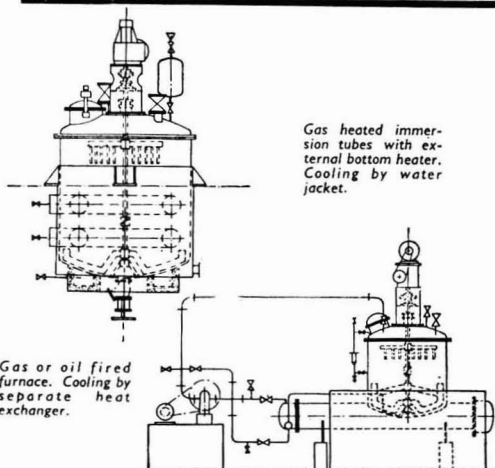
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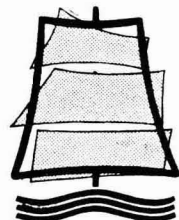
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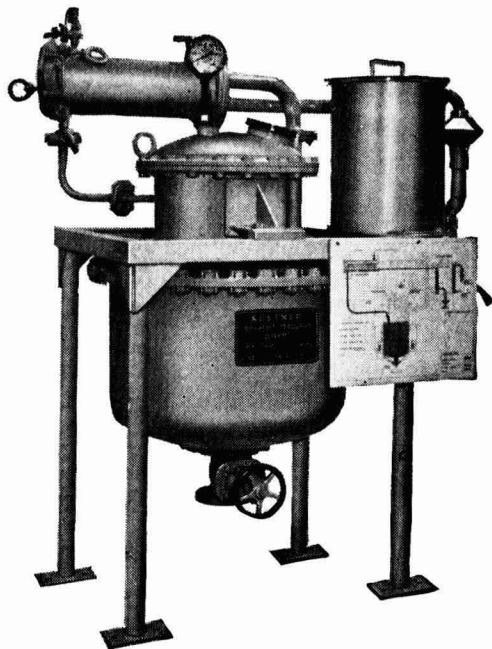
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PAINT TECHNOLOGIST with City and Guilds Certificate required to assist Chief Chemist in the development of new products in the laboratory of a progressive and expanding organisation in North-West Kent. This is an interesting position for a young man (23-28 years) with initiative and imagination. Prospects of advancement are good. Pension scheme in operation. A generous salary fully in accordance with qualifications and experience will be paid. Applications (in confidence) to Box No. 140/61.

THOMAS FORMAN & SONS LTD., Nottingham, invite applications for the position of Works Chemist. Laboratory facilities and assistance provided. This is a senior advisory appointment carrying the appropriate salary and providing long term opportunities for a suitably qualified candidate. Familiarity with printing techniques and materials an asset but more important is energy and a sense of purpose. Apply the Secretary.

SITUATIONS WANTED

CHEMIST/MANAGER, 23 years' experience technical development and production industrial lacquers, polishes, inks and plastics. Age 44, seeks permanency near South London. £1,200-1,500. Please reply to Box No. 141/61.

STUDENT (aged 16), taking G.C.E. this summer, wishes to obtain technical post in a paint laboratory, preferably in the London area. Please reply to Box No. 142/61.

WOOD Finishing Specialist, 25 years of age, previously self-employed, wishes to obtain a technical post in the paint or allied industries. Practical knowledge of the application of finishes. Wishes to embark upon a course of technical studies. At present residing in the London area. Please reply to Box No. 144/61.

PUBLIC APPOINTMENTS

CHEMISTS required at Headquarters, MINISTRY OF AVIATION, London.

Post 1. Take charge of section responsible for initiating and progressing research programmes to provide hydraulic fluids and aircraft lubricants of improved performance and prepare and maintain specifications for these materials.

Post 2. Initiate and control extramural research and development programmes connected particularly with use of paints and adhesives in aircraft and guided weapons; deal with problems arising from use of these materials and prepare and maintain specifications for these materials.

Post 3. Initiate and control extramural research and development programmes connected with use of plastics in aircraft and guided weapons, deal with problems arising from the use of plastics and prepare and maintain specifications for plastics for use in these fields.

Appointments as PRINCIPAL SCIENTIFIC OFFICER (minimum age 31) or SENIOR SCIENTIFIC OFFICER (minimum age 26). *Qualifications:* 1st or 2nd class honours degree, or equivalent, in chemistry and some years post-graduate research experience in appropriate field. *Salary ranges:* P.S.O., £1,781-£2,483; S.S.O., £1,402-£1,719, superannuation under F.S.S.U. Opportunity for candidates under 31 to compete for established (non-contributory pensionable) posts.

Forms from Ministry of Labour, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting reference F.263/1A and appropriate post. Closing date 29 June, 1961.

EQUIPMENT FOR SALE

ONE Norcross Recording Viscometer explosion-proof for Class 1, Group D applications. Consisting of measuring element and 24-hour recorder. The measuring element, Model 10 electric-pneumatic falling piston principle. Suitable for continuous measurement of fluid viscosity over a wide range and at pressures from 100 p.s.i. down to full vacuum; recorder calibrated 0-100 arbitrary units. Replies to Box No. 143/61.

JOURNALS FOR SALE

J.O.C.C.A., 1927-60 Vols. 10-43, some earlier, also *Paint Manufacture* 1931-37 Vols. 1-7, also Technical books. Offers. Further details to Box. No. 139/61.

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