MOULDING MATERIAL SECTION

BI-MONTHLY REPORT, MAY/JUNE 1966

CONTENTS

Review

NEW PRODUCT DEVELOPMENT

1. Phenolic moulding materials
   - 1.1 Phenolic closure grade with improved moulded finish 1
   - 1.2 Melamine/Phenolic moulding materials 1
     - 1.2.1 Decorative grades 1
     - 1.2.2 Electrical grades 2
   - 1.3 Heat resisting materials 3
   - 1.4 Glass filled granular phenolic moulding material 3
2. Alkyd Moulding Materials 4
   - 2.1 Diallyl phthalate moulding materials 4
     - 2.1.1 Self extinguishing long fibre glass filled materials 4
     - 2.1.2 Medium length glass fibre filled materials 4
     - 2.1.3 Glass fibre filled granular materials 5
   - 2.2 Polyester moulding materials 5
     - 2.2.1 Polyester resin 5
     - 2.2.2 Electrical grades 6
     - 2.2.3 Decorative grades 6
     - 2.2.4 Polyester dough moulding materials 7
3. Epoxide resins 7

TECHNICAL SERVICE

1. Phenolic moulding materials 7
   - 1.1 Matrix materials 7
     - 1.1.1 Improved surface coatings 7
     - 1.1.2 Rogers board 8
     - 1.1.3 Chamberlain board 8
     - 1.1.4 Matrix material for moulding against Dycril 8
   - 1.2 Glass filled phenolic materials 8
   - 1.3 Low price moulding materials for meter bases 8
   - 1.4 Dimensionally stable materials for brake components 9
   - 1.5 Materials for car ignition components 9
   - 1.6 Raw Materials 9
     - 1.6.1 Asbestos floats 9
   - 1.7 Low loss electrical material for moulded resistors 9
   - 1.8 Graphite filled moulding materials TX.10916/30 Black 10
   - 1.9 Injection moulding of thermosets 10
   - 1.10 Production difficulties 11

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Contents continued

	1.11 Moulding material resins	11
	1.11.1 Sulphuric acid catalysed novolaks	11
	1.11.2 Soda catalysed resol	11
	1.12 Extrusion compounding of phenolic moulding material - Studli unit	11
2.	Alkyd moulding materials	13
	2.1 Electrical grades	13
	2.2 D.A.P. resins	13
3.	Test results on X20/5 Red 139 type materials ex Studli unit	14
NEW MATERIALS		15
MEETINGS AND VISITS		17

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MOULDING MATERIAL SECTION

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REVIEW

The project for a glass fibre filled moulding material unit is beginning to emerge from our preliminary investigation stage. The study of types of mixers and grinders has disclosed a range of machines which would be suitable for the wet mixing operations, and the granulation of the dried or rolled products we have in mind; a new type of blender capable of homogenising ground product without degrading filler fibre looks promising; choice of plant for drying the wet-mix type of products is the major unresolved question but opinion is hardening away from vacuum drying towards controlled uniform air-flow drying. Therefore we are hoping to settle this point soon and then table a preliminary proposal to the manufacturing departments for more detailed joint study.

Meanwhile, as recorded in this report, detailed work on formulation and processing techniques has to continue, to enhance the properties of granular glass filled phenolics and DAPs, and to optimise the processing properties of the wet-mix alkyds.

We note this time an interesting small experimental project to determine the effect of small doses of epoxide resin on a variety of types of moulding materials. This arose from the thought that epoxides, being so reactive to almost any chemical entity, should co-condense widely and might add unusual properties; we do find some benefit to mechanical and electrical properties with types having scope for improvement, but we are also finding some shelf-life problems. It will be interesting to see how this work adds up to a balance of advantage and disadvantage.

Extrusion compounding in the Studli unit has progressed as far as making, for Sales offerings, red GP materials which have moulded well at Hoover and Healey, and have attracted the moulders by their clean uniform powder form. Benefit from uniform plasticity, batch to batch, will only become detectable when regular production and sale is established. Our Research and Development programme has barely started; and now the gearbox driving the screws has broken, which will delay us further.

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The numbers of moulding materials introduced since the end of 1965, transferred to works control or made obsolete are listed below:-

Materials introduced	-	8, comprising 4 phenolic 2 melamine/phenolic 2 alkyd.
Materials transferred to production	-	6 comprising 5 phenolic 1 alkyd
Materials made obsolete	-	7, comprising 5 phenolic 1 alkyd 1 epoxide
Materials still under R & D control	-	33 comprising 12 phenolic 5 melamine/phenolic 14 alkyd 1 epoxide

During 1965, the Research and Development Department were responsible for only 5% by weight of the total thermosetting moulding materials sold. The materials transferred to production during the first six months of 1966, offset in volume to a small degree only by the newly introduced materials, will have reduced this figure nearly to 4%.

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NEW PRODUCT DEVELOPMENT

1. Phenolic Moulding Materials (W. Gooch)

1.1 Phenolic closure grade with improved moulded finish

Kork-N-Seal have completed their preliminary trials satisfactorily with XW.54727 and a version with more external lubricant, XW.54727/1. The latter had slightly better release properties and they ordered 2 tons for further evaluation in respect of freedom from mould staining and consistency of performance. There was delay in producing this quantity because the Resin Manufacturing Department asked that modifications should be made to the resin used. RWY.53839, to reduce its viscosity at discharge. Resin Section "B" modified the p H of the resin to achieve this and one brew of this resin has been made and used to manufacture part of the 2 ton order for Kork-N-Seal. Processing was rather fast on the rolls and one blender load showed slight knit marks in the closure tool borrowed from Kork-N-Seal. The remainder of the production was satisfactory and has been released. Another batch of resin run to a slightly longer gel time has been requested to make the balance of the order.

1.2 Melamine/phenolic moulding materials (J.L. Greatrex/W.Gooch)

1.2.1 Decorative grades

A blue/grey colour match, XW.57079, has been made in DX.18952/2 for Crystalate Ltd. The colour was approved and one ton of XW.57079 was made under EWT 6282. Crystalate are moulding back plates for Morphy Richards iron handles.

The Singer Manufacturing Company, Canada, use a woodfilled melamine/phenolic material, Plenco 713, to make sewing machine foot switches. This 40 tons/yr business might be obtainable via Union Carbide Canada and a colour sample matched to Plenco 713 has been forwarded under the reference DX.19303, XW.57086.

Cisar and Mayr, our Austrian agents, have reported that there is a potential 100 tons/year business in Austria for woodfilled melamine/phenolics for electrical switch parts. A competitive natural coloured material similar in properties to our DX.19303 was sent to us for colour matching and we have now received an order for 100 kilograms of XW.57089 in "A" grinding for evaluation. EWT 6291 has been issued and the Aycliffe Production Department have agreed to try to remove 120 mesh fines.

Industrial Mouldings Ltd have been supplied with a brown woodfilled material, DX.19303, XW.57109, for trials in melamine foiled car fascia panels.

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1.2.2. Electrical grades

3%, 6%, 12% hexa borate (on the resin) in place of benzoic acid did not improve the insulation resistance at 100°C of the material for Brookhirst Igranic. We have evidence that free phenol is responsible for low and variable I.R. figures.

Reference	Composition	I.R. at 100°C (megohms)	CTI
A	Control - copolymer resin NE.21902 with some added melamine resin	70, 74, 52, 52	250
B	Same melamine/phenol ratio as 'A' but achieved with mixed phenol resol and solid laminating melamine resin.	210, 220, 250, 260	150
C	'B' with some phenol resol replaced by added phenol to give same "free phenol" as in "A".	76, 72, 36, 44	150
D	Control; phenolic ca. X250/4	170 - 250	ca150

Material "B" would be unacceptable because its CTI is below that of SMF 905 (ca. 220); also its raw material cost is high.

Experimentally, we have attempted to reduce the amount of free phenol in NE.21902 by using higher vacuum during dehydration. We have also explored the possibility of using a barium hydroxide catalysed analogue of NE.21902 which, previously, gave high insulation resistance but slow cure and of adding ethylene/ethyl acrylate copolymer to plasticise this resin. None of these experiments improved the I.R. at 100°C of the derived moulding material, e.g.

	% free phenol	IR at 100°C (megohms) of m.m.
Standard NE.21902 (Works brew)	14.0	18, 18, 16, 22.
Experimental NE.21902 (max vacuum)	13.5	27, 28, 30, 28
Barium hydroxide catalysed resin RW 53239	19.4	26, 23, 36, 34
RW.53239 - max vacuum	18.3	24, 19, 34, 26
RW.53239 plus 2½% ethylene/ethyl acrylate copolymer	17.9	16, 15, 15, 13

We have obtained another sample of Sterling SMF 905 currently used by Brookhirst and have found this variable in I.R. at 100°C on our tests. Therefore we have prepared on works plant two materials, XW's57101 and 57102, incorporating all the steps we have found favourable towards high IR/CTI so far as our resin system allows. These materials, compared below with SMF 905, will be tried at Minerva, Brookhirst and cross checks with SMF 905 on IR will be run with Brookhirst, if necessary, using our test pieces and their arc chambers.

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	XW.57101	XW.57102	SMF 905
CTI	250	350	220
IR at 100°C (megohms)	110, 110, 62, 74	18, 16, 26, 21	25, 100
Spiral flow (in)	8	8	11

1.3 Heat resisting materials (J. L. Greatrex/W. Gooch)

Nettle Accessories have successfull, moulded XW.54488/1 in several different lampholder component tools and approve it in place of Sterling SPF 5491 but will continue to buy the Sterling material until present contract expires. They expect demand for heat resistant lampholder material to grow substantially from the 5 ton/yr level of 1965, accompanying the growing use of high wattage small envelope electric lamps.

Our thermally insulated test cabinet for running life tests on lampholders, designed to provide the test conditions of draft BS.52:1963, generates an ambient temperature about 70°C higher than the crude hardboard cabinet used by Rantons which, although conforming to the rather vague draft British Standard, does impose less severe conditions on the mouldings. It would be technically advantageous to our materials to write into the British Standard the more severe conditions, and we hope that, through Nettle, we can get our cabinet design specified.

At Witton Moulded Plastics DTX 19316 had recently replaced X.18958, for a heat resistant moulding application, because of improved moulding properties. Pellet weight variation was then encountered and the customer changed to Sterling PD199 which contains some woodflour and on our tests has inferior heat resistance to DTX 19316 and is lower in impact strength but superior in granulation, (16 mesh with 120 mesh fines removed). We shall not be able to grind DTX 19316 as finely as PD 199 but we expect to obtain satisfactory pelleting consistency by removing and reworking some fines. We regard this as important because, as reported last time, we obtained about 15 cwt/week business at Joseph Lucas for DTX 19316 against Sterling competition, but PD 199 with its attractive grinding might reverse this position unless we provide better powder properties.

1.4 Glass filled granular phenolic moulding material (W. Gooch)

I.B.M. (U.K.) Ltd did not test the range of mouldings made by E. Elliott in DX.19326 but sent some of the moulding material to Yarsley Laboratories for testing by ASTM methods against IBM specification 24 - 162, of which we were unaware until IBM reported that our material failed to meet this specification in several respects. Probably the most important failures were in flexural and tensile strengths and coefficient of thermal expansion. Yarsley had to use machined specimens in some cases and did not run Fiberite FM 4005 as a control. On our BS 771 tests we had found that DX.19326 made in Bay 5 without fines reworked was equivalent to FM 4005, although thermal expansion had not been measured, but that material made in Bay 2 with fines reworked, i.e. as we should manufacture the grade in bulk, was lower in flexural and impact strengths but otherwise equivalent to FM. 4005. It is this Bay 2 material which Yarsley tested and their figures indicate lower tensile and flexural strengths than we would have expected. Dimensional stability, which IBM had said was vital and in which we found DX.19326 equal to FM 4005, was not measured by Yarsley and does not appear in the IBM specification. Now we have seen the latter

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we think DX.19326 could probably be modified to meet it by increasing the glass content, omitting fines reworking, and other moves. We are working on these lines and will test any promising material alongside FM 4005 by BS771 and ASTM methods; we understand that Yarsley will examine any new material we propose before IBM will approve, and we plan to discuss this testing with Yarsley.

2. Alkyd Moulding Materials

2.1 Diallyl phthalate moulding materials (J. B. Pratt)

2.1.1 Self-extinguishing long fibre glass filled materials

Results on the trial production of XW.5704O, a high mechanical strength, self-extinguishing modification of DAX 506 using a proportion of polyester resin to improve flow properties were disappointing. The physical form obtained from the Winkworth mixer, even after 45 minutes mixing at blade speeds of 34:17 r.p.m. was most unsatisfactory. Because of the bulky physical form prolonged drying was needed to remove acetone and the spiral flow was then only 1 inch using the 0.050 in gate at 25 ton and 150°C. A further trial is planned using higher mixer blade speeds and additional solvent to produce an open, more easily dried, form and hence better flow properties.

2.1.2 Medium length glass fibre filled materials

DAX 506/1 in improved physical form

DAX 506/1 made in the Winkworth mixer with blade speeds of 34:17 r.p.m. showed some improvement in physical form after 30 minutes mixing and a marked improvement after 45 minutes mixing. After drying and grinding the impact strength was found to have been reduced as follows, 2.5 ft lb after 10 minutes mixing, 1.8 ft lb after 30 minutes and 1.6 ft lb after 45 minutes. The use of extra solvent to reduce fibre degradation together with a further increase in mixer blade speeds to reduce the cycle time is planned.

Drying of DAX 506

Evaluation of the samples of DAX 506 dried by the Calmic Engineering Co Ltd in a C51 type vacuum oven heated by subatmospheric steam at 70°C gave the following results.

	Standard (70°C no vacuum)	Dried in C51 Oven		
Drying time (min)	40	60	120	180
% Volatiles	4	6.3	2.3	2.1
Spiral flow (in) using 36" tool, 0.200" gate.	30	32	23	20

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There was no evidence of loss of cure through removal of the catalyst under vacuum.

In view of the long drying time further trials with this type of oven at 90°C and with a C 3 oil heated type at 120°C have been carried out. In addition samples of the phenolic glass filled material X.17352/2 were also dried in these ovens

Materials were dried in each type of oven at 90°C or 120°C but did not reach the maximum oven temperature even after several hours drying. Initial test results suggest that the drying time of DAX 506 may be reduced from 3 hours at 70°C to 2 hours at 90°C, All samples of X.17352/2 had wet and dry patches on removal from the oven and moulded discs were blistered. Further test results are awaited but while vacuum drying in Calmic's ovens may be slow but technically satisfactory for DAP's it appears to be less promising for phenolics.

2.1.3 Glass fibre filled granular materials

Some Bridges scale rolling of DTAX 505 Blue 89 using the modified catalyst system of 3% tertiary butyl perbenzoate and 0.5% benzoyl peroxide (on the resin) described in the last report have shown this system to result in resin gelation during rolling on all except the smallest compounding rolls.

It has been noted that the use of a small percentage of the A 172 silane, the omission of zinc oxide, and the use of more resin have all improved the chloroform resistance of DTAX 505 type materials, but not to the extent obtained with the original mixed catalyst system of TBP/benzoyl peroxide.

2.2 Polyester moulding materials

2.2.1 Polyester resin (J. B. Pratt)

A works trial production of RW 54754, a butylene fumarate phthalate chlorendate (60:20:20:) polyester resin in acetone solution, was carried out in Stills 16 and 4 (Brew no 27859). The reaction time was excessive (10¾ hr) in spite of the addition of extra glycol in an attempt to force the acid value down. The resin was only dissolved in acetone with difficulty and its high dilution viscosity, 508 cs at 70% resin content instead of an expected 80 - 120 cs suggests that it was over-reacted; the reason for this is not known. Evaluation of this resin in AX604 type moulding material produced a flow pressure of >1400 lb/sq in after ½ minutes rolling. A further trial production of this resin using a greater excess of glycol will be attempted.

(Last reference Nov/Dec 1965 P4)

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2.2.2 Electrical Grades

Material for buffer blocks (J. L. Greatrex)

No report has yet been received from A.E.I. Woolwich, on the buffer block mouldings supplied to them in XW.54798.

Use of 10% epoxy resin in XW.54798 has had no adverse effect on shelf life as measured by flow pressure after 10 weeks storage at 40°C. After 6 weeks at 60°C and 95% R.H., expansion was 0.006 "/" and weight increase 1.75%. Comparative figures for standard XW 54798 were 0.003 "/" and 2.68%.

Wet mixed, fast curing, glass filled materials

The longer pre-heat recommended to A.E.I. to eliminate internal cracking of cross-jet explosion pots moulded in DAX 612 had the desired effect but resulted in an external crack at the bottom of the moulding, black marks and exudation. A visit showed that the cracking trouble was caused by trapped air preventing complete knitting together of two advancing walls of material. The trapped air also inhibited cure and liquid calcium stearate oozed out from the cracks. Black marks were caused by compressed air burning the resin off the glass. To allow the trapped air to escape, we recommended machining grooves in the bottom plug and when this was done, good mouldings resulted. A.E.I. have since used a further ton of DAX 612 without comment.

2.2.3 Decorative grades

Heat resisting, white lampholder materials

Ranton and Company complained that DAX 610 was bridging in the hoppers of their Bipel presses causing short moulding. A visit showed that the trouble was due to low powder density and not sintering. A new delivery of material with a higher density moulded without trouble and also worked well when mixed with lower density material.

Grinding trials have been carried out at Aycliffe to try to improve powder density and pouring properties. Two materials, XW.57077 ground through a $\frac{1}{4}$" screen in the Harrison Carter grinder and XW.57077/1 ground through a 3/16" screen in the Cumberland granulator have been blended after a two week maturing period and have been sent to Ranton for trials.

Stain resisting materials

XW.54405, DAX 609 with the 3 parts of zinc stearate replaced by 0.5 parts of butyl stearate to eliminate the danger of white specks showing on moulded surfaces, has processed satisfactorily at Aycliffe. Back roll lining was reduced compared with the previous standard material and grinding presented no difficulties. The material was moulded without comment by Roanoid and the formula has now been amended to include the new lubricant balance.

(Last ref: Sept/Oct 1965 p.4)

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Materials for radiator valve handles

As the attempt to make a butylene fumarate phthalate chlorendate resin, RW 54754, in a production still was not successful, further XW.54787 type materials were made based on N.21708 (ethylene fumarate phthalate chlorendate). Use of a glass flock obtained from Turner Brothers and costing 1/3d lb against approximately 3/- lb for hammermilled glass from Silenka, gave good powder density and pouring properties. Mechanical properties were no better than standard and doubling the glass content from 7% to 14% had no effect on this property. Moulded boxes were placed on live steam jets and although AX 604 cracked in only 1 day, the modified XW.54787 materials took approximately 6 days. A larger sample of glass flock is being obtained for further evaluation and if the preliminary findings are confirmed we shall submit material based on this filler to Paragon Plastics Ltd for trial.

2.2.4 Polyester dough moulding materials (J. B. Pratt)

DAX 603 Grey 55

Wolf Electric Tools Ltd have reported that the modified DAX 603 Grey 55 supplied as XW.57008 moulded in their tools after 8 weeks aging more easily than standard DAX 603 Grey 55. The formulation of DAX 603 Grey 55 has therefore been modified to that of XW.57008.

3. Epoxide resins (J. B. Pratt)

Work is in hand to assess the effect of replacing 5 and 10% of the resin in a phenol, melamine/phenolic, polyester or DAP resin based moulding material, by DR 19120/1. With the glass filled phenolic, DX.19326, an increase in flexural strength and surface resistivity was obtained but some loss of storage stability at 40°C occurred. With DAP and polyester granular glass filled materials there was again an increase in flexural strength but the DAP material was slow curing and the polyester is stiffening rapidly at 40°C. This work is continuing and will be extended to included wet mixed glass fibre filled materials based on each resin type.

TECHNICAL SERVICE

1. Phenolic moulding materials

1.1 Matrix materials

1.1.1 Improved surface coatings (P. S. Ibbotson/D. H. Hogg)

Five tons of DM4/4 Green have been made without difficulty since the last report. One complaint of surface picking of DM4/4A Green has been reported by our German distributor, Dortschy, but full details have not yet been received.

Production batches of N.28238 and NE.28245 moulding materials have been made using "clean" batches of N.21001 and N.21012 resins. Special precautions were taken in manufacture of these resins to minimise insoluble resin specks which from time to time have given rise to surface lumps on M2 and DM4 materials. Surface coating trials will be carried out shortly.

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Experimental work is being undertaken with the Production Department to eliminate mottling and occasional surface porosity in the black areas of matrices from M2 materials. Results so far have indicated that the defects can be remedied either by giving extra heat treatment to the N.28238 moulding material or the M2 matrix material, or by replacing N.28238 with NE.28245 used in DM4 materials. Production trials are in progress in which N.28238 has been made in a range of flows for assessment shortly in surface coating trials. MW.57065, a modification of M2/4-A based on NE.28245 in place of N.28238, has also been prepared for trials at Plastotype.

1.1.2 Rogers board

Defects in recent supplies of Rogers board have given rise to customer complaints of black spots, asbestos specks and floor rippling. These have been referred to the supplier who will investigate.

1.1.3 Chamberlain board

The improvement in consistency and quality noted in the initial consignment from Chamberlain's 10 ton production covered by TGB 30324 has been maintained throughout this run, apart from 1 cwt of very soft board which will be returned to them. There have been no adverse customer comments on the DM5/4 in which it has been used. Chamberlains are processing another 10 tons to be covered by TGB.30335.

Chamberlains have so far based their matrix board on the 90:10 phenol/o-cresol resin RW 51836. An alternative resin will need to be established to align with Company policy of changing over from 90:10 to pure phenol. Results of Chamberlains laboratory tests on a pure phenol version RW 54816 were unsatisfactory however due to different water dispersibility properties. RW 54822 based on a synthetic 90:10 mixture of phenol and m-cresol was satisfactory on laboratory tests and will be used in a mill trial to be undertaken shortly.

1.1.4 Matrix material for moulding against Dycril

MW 57011 has been approved by Alacra Ltd for moulding matrices from Dycril original printing plates, and an order for $\frac{1}{2}$ ton of this material has been received. MW.57011 Green is based on Rogers "Y" thickness board (0.085" thickness) and is coated on both sides to enable flat matrices to be moulded from deep relief originals.

1.2 Glass filled phenolic materials (P. A. Dent)

We have supplied Ferranti with two experimental modifications of X.17352/1 Natural 8 for their transformer housing job. XW.57045 uses $\frac{1}{4}$" fibre length glass - instead of $\frac{1}{2}$". And XW.57046 uses higher resin content. It is hoped that these modifications will overcome the customer's porosity difficulty without adversely affecting other essential properties.

1.3 Low priced moulding materials for meter bases (P. A. Dent)

Since last summer English Electric have been using DX.19307 black for moulding meter bases at the rate of about 100 tons per year. Recently they have become more conscious of dust in their shop and have asked us to reduce the fines content of DX.19307. This is a relatively expensive material sold at a low price and we are

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proposing a partial reduction rather than complete elimination of fines in order to restrict cost increase as far as possible. The partially fines reduced material will be supplied as XW57093.

1.4 Dimensionally stable materials for brake components (P. A. Dent)

Industrial Mouldings (Warwick) Ltd have had an initial order for brake components moulded from DX.19325 Black. They made a trial run of 100 mouldings under the same conditions that they use for Durez 792B. The DX.19325 moulded very satisfactorily but after 14 days storage two of the mouldings were found to be cracked. A further extended run has been made and the mouldingsfrom this are awaiting Inspection after 14 days storage. A representative from the TSG was present during part of this run (by invitation of the customer). He was quite satisfied with the way they were being moulded, and mouldings brought away for examination showed no latent or incipient cracking. Unfortunately we have now heard that some of the mouldings cracked on machining and we are investigating.

1.5 Materials for car ignition components (J. M. Hunt)

Reciprocal visits between J. Lucas and ourselves have revealed some differences in moulding and test procedures which may account for the discrepancies in electric strength test results obtained by the two companies. These differences are being investigated and in the meantime work is continuing to develop a material with higher electric strength than XW,57018 rejected by Lucas.

(Last ref. Mar/Apl 1966 p.9)

1.6 Raw materials (J. A. Mills)

1.6.1 Asbestos floats

The closure of Johnson's mill in Canada left us dependent on one established supply of asbestos floats, from Lake Asbestos. 11 tons of an alternative, ref: KB-785-7RS from Asbestos Corporation, has been used satisfactorily in 40 tons of heat and water resistant grades under TGB's 20095 and 20102. This new asbestos is now being approved for restricted use as GB.26106. No savings in raw material costs are anticipated.

(Last ref: Mar/Apl, 1966 p.12)

1.7 Low loss electrical material for moulded resistors (H.H. Ball/D.H. Hogg)

Following a promising pilot evaluation of XW.57048, a modification of a previous resistor material X.18915, a small production was successfully made in Bay 2. Tests on this material indicated improved humidity resistance over the current resistor material X.18943 and IRC's Selectrez PM.6592 Brown.

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	XW.57048	X.18943	PM.6592
Powder density (g/ml)	0.80	0.80	0.84
Rossi-Peakes (lb/sq in)	450	175	350
Cup cure (secs)	65	55	65
Surface resistivity ($\log_{10}$ ohm)	>14.23	>14.23	13.53
" " after immersion	14.23	14.2	13.2
after 24 hr boil	11.7	9.7	11.2
Insulation resistance ($\log_{10}$ ohms)	12.7	12.7	12.7
" " after 6 hour steam	11.5	9.4	10.4

Mr. Ball visited Vitrohm, Denmark and carried out moulding trials with XW.57048 material and reported that whilst moulding was on the whole satisfactory, there was incipient cracking which was thought to be due to insufficient compounding of the moulding material during manufacture. Subsequently, further productions of XW.57048 were made in Bay 2, and longer compounding times achieved. This material was successfully moulded at Infin, Italy, under Mr. Ball's guidance and good mouldings with no sign of cracking were obtained, Both Infin and Vitrohm are now subjecting their moulded resistors in this material to the IRC BTI and BT 27, accelerated humidity tests. As Dr. Ruata of Infin was visiting IRC in the U.S.A. it was arranged that he should take sample resistors with him for IRC to carry out comparison tests, since their test apparatus is not identical with that of Infin or Vitrohm.

1.8 Graphite filled moulding materials TX.10916/30 Black (E.J. Allday)

Following successful experience at English Electric Ltd (D)TX.10916/30 Black was transferred to Works control during this period but a complaint of sticking arose from a new customer for the grade, Roanoid Ltd. On investigation it was found that Roanoid, who are transfer moulding a large, complicated gas meter part, experienced sticking only in the transfer pot area and a change from oxalic acid catalysed to hydrochloric acid catalysed novolak has overcome their trouble.

1.9 Injection Moulding of Thermosets (E.J. Allday)

Moulders' interest in injection moulding of phenolics continues and widens. L.G.G. Charlesworth have tried X.11063/2 and E. Elliott's X261/4, both in Transojet machines and both materials not altogether surprisingly, have failed to fill out. Modification of X.11063/2 by increasing the amount of lubricant has overcome Charlesworths problem but this course is not practicable with X261/4 as it impairs heat resistance. We have sent Elliotts a modification of X.261/4 containing a small proportion of internal lubricant and await their report.

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1.10 Production difficulties

Two difficulties - batch to batch variation of pelleting properties of X.18925 Black, rough surface on flat moulded areas of X.11085/2 Black - are associated with variations in quality of the nylon filler.

In X.18925, the powder (density and pouring) properties are influenced by the physical state of the nylon fabric offcuts which our supplier grinds to a fibrous filler; heavy duty fabrics yield low density filler, and hence low density unsatisfactory moulding material, whilst light weight underwear fabrics yield denser filler and moulding material. Supplies of the latter type are at present inadequate and the search for more continues.

In X.11085/2, rough surface - which was studied 6 years ago, see R & D report 1412 - has recently recurred twice, to a greater degree than previously encountered. The nylon fibre involved had an abnormally high (53%) proportion of nylon 6; reversion of manufacture to a nylon fibre containing not more than 10% nylon 6 and the balance mainly nylon 66, eliminated rough surface. The correlation of these facts, and improved means of inspecting the raw material for nylon-type content, are now being envestigated.

1.11 Moulding material resins (J. B. Holmes)

1.11.1 Sulphuric acid catalysed novolaks

Some work has been started to investigate possible advantages of the above resins. A series of modifications of BRN 5350 with melting points between 66 and 80°C have been made and evaluated in heat resistant moulding materials XW.54488 and general purpose moulding material X20/5. The moulding materials processed satisfactorily and are now being tested.

1.11.2 Soda catalysed resol

We are investigating means of improving BRN 2120 by reducing its viscosity when dropped from the still and reducing the evolution of formaldehyde when moulding material based on it is rolled. Initial experiments included the controlled variation of intermediate pH within the range 3.5 to 5.0 by altering the amounts of boric acid neutraliser.

1.12 Extrusion compounding of phenolic moulding material - Studli unit

The best extrusion compounding properties have been achieved using N.21012 resin processed to a soft melting point (RWY 54819) similar to that of Studli's own resin, (RWY 54804). Studli control their resin consistency using a Haake falling-ball Viscometer (industrial model); we have purchased a Haake Viscometer and the results tabulated clearly demonstrates the softness of Studli resin.

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RESINS	Studli's resin our ref: RWY 54804	RWY.54819 N.21012 processed to the similar melting point to Studli resin.	STANDARD N.21012 resin pure phenol novolak	STANDARD N.21013 resin stiffer version of N.21012
Melting point°C	48°C	56°C	60-90°C	63 - 73°C
Haake falling ball viscosity (seconds) (D.T.P. 159)	98.9	103	126.5	147.4

Two X20/5 Red 139 type phenolic materials have been formulated, as shown below, using RWY.54819 resin and a lubricant/plasticiser balance to obtain good extrusion properties consistent with maximum piece and flash release of the finished product:-

FORMULA	XWF 30413 Red X20/5 Red 139 Type using 1.5 parts of aluminium stearate and 1.5 parts of 2:1 wood/Luxiol master batch	XWF 30414 Red X20/5 Red 139 Type 1.0 parts aluminium stearate and 1.0 parts of 1:1 wood/ oleic acid master batch
RWY54819 Resin (batch51835)	50	50
GB22341 (120 mesh woodflour)	55	55
GB67151 (Magnesia)	1.0	1.0
GB14071 (Hexamine)	6.0	6.0
GB64001 (Alumina stearate)	1.5	1.0
GB75101 (Resinoid scarlet)	4.5	4.5
GB26001 (Devolite)	5.0	5.0
GB73002 (Titanium dioxide)	0.4375	0.4375
GB75022 (Oil vermilion)	0.75	0.75
2:1 Wood/Loxiol G 40 master batch	0.75	-
1:1 Wood/Oleic acid master batch	-	1.0

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Aluminium stearate lubricant (GB64001 melting point 165 - 170°C) was selected to maximise piece and flash release; due to its high melting point it is believed to become effective as a release agent only at the moulding temperature e.g. 160°C and consequently not to cause materials to slip against the screws during extrusion.

A small amount of a liquid plasticiser, Loxiol G40, is used to obtain the necessary slip in the extruder and helps control of plasticity during extrusion.

Oleic acid was recommended by Studli to achieve further improvement in mould release properties.

XWF 30413 and XWF 30414 Red were evaluated for pelleting and moulding properties at Hoover Limited. The pelleting properties, in a 35 ton Bipel machine using a two impression tool producing 3" diameter pellets 1" thick, were excellent. The machine operators were impressed with the new granulation due to ease of feeding from the hopper, consistent powder charge weights and appreciable reduction in dustiness; they expressed a desire for a continued supply of material in this granulation. Moulding trials in Hoovers 3-impression steam iron handle tool were successful, although the mouldings were not entirely free from some slight colour streaking; no gas marking was experienced, a prevalent difficulty until recentl with standard X20/5 Red 139. Hoover are now fully testing the resultant mouldings before deciding further action. A table of full test results on the extruded materials is shown below together with properties of standard X20/5 Red 139 for comparison.

2. Alkyd Moulding Materials (P. A. Dent)

2.1 Electrical Grades

AEI Ltd Colne have complained that aircraft contactor bases transfer moulded from AX 503 Brown 184 have shown knit line cracks around the transfer gate. They claimed that this had only recently occurred and queried possible changes to our material. Late in 1965 we changed from waste to virgin glass fibre filler because the former was scarce. We therefore made a batch of material with the old filler and this also cracked similarly on moulding. The cause of cracking has not been established but it could be associated with moulding procedural changes made by the customer. Permission has now been given by AEI Coventry for the moulding to be made from DAX 506, which moulds perfectly satisfactorily without cracking.

2.2 D.A.P. Resins

Supplies of N.21801 are scarce and likely to remain lower than possible future requirements. AX 500/2 and AX 501, major consumers of N.21801 are formulated on a partial replacement of this resin by GB.53106, Dapon polymer. Works trials have been issued to see whether the usage of N.21801 may be reduced by use of a higher proportion of Dapon.

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FULL TEST RESULTS ON X20/5 RED 139 TYPE MATERIALS (XWF30413 AND XWF30414) EXTRUDED ON BAY 6 STUDLI UNIT HND USED AT HOOVER LIMITED FOR MOULDING TRIALS IN THEIR STEAM IRON HANDLE TOOL

TEST	SPECIFICATION FOR X20/5 RED139	ESTIMATED PROPERTIES OF X20/5 RED 139 FROM THE LAST 6 MONTHS MANUFACTURE	BAY 6 STUDLI EXTRUDED PRODUCTS XWF30413 BAG No. 4	XWF 30414 BAG No. 2
POWDER PROPERTIES				
APPARENT DENSITY (g/ml)	NOT LESS THAN 0·61	0·57	0·52	0·52
POURABILITY (SEC)	TO BE RECORDED	20	17	15
SHRINKAGE (IN/IN)	0·0046 - 0·0085	0·0058	0·0061	0·0061
FLEXIBILITY AT 1000 GRAMS	NOT GREATER THAN 2·5	1·9	2·0	1·9
CUP FLOW (SEC)	12 - 16	13	13	13
FLOW PRESSURE (lb/sq in.)	RECORDED	650	550	650
CURING TIME (SEC)	NOT GREATER THAN 65	50·55	50	55
SPECIFIC GRAVITY	1·38 - 1·43	1·41	1·34(6)	1·39(6)
SCREEN ANALYSIS TO 'B' GRINDING. PERCENT OF MATERIAL RETAINED ON :-				
8 MESH	NIL		NIL	NIL
12 "	0 - 21		NIL	NIL
16 "	10 - 48		3·0	5·0
30 "	28 - 60		58·0	56·0
60 "	9 - 30		33·0	30·0
85 "	0 - 16		6·0	6·0
120 "	0 - 12		1·5	2·0
PASSING 120 "	0 - 3·0		0·5	0·5
MECHANICAL PROPERTIES	X L			
IMPACT STRENGTH (ft lb)	0·15 0·12	0·16	0·18	0·19
CROSSBREAKING STRENGTH (lb/sq. in)	11,900 10,300	12,170	12,350	12,550
TENSILE STRENGTH (lb/sq in)	8,000 7,000	8,250	7,450	7,800
PLASTIC YIELD AT 140°C (M.M)	1·5 1·0	1·1	0·5	1·8
ELECTRICAL PROPERTIES				
POWER FACTOR AT 800 c/s (tan δ)	0·06 0·22	0·13	0·071	0·119
VOLUME RESISTIVITY (AS MOULDED) ($\log_{10}$ ohms cm)	11·3 10·2	11·38	11·45	11·16
SURFACE RESISTIVITY (AFTER IMMERSION) ($\log_{10}$ ohms)	9·5 8·9	4·99	10·11	10·0
ELECTRIC STRENGTH AT 90°C (V/mil)	140 80	196	246	249
OTHER PROPERTIES				
WATER ABSORPTION (mg)	55 70	44	34	34
ACETONE SOLUBLE MATTER (%)	4·0 6·0	2·3	3·1	2·1
MOULD RELEASE PROPERTIES OF 12 CUP FLOW CUPS MOULDED CONSECUTIVELY IN RED CUP FLOW MOULD		X20/5 RED 139 6/6928 SATISFACTORY	SATISFACTORY	
NICKEL PLATE RELEASE TEST (LOWEST NUMBER INDICATES BEST RELEASE (DTD 35D))		6	4	4
NICKEL DISC RELEASE TEST (3" DIA DISC MOULD WITH FOR FORCE NICKEL COATED) LOWER NUMBER INDICATES BEST RELEASE (DTD 35E)		3·4	2	2-3
MEASURMENT OF FLEXIBILITY ON FLECTION OF CUP FLOW CUP MOULDING AT THE FOLLOWING CURE TIMES (DTD 34) :-				
DEFLECTION IN INCHES AT 45 SEC CURE		0·65	0·41	0·39
" " " " 60 " "		0·62	0·34	0·34
" " " " 75 " "		0·47	0·24	0·25
" " " " 90 " "		0·38	0·23	0·22
" " " " 3 MIN CURE		0·08	0·16	0·11
MOULD RELEASE PROPERTIES FROM A FOUR IMPRESSION SF6 BASE TOOL LOCATED IN A 60 TON BIPEL PRESS IN R&D. DEPARTMENT BLOCK 29		50 LIFTS NO STICKING	60 LIFTS NO STICKING	
BIPEL PERLETTING TRIALS USING 2" DIA SINGLE DIE AND 12 TONS TOTAL PRESSURE — MEAN WEIGHT (GRAMS)		57·64	50·25	49·54
WEIGHT RANGE (GRAMS)		57·18 - 58·10	50·04 - 50·49	49·29 - 49·78
MAXIMUM WEIGHT VARIATION (GRAMS)		0·92	0·45	0·49

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NEW MATERIALS

DTX.19328 Black	Medium shock track and arc resistant melamine/phenolic with alumina trihydrate filler.
DTX.19329 Black	GP track and arc resistant melamine/phenolic with alumina trihydrate filler.
MW.57011	Matrix material for moulding against Dycril plates.
XW.57033	Soft flow X250/4 Natural for transfer moulding.
XW.57045	X.17352/1 Natural 8 with $\frac{1}{4}$" fibre glass.
XW.57046	X.17352/2 Natural 8 with plasticiser omitted.
XW.57048	Modification of X.18915 for electrical resistor encapsulation.
XW.57049	DX.18952/2 in grey 57 for Ciech Poland.
XW.57052 Brown	G.P. electrical grade melamine/phenolic for AEI Ltd
XW.57053	AX 604 in dark grey for Birkbys Ltd.
XW.57060 Black	DX.19321/2 Black in TX flow properties for Export Unit.
XW.57061 Green	DTX 19326 Green 166 with increased lubricant for Paintons Ltd.
XW.57065	Improved moulded appearance M2/4-A.
XW.57066 Brown	DTX.19316 in Brown for J. Lucas Ltd.
XW.57074	DX.18952/2 in Green for Minerva Mouldings Ltd.
XW.57075	Thicker face version of M2/1-A.
XW.57077	Modified grinding of DAX 610 for Rantons Ltd.
XW.57079	DX.18952/2 in blue/grey for Crystalate Ltd.
XW.57081	X95 Black HD in fines reduced grinding.
XW.57082 Black	Our version of Studli H.POP 185E for Studli trials.
XW.57083 Black	" " " " " " " " "
XW.57084 Black	" " " " " " " " rolling trials.
XW.57086	DX19303 in grey for Singer (Canada)
XW.57089	DX.19303 in buff for Cisar and Mayr (Austria)
XW.57093	DX.19307 in fines reduced grinding
XW.57094	DTAX 505 in Black for Belling and Lee Ltd.
XW.57095	DAX 509 in brown for Miniature Electronic Components Ltd.
XW.57096	Modified version of XW.57083 with additional Loxiol for rolling trials.
XW.57098	Studli H.POP 1857OE using Studli resin.
XW.57099	" " " using RWY 53838 resin.
XW.57101 Brown XW.57102 Brown	Medium shock electrical grade melamine/phenolicsfor Minerva Mouldings.
XW.57105	DTAX 505 in yellow for Crystalate Ltd.
XW57110	Self extinguishing modification of DAX 506
XW.57114	Heat resisting phenolic moulding material for lampholders.

Materials made obsolete

DX.19305 Black
DX.18915/2 Natural
DX.18954
DX.19315 Black

UCASB00984726

New Material

X.5073/10 Black	Camouflage reference for X.5073 Black
X.19401 Natural	Camouflage reference for X.18943 Natural

Materials transferred to normal works manufacture

(D)X.4933/14 Natural

(D)TX.10916/30 Black

(D)TX.19313 Black — Medium shock heat resisting phenolic moulding material

Research and Development Reports

1873	-	12th May 1966 J. B. Pratt	Request for N(E)21902, a melamine/phenol formaldehyde copolymer resin to be accepted for Standard Works Manufacture.
1863	-	27th May 1966 D. H. Hogg	A laboratory evaluation of extruded polysulphone sheet, P.1700 as a printing plate matrix material

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MEETINGS AND VISITS

7th April	J.L. Greatrex	A.E.I. Manchester	Moulding of DAX 612
25th "	E.J. Allday	Streetly Manufacturing Co.	Moulded wall tiles
25th "	Mr. Holiburton	of Fibreglass to Tyseley.	Glass fibres for DAPand polyester dough moulding materials.
27th "	J.B. Pratt	G.E.C. Birmingham	Track and arc resistant polyester dough moulding materials.
27th "	H.H. Ball	Quickfit & Quartz	Injection moulding of X.18955/1/A
2nd May	P.S. Ibbotson	J. Lucas Ltd	E.S. testing and moulding material for car ignition.
3rd May	J. B. Pratt	Aycliffe	DAP production
6th May	Mr. P. Lees Mr. J. Airey	of J. Lucas to Tyseley	E.S. testing and moulding material for car ignition.
4th to 6th May	H.H. Ball	Votrohm, Copenhagen	Materials for moulded resistors.
9th May	H.H. Ball D.H. Hogg	London	Duplicate plate conference
9th May	J.B. Pratt	GEC Birmingham	Track and Arc resistant polyester doughs.
16th May	Mr. Calvert Dr. Preston	Laporte Chemicals to Tyseley	Catalysts for DAP moulding materials.
24th May	P.A. Dent	A.E.I. Colne	Moulding difficulties AX 503
24th May	D.J. McPhail	Aycliffe	DAP moulding materials.
24th to 27th May	H.H. Ball	Infin, Turin	Materials for moulded resistors
25th to 26th May	J.B. Pratt	Calmic Engineering Company Limited	Drying trials with DAX 506 and X.17352/2
26th May	P.A. Dent	Industrial Mouldings Limited.	Moulding difficulties DX 19325
26th May	H.T. Deeley	Hoover Ltd	Studli extruded phenolic XWF 30413 and 30714, X20/5 Red 139 types.
2nd May	J.L. Greatrex	Ranton	Moulding difficulties with DAX 610
20th May	A.L. Ashton	Plessey Ltd	Alkyd moulding materials for new T.V. switch.
28th May	E. J. Allday	Streetly Manufacturing Company	Moulding difficulties TX.19318/1
10th May	J.E.H. Hayward	A.E.I. Nelson	Arc resistance of polyester dough moulded contactors.

J. E. H. Hayward

JEHH/JMD
21.6.66.

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