ABOUT THE SCHEME . . .

The B.M.C. Service Paint Scheme was introduced to enable B.M.C. Distributors and Dealers to carry out refinishing jobs quickly, easily, and at minimum cost.

Reference to the Index Sheet will show how comprehensive the Scheme is; it embraces the complete respray in ready-mixed and basic colours for those who do their own paint-mixing. The simple 'touch-up' job is provided for by means of a small container designed for owner use. The Scheme also embraces decorative paints, for both Austin and Nuffield house colours.

All these paints conform to the same exacting specifications and quality as those used by us on vehicle production and renovation purposes in our own factories. The materials are of the highest standard and have been thoroughly tested and approved by our Engineering and Designs Departments. Our Supplier offers, in conjunction with our own engineers, a Technical Service aimed to advise and help the Trade on all paint problems. For further information Distributors should apply through their normal Zone contact at Cowley.

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AUTOMATION IN A PAINT WORKS

H. M. Morley and P. Rogers

AUTOMATIC CONTROL ENGINEERING LTD.

Automation in a Paint Works

H. M. Morley* and P. Rogers†

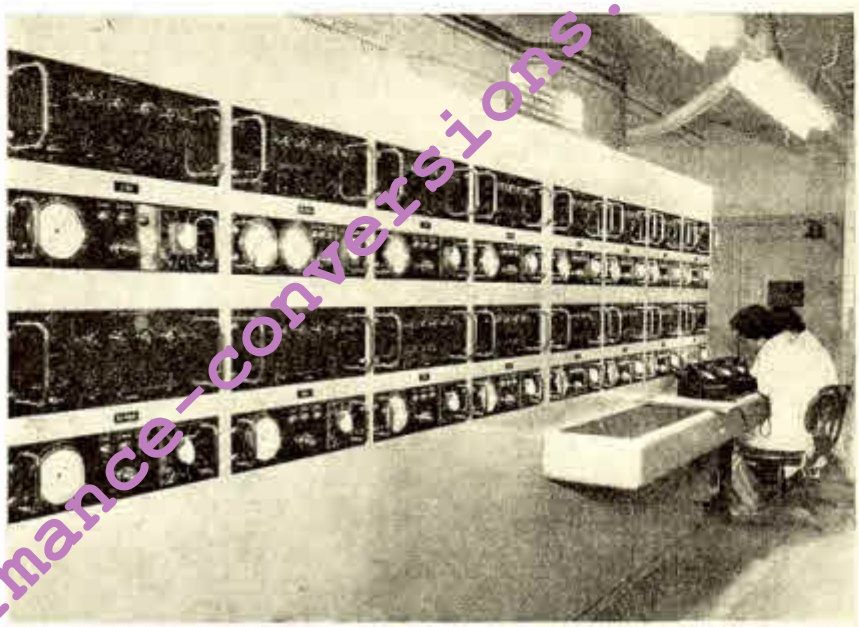
Increased production, lower labour costs, better and closer quality control, less wastage and improved cleanliness have resulted from the installation of an automatic centrally controlled liquid-metering system, which handles solvents and paint media.

Increasing business over the years has meant more congestion in the manufacturing areas of the Greenford plant of General and Industrial Paints Ltd., and the possibility of further expansion on the present site is limited. It was therefore decided to make better use of the existing plant wherever possible by introducing automation.

An intensive study was undertaken of all manufacturing operations, with particular emphasis on handling, and it was found that the practice of weighing and handling all liquids created the greatest congestion, leading to wasted man-hours and unnecessary losses by evaporation and spillage from portable containers. It was agreed to replace these costly methods by the most efficient system of handling, metering and dispensing of liquids that could be designed.

After many consultations on various methods and designs to meet the specified requirements, it was decided to adopt the plan put forward by Automatic Control Engineering Ltd. for the design and installation of a modern automatic centrally controlled liquid-metering scheme. This could be provided at a cost allowing for capital recovery over a reasonable period and could be completely erected and handed over in working order without interference with normal production.

The original operational requirement put forward by the paint company was that eleven different alkyd resins and five different solvents were required to be pumped in pre-set volume quantities to preselected destinations, the whole operation to be under the sole control of an operator situated in a control room remote from the factory floor.



The control panel of the automatic liquid-metering system designed by Automatic Control Engineering Ltd. for General and Industrial Paints Ltd.

Preliminary survey

The preliminary stages of job-planning involved an examination of the existing pattern of the flow of materials in the factory buildings and yards. Thereafter, discharge points for the various materials were selected in consultation, and possible flow rates decided upon. Next, a survey of the site was carried out and detailed piping and cabling layouts were prepared. A programme of site installation work was drawn up by the Construction Group of A.C.E. Ltd., who were required to work for early completion, whilst creating only the minimum of interference with paint production.

Remote siting of the control desk was postulated on two grounds, the first being the difficulty of satisfying the necessary flameproof requirements for equipment located in a hazardous area. Secondly, it was considered desirable to take the operator away from the actual scene of activity to avoid interference and distraction.

The system of measurement and control finally selected was to place a positive displacement type of flowmeter in each of the sixteen lines involved, at a point before the line splits into its various branches, provision being made for up to twelve separate outlets after the flowmeter. One of these outlets is selected by the operator in accordance with his instruction from the factory.

*General and Industrial Paints Ltd.
†Automatic Control Engineering Ltd.

The *Tylor* semi-rotary flowmeters used are fitted with flameproof electrically contacting heads, which produce ten changeover functions of a micro-switch per gallon of liquid passing through the meter. These flow pulses are transmitted through the flameproof cabling installation to the batch counters in the control desk.

The flowmeter for each liquid is associated with a four-decade *Dekatron* batch counter, on which the maximum batch is 999·9 gallons, and a sub-panel on which is mounted the storage tank contents gauge, a 'start' button, an outlet location selector switch, and indicator lamps showing the progress of the batch. Any quantity up to 999·9 gallons can be set, the smallest increment being 0·1 gallon.

A mechanically resettable electro-mechanical register on each batch counter is driven from the units decade. Should there be any mains failure, the whole system will fail to safety, control valves will close, pumps will shut down, etc. On restoration of the supply, the progress of any partially completed batches may be discovered from the electro-mechanical register, thus allowing the balance to be set on the batch register, and the process completed.

Each branch of a product line is terminated by a normally closed solenoid-operated flameproof valve, discharging directly into a mixer, mill or other unit. Mounted on each discharge valve is a flameproof push button, termed the 'ready' button, which must be pressed by the plant operative when his machine is available to indicate to the control panel operator that he is ready to receive the quantity of the particular material he has previously demanded.

Requests for materials are made over the telephones which form an integral part of the control system.

Operation

The following step-by-step description of the procedure for ordering a batch of material and the execution of the order gives an indication of the operation of the control system. The request for a batch will specify the material code number, the discharge location, the amount of the batch in gallons, the formula number and the operative's name.

These data are recorded on the daily log sheet by the control operator, who then sets up the batch on the appropriate *Dekatron* batch counter, selects the destination on a twelve-position switch on the product sub-panel, and resets the batch counter electro-mechanical register to zero.

The operation can go no further until the receiver has pressed his 'ready' button. An electrical interlock ensures that delivery of material (which can only be started from the control panel) cannot take place until the 'ready' button mounted on the discharge valve has been pressed; this is indicated by a panel lamp. A second interlock ensures that the correct 'ready' button has been pressed, i.e. the button corresponding to the position of the panel outlet selector switch.

When the 'ready' lamp lights, the control operator presses the 'start' button and this operates a relay, which holds on, and energises the pump starter and the solenoid discharge valve. Liquid is then pumped through the meter and solenoid valve, and the count-down to zero commences on the batch counter. At the end of flow of the pre-set volume, a relay in the batch counter operates and closes the solenoid valve, stops the pump and lights a lamp on the product panel indicating 'process complete'.

Pipeline and valve design

It will be seen that the fundamental assumption of the metering system is that the whole length of pipe from flowmeter to discharge valve remains fully charged with liquid at all times, so that the quantity of liquid passing through the flowmeter is identical with the quantity discharged. This condition is secured by the design of the pipe-runs, air vents being incorporated to ensure complete filling on installation. Non-return valves are fitted at the pump end of the lines to prevent run-back, and the discharge orifices are adjusted initially to prevent liquid in the vertical sections of the pipe from running out under the static head; otherwise, air would enter the line.

As an additional safeguard, air eliminators are fitted upstream of the flowmeter in the solvent lines.

A separate pump, remotely started from the control desk, is used for each product line. Positive-displacement pumps are used on the media lines and centrifugal pumps on the solvent lines. Pumping pressures are about 150 p.s.i. for media and 20 p.s.i. for solvents, with corresponding flow rates of 20 and 28 gal. per min.

The resin and solvent lines have diameters of 3 in. and 1½ in., respectively, with typical line lengths of 300 ft. from pump to discharge valve. Resins are pumped at ambient temperature and at first, some difficulty was experienced due to their marked rise in viscosity at low temperatures. For example, at 7° C. (45° F.) viscosities increase to as much as 160 stokes and some reduction in throughput is therefore experienced.

A tank-gauging system is included in the control scheme. Pressure transmitters in each storage tank transmit pneumatic signals back to the control desk and these operate a gauge scaled in gallons on the appropriate liquid sub-panel. The operator thus receives complete information as to material status.

Future developments of the system will probably be in the direction of a single-liquid control module that is complete in itself, with batch counter, tank contents gauge, electro-mechanical register and all relays and switching circuits. From this module, control systems of any desired size and complexity could be assembled.

Accuracy

Extensive operating experience has shown that batches of 3 gallons and

over can be delivered to any outlet with an absolute accuracy of ±1·5% and a repeatability of ±1%. To ensure consistent results, routine attention to the glands of the pumps and gate valves is absolutely essential to prevent the admission of air to the pipelines. Trapped vapour must also be vented off from all the lines from time to time.

Experience has shown that if the liquids are kept at constant temperature, a greater degree of accuracy than that stated above can be obtained.

Conclusions

The plant has been in operation for over six months and certain conclusions may now be drawn.

Firstly, this installation has enabled a greater volume of paint to be produced during periods of considerable overtime working without any addition to the plant or increase in the size or number of buildings. Secondly, during quieter periods, the same amount of paint has been produced with a considerable reduction in the number of man-hours wastefully spent in drawing materials from tanks and portering them in the vessels from one point in the factory to another for weighing, blending, etc.

This increase in productivity has been accompanied by better and closer quality control, an obvious relief of congestion in factory floor space, and greater cleanliness in all respects, due to freedom from accidental spillings.

In addition, it was shown that the greater part of the construction and installation of such a control system can be carried out without any dislocation of production programmes.

It is considered that similar centrally controlled liquid-batching plants can have wide application in industries concerned with the volume production of liquids and compositions of many different formulations. Indeed, in some circumstances, e.g. where physical expansion of factory premises is impossible, such a method of distributing materials used in large accurately controlled proportions may be the only way of increasing the volume of production.

PAINT CODE OF PART NUMBERS

To avoid the various divisions of the British Motor Corporation duplicating part numbers for the same paint, the following codes have been established for different materials and, together with the paint colour codes, shall comprise the B.M.C. part number.

CL—Cellulose.
ET—Self-etching.
SA—Synthetic Air-drying.
SE—Synthetic Stoving—Electro Static.
SH—Synthetic Half-hour.
SL—Synthetic Low-baking.
SS—Synthetic Stoving.
RC—Chlorinated Rubber—Chassis.
RE—Chlorinated Rubber—Engine.

Example—Part No. RD.9/SS = Tartan Red Synthetic Stoving.

COLOUR CODE OF PART NUMBERS

Colour	Code	Page PAC
Aluminium	AL.1	
Aluminium Bright	AL.2	
Champagne Beige	BG.1	3
Kashmir Beige	BG.2	3
Sandy Beige—see BG.15	BG.3	3
Whitehall (Nevada) Beige	BG.4	3
Royal Tan	BG.5	3
Cheviot Fawn	BG.6	3
Phoenix Beige	BG.7	3
Beige	BG.8	3
Alamo Beige	BG.9	3
Tan	BG.10	3
Stone Grey	BG.11	3A
Light Beige	BG.12	3A
Arianca Beige	BG.13	3A
Stone	BG.14	3A
Sandy Beige '61'	BG.15	3
Black	BK.1	
Wrinkle (Crackle) Black	BK.2	
Speedwell Blue	BU.1	4
Ice (Healey) Blue—Metallichrome—see BU.18	BU.2	4
Steel Blue	BU.3	4
Glacier Blue	BU.4	4
Kingfisher Blue	BU.5	4
Turquoise—for Turquoise Blue see BU.26	BU.6	4
Florentine Blue	BU.7	4
Island Blue	BU.8	4
Mineral Blue	BU.9	4
Teal Blue	BU.10	4
Basilica Blue	BU.11	4A
Iris Blue	BU.12	4A
Navy Blue	BU.13	4A
Clipper Blue	BU.14	4A
Smoke Grey	BU.15	4A
Ocean Blue	BU.16	4A
Horizon Blue	BU.17	4A
Ice Blue Straight—see BU.2	BU.18	4A
Reef Blue	BU.19	4A
Capri Blue	BU.20	4A
Streamline Blue	BU.21	4B
Conway Blue	BU.22	4B
Stardust Blue	BU.23	4B
Dark Blue	BU.24	4B
Wembley Blue	BU.25	4B
Turquoise Blue	BU.26	4B
Azure Blue	BU.27	4B
Smoke Blue	BU.28	4B
Alaskan Blue	BU.29	4B
Dynasty Blue	BU.30	4B
Thames Blue	BU.31	4C
Blue Metallic	BU.32	4C
Delft Blue	BU.33	4C
Cambridge Blue	BU.34	4C
Surf Blue	BU.35	4C
Light Blue	BU.36	4C
Trafalgar Blue	BU.37	4C
Blue Royale	BU.38	4C
Persian Blue	BU.39	4C
Bermuda Blue	BU.40	4C
Florida Green	GN.1	5
Ash Green	GN.2	5
Palm Green	GN.3	5
Pastel Green	GN.4	5
Sage Green—Morris	GN.5	5
Island Green	GN.6	5
Tyrolite Green	GN.7	5
Berkshire Green	GN.8	5
Pacific Green	GN.9	5
Reseda Green	GN.10	5
Shalston Green	GN.11	5A
Fern Green	GN.12	5A
Spruce Green	GN.13	5A
Alhambra Green	GN.14	5A
Leaf Green	GN.15	5A
Vale Green	GN.16	5A
Porcelain Green	GN.17	5A
Connaught Green	GN.18	5A
Sutherland Green	GN.19	5A
Tintern Green	GN.20	5A
Rydal Green	GN.21	5B
Empire Green	GN.22	5B
Metallic Green	GN.23	5B
Sherwood Green (Austin—Sage Green)	GN.24	5B
Racing Green	GN.25	5B
Lizard Green	GN.26	5B
Romain Green	GN.27	5B
Mist Green	GN.28	5B
Woodland Green	GN.29	5B
M.G. Green	GN.30	5B
M.G. Green Metallic	GN.31	5C
Westminster Green	GN.32	5C
Willow Green	GN.33	5C
Lincoln Green	GN.34	5C
Cumberland Green (Riley One-Point-Five—Leaf Green)	GN.35	5C
Bronze Green	GN.36	5C
Almond Green	GN.37	5C
Mid Green	GN.38	5C
Fern Green	GN.39	5C
Court Grey	GR.1	6
Cardigan (Swiss) Grey	GR.2	6
Birch Grey	GR.3	6
Tweed Grey	GR.4	6
Frilford Grey	GR.5	6
Clarendon Grey	GR.6	6
Yukon Grey	GR.7	6
Charcoal Grey	GR.8	6
Dark (Twilight) Grey—see GR.20	GR.9	6
Pearl Grey	GR.10	6
Farina Grey	GR.11	6A
Grampian Grey	GR.12	6A
Seal Grey	GR.13	6A
Regency Grey Metallic—see GR.19	GR.14	6A
Smoke Grey—see BU.15		4A
Chelsea Grey	GR.15	6A
Metallic Grey	GR.16	6A
Steel Grey	GR.17	6A
Carlton Grey	GR.18	6A
Regency Grey Straight—see GR.14	GR.19	6A
Twilight Grey Metallic—see GR.9	GR.20	6A
Gascoyne Grey	GR.21	6B
Moonstone Grey	GR.22	6B
Mist Grey	GR.23	6B
Platinum Grey	GR.24	6B
Silver Streak Grey Metallic	GR.25	6B
Dove Grey	GR.26	6B
Rose Taupe	GR.27	6B
Light Grey	GR.28	6B
Cumulus Grey	GR.29	6B
Peat	GR.30	6B
Mardi Gras Red	RD.1	7
Colorado (Signal) Red	RD.2	7
Orient Red	RD.3	7
Cherry Red	RD.4	7
Damask (Morris) Red	RD.5	7
Autumn Red	RD.6	7
Royal Maroon	RD.7	7
Maroon	RD.8	7
Tartan Red	RD.9	7
Orchid	RD.10	7
Coral Red	RD.11	7A
Chestnut	RD.12	7A
Carmine	RD.13	7A
Reno Red	RD.14	7A
Richmond Red	RD.15	7A
Chariot Red	RD.16	7A
Lilac	RD.17	7A
Deep Pink	RD.18	7A
Claret	RD.19	7A
Orange	RD.20	7A
Embassy Maroon	RD.21	7B
Agate Red	RD.22	7B
Frost White	WT.1	8
	WT.2	8
Ivory White / Old English White (Off White)	WT.3	8
Snowberry White	WT.4	8
Pale Ivory	YL.1	9
Chartreuse Yellow	YL.2	9
Primrose (Sunburst) Yellow	YL.3	9
Autumn (Yellow) Gold	YL.4	9
Cream (Ivory)	YL.5	9
County Cream	YL.6	9
Marigold	YL.7	9
Golden Yellow	YL.8	9
Highway Yellow	YL.9	9
Morris (Deep) Cream	YL.10	9
Fiesta Yellow	YL.11	9A

COLOUR BASIC TINTERS—CODE OF PART NUMBERS

TINTER COLOUR	CODE	TINTER COLOUR	CODE
Black	BKT.1	Helio Red	RDT.1
		Crimson	RDT.2
		Red Oxide	RDT.3
Prussian Blue	BUT.1	Deep Maroon	RDT.4
Monastral Blue	BUT.2	Fast Purple	RDT.5
Light Blue	BUT.3	Purple Oxide	RDT.6
Middle Blue	BUT.4	Pink Oxide	RDT.7
Extra Pale Blue	BUT.5	Pale Fast Maroon	RDT.8
		Extra Pale Fast Maroon	RDT.9
Middle Brunswick Green	GNT.1	White	WTT.1
Light Fast Green	GNT.2		
		Yellow Ochre	YLT.1
		Lemon Chrome	YLT.2
Light Grey	GRT.1	Orange Chrome	YLT.3
Dark Grey	GRT.2	Pale Ochre	YLT.4
Extra Pale Grey	GRT.3	Pale Yellow	YLT.5
		Pale Fast Yellow	YLT.6
		Middle Chrome	YLT.7
		Extra Pale Ochre	YLT.8

MIXING FORMULAE

	B.M.C. Code	Colour	Formulae	
BU.1	**SPEEDWELL BLUE**			
	WTT.1 ..	WHITE	59½%	
	BUT.3 ..	LIGHT BLUE	12½%	(72)
	GRT. 1 ..	LIGHT GREY	26%	(98)
	RDT.6 ..	PURPLE OXIDE	2%	
			100%	
	This colour could take a trace of GNT.2			
BU.8	**ISLAND BLUE**			
	BUT.3 ..	LIGHT BLUE	36%	
	BUT.2 ..	MONASTRAL BLUE	19%	(55)
	RDT.6 ..	PURPLE OXIDE	26½%	(81½)
	GRT.2 ..	DARK GREY	18½%	
			100%	
BU.14	**CLIPPER BLUE**			
	GRT.2	DARK GREY	48%	
	BUT.3 ..	LIGHT BLUE	36%	(84)
	GRT.1 ..	LIGHT GREY	13%	(97)
	YLT.4 ..	PALE OCHRE	3%	
			100%	
BU.15	**SMOKE GREY**			
	GRT.1 ..	LIGHT GREY	63%	
	WTT.1 ..	WHITE	22%	(85)
	BUT.3 ..	LIGHT BLUE	8%	(93)
	YLT.4 ..	PALE OCHRE	7%	
			100%	
BU.35	**SURF BLUE**			
	BUT.3 ..	LIGHT BLUE	71½%	
	YLT.5 ..	PALE YELLOW	13%	(84½)
	YLT.4 ..	PALE OCHRE	8%	(92½)
	WTT.1 ..	WHITE	7½%	
			100%	
	This colour could take a trace of WTT.1 or YLT.4			
GN.37	**ALMOND GREEN**			
	YLT.7 ..	MIDDLE CHROME	60%	
	GRT.2 ..	DARK GREY	29%	(89)
	BUT.2 ..	MONASTRAL BLUE	11%	
			100%	

MIXING FORMULAE

	B.M.C. Code	Colour	Formulae	
GR.4	**TWEED GREY**			
	GRT.1 ..	LIGHT GREY	44%	
	GRT.2 ..	DARK GREY	38%	(82)
	YLT.4 ..	PALE OCHRE	15%	(97)
	BUT.3 ..	LIGHT BLUE	3%	
			100%	
	This colour could take a trace of YLT.4			
GR.11 (1960)	**FARINA GREY (1960)**			
	WTT.1 ..	WHITE	66%	
	GRT.1 ..	LIGHT GREY	31%	(97)
	YLT.4 ..	PALE OCHRE	3%	
			100%	
GR.11 (1961)	**FARINA GREY (1961)**			
	GRT.3 ..	EXTRA PALE GREY	67%	
	GRT.1 ..	LIGHT GREY	25%	(92)
	YLT.8 ..	EXTRA PALE OCHRE	6%	(98)
	RDT.7 ..	PINK OXIDE	2%	
			100%	
RD.4	**CHERRY RED**			
	RDT.2 ..	CRIMSON	83%	
	RDT.7 ..	PINK OXIDE	13%	(96)
	RDT.3 ..	RED OXIDE	3%	(99)
	GRT.2 ..	DARK GREY	1%	
			100%	
	Use undercoat Light Red AKJ2303 to 2307			
RD.9	**TARTAN RED**			
	(Not available)			
WT.3	**OLD ENGLISH WHITE/IVORY/OFF WHITE**			
	WTT.1 ..	WHITE	92½%	
	YLT.4 ..	PALE OCHRE	3%	(95½)
	GRT.1 ..	LIGHT GREY	4%	(99½)
	RDT.7 ..	PINK OXIDE	½%	
			100%	
	This colour could take a trace of WTT.1			
WT.4	**SNOWBERRY WHITE**			
	WTT.1 ..	WHITE	66%	
	GRT.3 ..	EXTRA PALE GREY	15%	
	YLT.8 ..	EXTRA PALE OCHRE	14%	
	GNT.3 ..	EXTRA PALE FAST GREEN ..	5%	
			100%	

MIXING FORMULAE

B.M.C. Code	Colour	Formulae	
YL.11	**FIESTA YELLOW**		
GRT.3 ..	EXTRA PALE GREY	59½%	
YLT.9 ..	PALE PRIMROSE	31%	(90½)
GRT.1 ..	LIGHT GREY	6%	
BUT.5 ..	EXTRA PALE BLUE	3½%	
		100%	

This colour could take a trace of WTT.1