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A Rapid, Systematic, and Comprehensive Classification System for the Identification and Comparison of Motor Vehicle Paint Samples. II: Paint Data Collected from Chrysler-Manufactured Cars

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ABSTRACT: A rapid system for the identification of Chrysler Corp. vehicles from paint samples has been devised. The data presented outline the production relationships of Chrysler vehicle lines to their various assembly plants from 1960 to 1979. Marketing trends seen in our data illustrate the usefulness of a statistical data base. Microscopic and chemical data from the analysis of 107 core samples, representing paint samples collected from 1452 Chrysler Corp. vehicles, are presented and discussed.

KEYWORDS: criminalistics, automobiles, paints, classifications

The identification of hit-and-run vehicles through the analysis of paint chips left at the scene is widely employed in forensic science laboratories. The paint classification system developed within our laboratory to narrow the possible sources of a vehicle employs both microscopic and chemical techniques [*1*]. In this paper we present a summary of the core data representing paint samples from 1452 Chrysler Corp. vehicles.

Results and Discussion

The coded data within our files use the format previously described for computer retrieval of individual pieces of information [*1*]. Although our computerized data system for paint was designed as a result of this work, the information in this paper has been organized in a slightly different format to accommodate a rapid manual searching procedure for those laboratories that do not have access to all our data.

The vehicle line abbreviations (Table 1) that were employed for the Chrysler sample identification numbers (SIN) identify the vehicle lines covered in Table 2, which outlines the production relationships of the various vehicle lines and assembly plants for specific years.

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TABLE 1—*Chrysler Corp. SIN vehicle line filing code abbreviations.*

Plymouth Division		Dodge Division		Chrysler/Imperial Division	
Vehicle Line	Abbreviation	Vehicle Line	Abbreviation	Vehicle Line	Abbreviation
Barracuda	BCUDA	Aspen	ASPEN	Cordoba	CORD
Belvedere	BELVE	Challenger	CHALL	Crown	CROWN
Carevelle	CARE	Charger	CHARG	Imperial	IMPER
Fury	FURY	Coronet	CORNT	LeBaron	LEBAR
Gran	GRAN	Dart	DART	Newport	NPORT
Gran Fury	GFURY	Diplomat	DIPLO	New Yorker	NYORK
GTX	GTX	Demon	DEMON	Town & Country	T&C
Horizon	HORIZ	Dodge	DODGE	Three Hundred	THREE
Road Runner	ROAD	Magnum	MAG	Windsor	WIND
Satellite	SLITE	Monaco	MON		
Savoy	SAVOY	Omni	OMNI		
Valiant	VALI	Polara	POLAR		
Volare	VOLAR	St. Regis	STREG		
		Matador	MAT		
		Royal Monaco	RYMON		

Chrysler's assembly plants and corresponding plant codes are given on the top row. The upper-case lettering in the table indicates that a paint sample from that vehicle line was held within our files, while the lower-case lettering indicates that a particular vehicle line was reported to have originated from that plant. With the exception of the Windsor, Ont., plant, we were unable to verify which plants manufactured which vehicle lines before 1966. The Windsor plant produced all Chrysler vehicle lines for the Canadian market before the 1965/1966 United States-Canada Autopact. Since that time, and especially since the early 1970s, individual assembly plants have tended to manufacture specific "corporate twins." For example, the full-sized Furys and Polaras were made in Belvedere, while the compact Darts and Valiants were assembled in Hamtramck. Thus, even though we were fairly confident that the Newport, Three Hundred, and New Yorker vehicle lines were manufactured exclusively in Detroit before 1966, for those three vehicle lines only data from samples were included in Table 2. From 1960 to 1965 the Belvedere plant did not exist and the Los Angeles plant went out of production after the 1972 model year.

Years of manufacture for every individual vehicle line or series that was manufactured by the four Chrysler divisions is illustrated in Figs. 1, 2, and 3. The abbreviation codes for the individual vehicle series are included in Fig. 1. The black circles indicate that the vehicle series was not produced in that model year.

Data from the *National Auto Theft Books* aided in compiling this manufacturing data. However, samples were obtained from certain vehicle series that, according to these books, did not exist. For example, samples were collected from 1966 Dodge Polara 440s (Fig. 2), which were not reported by the *National Auto Theft Books* as having been manufactured.

The data in Table 2 and Figs. 1 to 3 are necessary to completely identify, within any model year, the specific vehicle line or series produced in any Chrysler assembly plant. The bottom rows in Figs. 1 to 3 give the individual codes for the assembly plants where the vehicle lines were manufactured, while the main body identifies which vehicle series were produced. The vehicle line designations in Table 2 identify every line manufactured for a particular year in a specific plant. For instance, Table 2 would show that from 1970 to 1973 the Lynch Road plant produced Dodge Coronets and Chargers, Plymouth Road Runners and Satellites, and some Furys and GTXs. Figures 1 to 3 indicate which vehicle series were manufactured in each model year. In 1970, for example, only the Satellite and Satellite Sport were manufactured, whereas in 1971 the Sport was not manufactured but the Custom, Sebring Plus,

TABLE 2—*Chrysler Corp. assembly plant vehicle production data.*

	Assembly Plants								
Model Year	Lynch Rd. (A)	Hamtramck (B)	Detroit (C)	Belvedere (D)	Los Angeles (E)	Newark (F)	St. Louis (G)	Windsor (R)	Windsor (R)
1960					FURY			WIND	polar
								three	vali
								nyork	savoy
								DART	belve
								mat	fury
1961								WIND	polar
								three	VALI
								nyork	savoy
								mat	belve
								dart	fury
1962		VALI	IMPER					WIND	polar
								three	VALI
								nyork	SAVOY
								DART	belve
								dodge	fury
1963		DART			VALI			wind	POLAR
		POLAR						THREE	VALI
								nyork	savoy
								dart	BELVE
								DODGE	FURY
1964	FURY	POLAR						WIND	VALI
								THREE	savoy
								NYORK	BELVE
								dart	FURY
								DODGE	BCUDA
								polar	
1965		FURY	NPORT		FURY	FURY		wind	MON
								THREE	VALI
								nyork	SAVOY
								dart	BCUDA
								DODGE	belve
								POLAR	FURY

1966	CORNT BELVE SLITE	BCUDA FURY	THREE IMPER				SLITE	WIND NPORT THREE NYORK DART POLAR	MON vali belve FURY slite
1967	CORNT BELVE SLITE gtx	DART CHARG VALI BCUDA	NPORT THREE NYORK t&c IMPER		DART vali		CORNT slite GTX	NPORT dart POLAR MON	vali belve FURY
1968	CORNT BELVE ROAD SLITE GTX FURY	DART CHARGE VALI BCUDA	NPORT THREE NYORK t&c imper	MON	DART VALI		CORNT SLITE GTX road	dart POLAR MON VALI belve FURY	
1969	CORNT BELVE ROAD SLITE gtx fury	DART CHARG VALI BCUDA	NPORT THREE NYORK T&C imper	MON FURY	dart VALI ROAD slite gtx		cornt slite gtx ROAD dart	POLAR MON VALI BELVE FURY	
1970	CORNT charg FURY ROAD SLITE GTX	DART CHALL VALI BCUDA	NPORT THREE NYORK t&c IMPER	POLAR MON FURY	slite road gtx		cornt CHARG SLITE gtx road	DART POLAR MON VALI	ROAD slite GTX FURY
1971	CORNT CHARG road gtx slite	DART DEMON CHALL VALI BCUDA	NPORT THREE NYORK T&C imper	POLAR MON FURY	SLITE road gtx		cornt charg SLITE gtx road	DART VALI ROAD SLITE gtx	
1972	CORNT CHARG road slite	dart DEMON CHALL VALI BCUDA	NPORT NYORK t&c imper	POLAR MON FURY GRAN	slite road	SLITE road	cornt charg slite road	DART VALI road SLITE	

TABLE 2 (continued)—*Chrysler Corp. assembly plant vehicle production data.*

	Assembly Plants								
Model Year	Lynch Rd. (A)	Hamtramck (B)	Detroit (C)	Belvedere (D)	Los Angeles (E)	Newark (F)	St. Louis (G)	Windsor (R)	Windsor (R)
1973	CORNT	DART	NPORT	T&C		polar	cornt	DART	
	CHARG	CHALL	NYORK	POLAR		MON	charg	VALI	
	road	VALI	IMPER	MON		FURY	slite	ROAD	
	slite	BCUDA		FURY		gran	road	SLITE	
				gran					
1974	CORNT	DART	NPORT	T&C		DART	cornt	DART	
	CHARG	CHALL	NYORK	MON		vali	CHARG	VALI	
	road	VALI	IMPER	FURY		FURY	SLITE	ROAD	
	SLITE	BCUDA		GRAN			road	SLITE	
1975	CORNT	DART	NPORT	T&C		dart	DART	CORD	
	CHARG	VALI	nyork	RYMON		vali	CORNT	DART	
	ROAD		IMPER	MON			vali	CHARG	
	FURY			GFURY			FURY	VALI	
	GFURY								
1976	CORNT	dart	NPORT	NPORT		DART	DART	CORD	
	CHARG	ASPEN	NYORK	T&C		vali	aspen	CHARG	
	FURY	VALI		rymon		aspen	VALI		
		VOLAR		MON		VOLAR	volar		
				GFURY					
1977	CHARG	ASPEN	NPORT	NPORT		ASPEN	lebar	CORD	
	MON	VOLAR	NYORK	T&C		VOLAR	aspen	CHARG	
	FURY			RYMON			diplo		
				GFURY			volar		
1978	mon	aspen	nport	omni		aspen	lebar	cord	
	fury	volar	nyork	horiz		volar	diplo	charg	
							care	mag	
1979	nport	aspen		omni		aspen	lebar	cord	
	nyork	volar		horiz		volar	diplo	mag	
	streg					lebar	care	three	

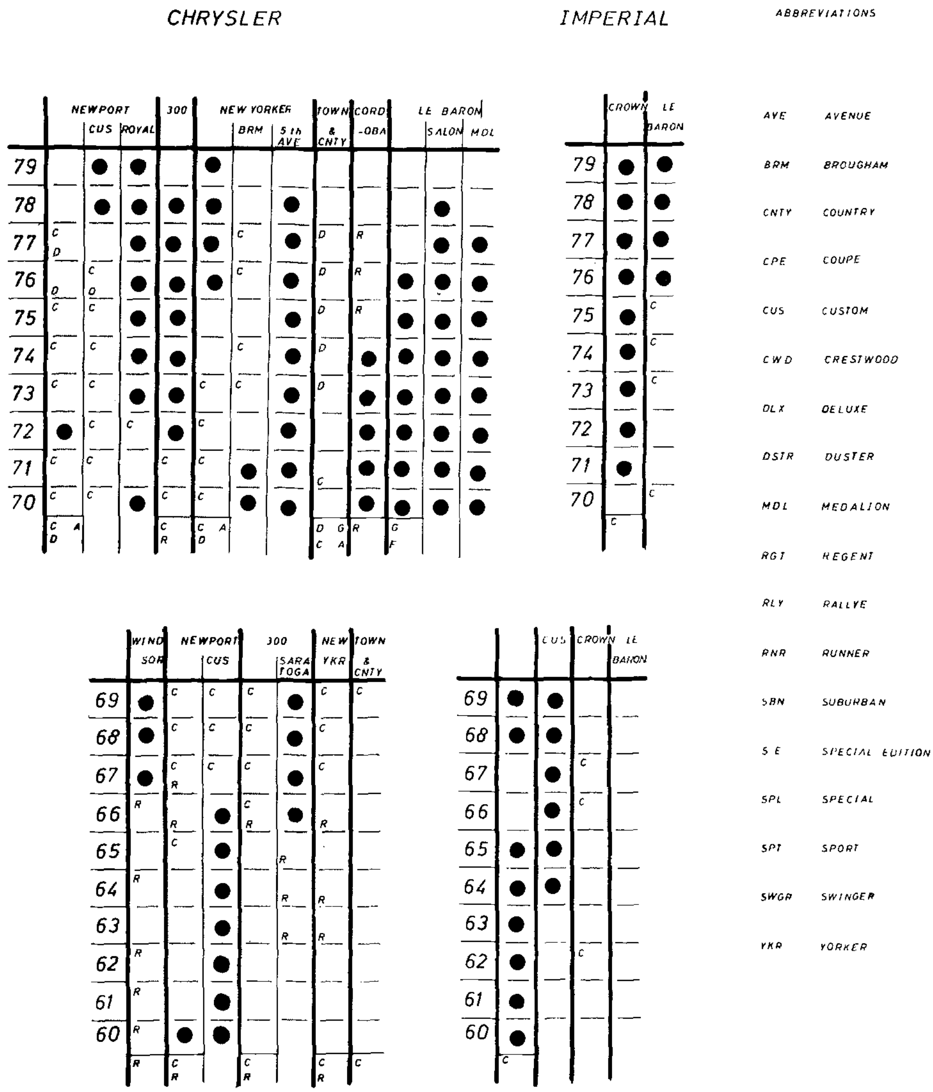


FIG. 1—*Chrysler Division's vehicle line and series production data.*

Brougham, and Regent series were. Similar vehicle series trends can be seen in Coronets and Chargers between 1970 and 1973. Thus, the corresponding partial Vehicle Identification Numbers for the vehicle series can be determined for use by the Motor Vehicle Branch computers in searching for registered owners.

Assembly plant data were recorded in the main body of Figs. 1 to 3 only for those vehicle series where a sample was obtained, even when other information indicated that all vehicle series were produced in that plant. These figures indicate possible marketing trends that may statistically indicate the most probable vehicle series registered within a specified area, even though the other vehicle series cannot be eliminated. For example, the Dodge Coronets (Fig. 2) manufactured in St. Louis were seen even in Alberta in 1967, 1968, and 1975. From 1970 to 1974, the Coronets originated from Lynch Road. That does not mean they were not

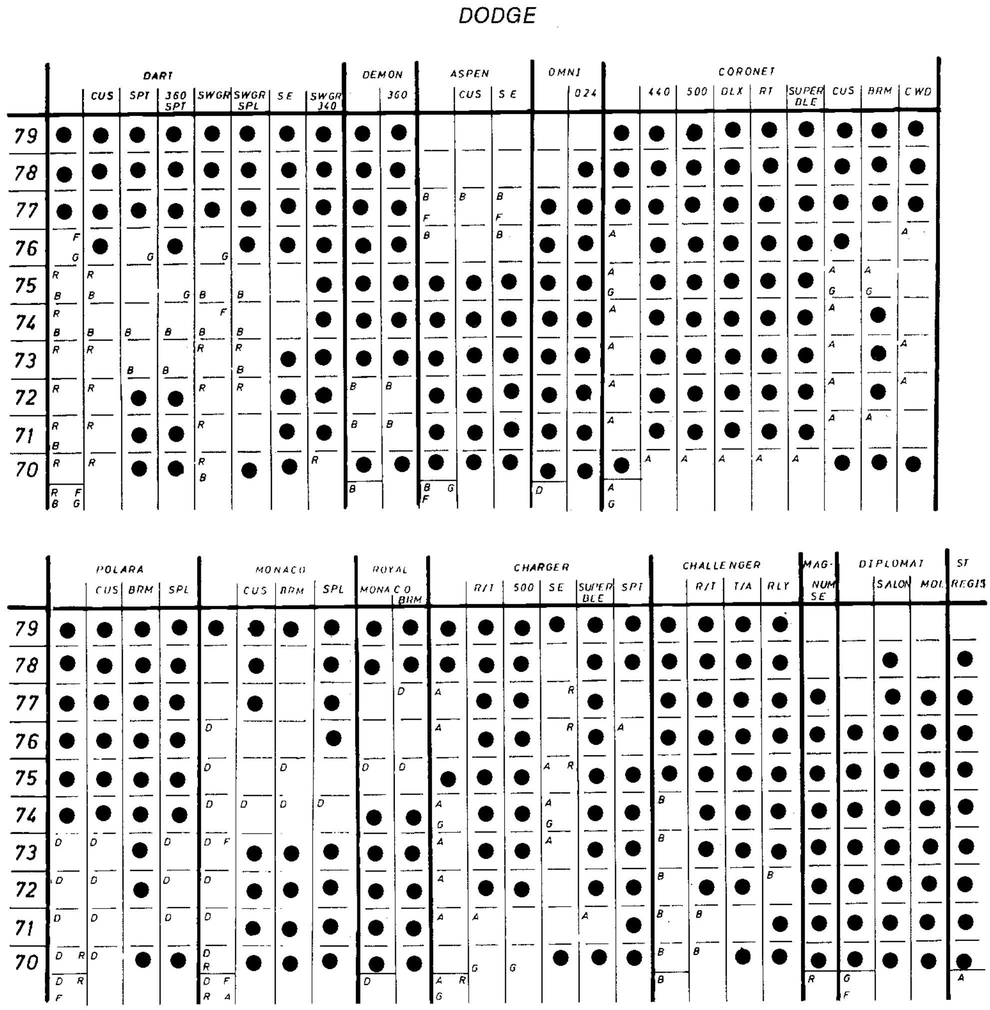


FIG. 2a—*Dodge Division's vehicle line and series production data for 1970–1979.*

manufactured in St. Louis for those years, just that they were not routinely observed within our area. As with the Valiants [*1*], the Darts (Fig. 2) between 1973 and 1974 also indicate possible marketing trends within individual vehicle series. The 1973 Darts and Dart Customs originated from Windsor, while the Sport and Sport 360s originated from Hamtramck only. In 1974 the first two series were marketed from both Hamtramck and Windsor, while the latter two were still marketed from Hamtramck. This would indicate that either the latter two vehicle series were not made in Windsor or that there was a distinct marketing trend in these vehicle series. Either way, we would not normally expect to see a Windsor-assembled 1973 or 1974 Dart Sport or Sport 360 in Alberta.

With all the information from the correlated microscopic and chemical data, a final set of 108 Chrysler core undercoat standards were obtained. Table 3 presents data from the core samples, using the abbreviations previously given [*1*]. The table designates the core SINs as well as the corresponding assembly plant, area on the vehicle, undercoat code, color/chemi-

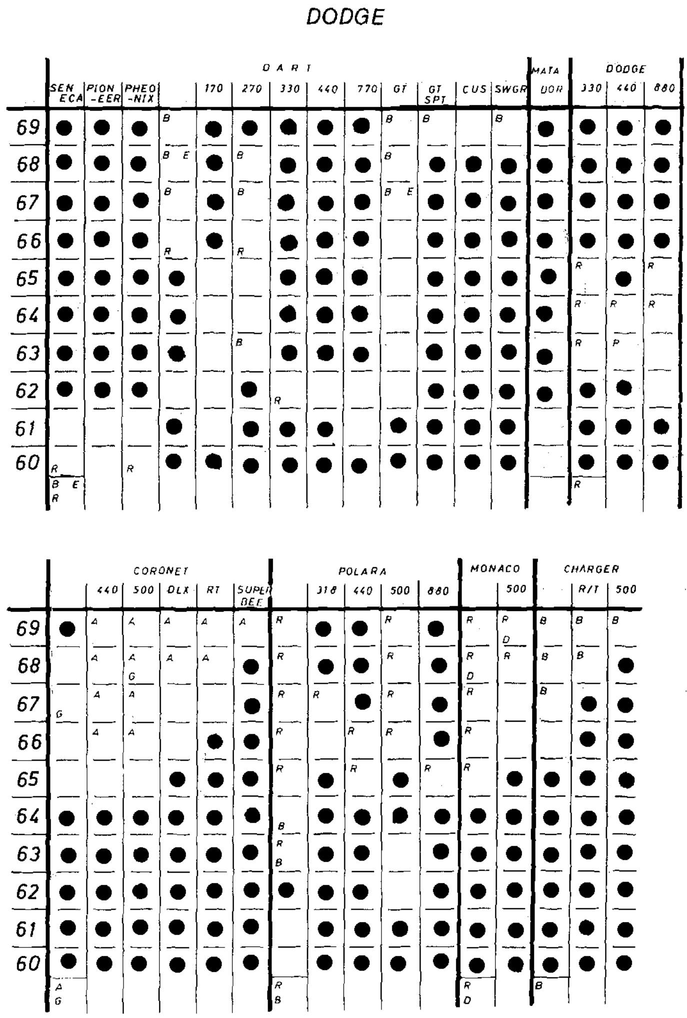


FIG. 2b—*Dodge Division's vehicle line and series production data for 1960–1969.*

cal descriptor sequence code, undercoat data, and chip board position (indicating the position where the core undercoat standard is mounted in our collection [Fig. 4]). The undercoat data are composed of the core infrared spectrum (IR) descriptor and the corresponding Munsell color code [*2*]. The Munsell coordinates defining the undercoat colors were chosen with large enough searching parameters that any forensic scientist would be able to obtain initial access to the data system. However, the final color comparisons always had to be conducted on the core undercoat standard. Blanks in the core IR column indicate insufficient quantities for a chemical analysis, while blanks in the adjoining Munsell code column indicate that the layer was so thin that significant bleed-through from another colored layer seriously affected the assignment of a color coordinate. By our previously stated convention [*1*], the undercoats are numbered sequentially from the topcoat downwards.

In establishing the core data, it was determined that quite frequently several distinctly different colors, some with the same Munsell coordinates, were represented by a single infrared

PLYMOUTH

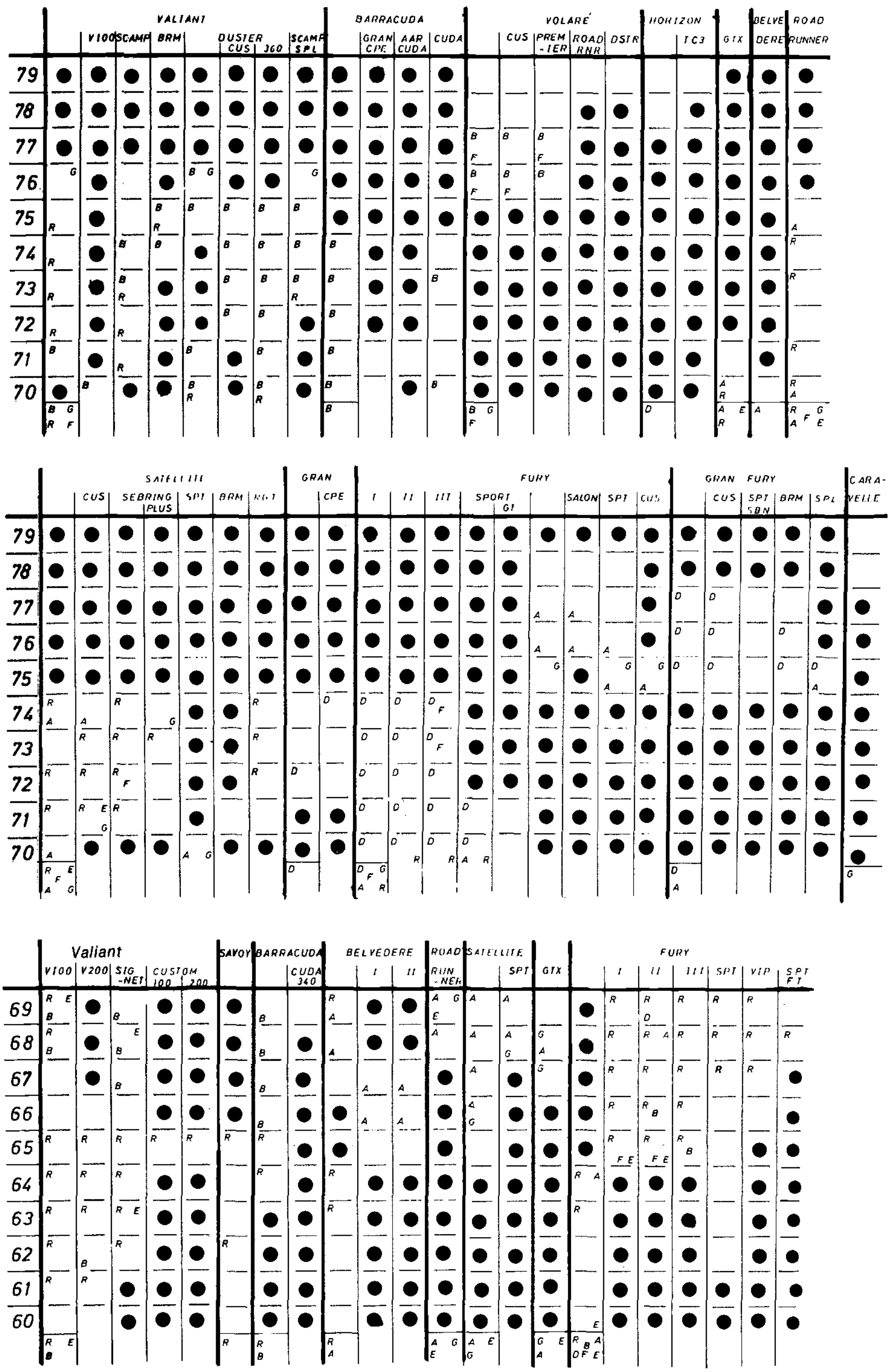


FIG. 3—*Plymouth Division's vehicle line and series production data.*

TABLE 3—*Core data for Chrysler Corp.*[a]

SIN	AP	AOV	UCC	Color/ Chemical Descriptor Sequence	UC(1) Data		UC(2) Data		UC(3) Data		UC(4) Data		CBP
					CIR	Munsell Code [2]	CIR	Munsell Code	CIR	Munsell Code	CIR	Munsell Code	
60FURY1	E	LRF	13	1/1	Gy6-1	N7/-	Br6-	10R3/2	...	...	...	...	A01
60WIND1	R	LD	13	2/2	Gy6-2	N4/-	Br6-1	10R3/2	...	...	...	...	A02
61VALI1	R	LFF	13	2/3	Gy6-2	N4/-	Br6-2	10R3/2	...	...	...	...	A03
62VALI2	B	RFF	13	3/4	Gy6-2	5Y6/1	Br6-3	10R2.5/1	...	...	...	...	A04
62CROWN1	C	RFF	13	4/5	Gy6-3	N5/-	Br6-4	10R3/2	...	...	...	...	A05
63VALI5	E	LRF	113	6/5/6	Gy6-	N6/-	Gy6-4	5Y6-1	Br6-5	2.5YR3/2	...	...	A06
63POLAR1	R	RFF	13	7/3	Gy6-5	N4/-	Br6-2	10R3/2	...	...	...	...	A07
64FURY4	A	RRF	13	8/7	Gy6-	5G5/1	Br6-6	10R3/2	...	...	...	...	A08
65FURY12	B	LRF	13	9/8	Gy6-6	N6/-	Br6-7	10R3/2	...	...	...	...	A09
65SAVOY2	R	LFF	13	11/3	Gy6-8	...	Br6-2	10R3/2	...	...	...	...	A10
66CORNT2	A	LFD	13	10/9	Gy6-7	5G5/2	Br6-8	2.5YR3/2	...	...	...	...	B01
66SLITE6	A	LRF	113	12/10/9	Gy6-9	...	Gy6-7	5G5/2	Br6-8	2.5YR3/2	...	...	B02
66FURY18	B	T	13	13/10	Gy6-8	N6/-	Br6-9	2.5YR2.5/2	...	...	...	...	B03
66FURY8	R	H	13	14/10	Gy6-8	N5/-	Br6-9	2.5YR2.5/2	...	...	...	...	B04
67VALI3	B	LFF	13	15/8	Gy6-6	N5/-	Br6-7	10R3/2	...	...	...	...	B05
67FURY6	R	LRF	113	17/16/10	Gy6-11	...	Gy6-10	5G5/1	Br6-9	2.5YR2.5/2	...	...	B06
68CORNT4	A	LRF	1313	10/9/10/9	Gy6-7	5G5/2	Br6-8	2.5YR3/2	Gy6-7	5G5/2	Br6-8	2.5YR3/2	B07
68CORNT3	A	RFF	13	18/11	Gy6-12	N6/-	Br6-24	10R3/4	...	...	...	...	B08
68DART12	B	LRF	13	19/8	Gy6-6	N6/-	Br6-7	10R3/2	...	...	...	...	B09
68DART8	B	RRF	2	1	Bk6-1	N2.5/-	...	...	...	...	...	...	B10
68FURY9	R	LFF	13	16/10	Gy6-10	5G5/1	Br6-9	2.5YR2.5/2	...	...	...	...	C01
68VALI6	R	LFF	13	20/12	Gy6-13	...	Br6-10	10R3/4	...	...	...	...	C02
69BCUDA3	B	H	13	21/3	Gy6-13	N5.5/-	Br6-11	10R3/4	...	...	...	...	C03
69NYORK1	C	LFF	131	10/9/10	Gy6-7	5G5/2	Br6-8	2.5YR3/2	Gy6-7	5G5/2	...	...	C04
69ROAD3	G	LFF	13	22/15	Gy6-14	N5.5/-	Br6-12	10R3/2	...	...	...	...	C05
69POLAR8	R	F	13	23/10	Gy6-15	7.5GY5/2	Br6-9	2.5YR2.5/2	...	...	...	...	C06
69FURY2	R	RD	13	24/16	Gy6-16	5G5/1	Br6-13	10R3/2	...	...	...	...	C07
69MON6	R	LFHB	13	25/17	Gy6-9	N5.5/-	Br6-14	10R3/4	...	...	...	...	C08
70SLITE6	A	LRF	313	18/27/9	Br6-12	10R3/4	Gy6-17	5G5/1	Br6-8	2.5YR3/2	...	...	C09
70NPORT5	C	H	13	28/18	Gy6-14	N5.5/-	Br6-12	10R3/2	...	...	...	...	C10
70FURY14	R	LR	13	32/10	Gy6-15	5G5/1	Br6-9	2.5YR2.5/2	...	...	...	...	D01
70ROAD4	R	LD	213	2/31/18	Bk6-	N2/-	Gy6-14	N5.5/-	Br6-12	10R4/4	...	...	D02

TABLE 3 (continued)—*Core data for Chrysler Corp.*[a]

SIN	AP	AOV	UCC	Color/ Chemical Descriptor Sequence	UC(1) Data CIR	UC(1) Data Munsell Code [2]	UC(2) Data CIR	UC(2) Data Munsell Code	UC(3) Data CIR	UC(3) Data Munsell Code	UC(4) Data CIR	UC(4) Data Munsell Code	CBP
70DART7	R	LFF	2	3	Bk6-2	N2/-	...	...	...	...	...	...	D03
70GTX3	R	LD	13	34/19	Gy6-20	N6/-	Br6-13	10R3/2	...	...	...	...	D04
70MON2	R	LFHB	132	32/10/5	Gy6-15	5G5/1	Br6-9	2.5YR2.5/2	Bk6-	N2.5/-	...	...	D05
70DART10	R	RFF	12	33/4	Gy6-19	N4/-	Br6-3	N2/-	...	...	...	...	D06
71CORNT2	A	LFF	13	26/18	Gy6-14	N5.5/-	Br6-12	10R3/2	...	...	...	...	D07
71VALI1	B	RRF	13	21/20	Gy6-13	N5.5/-	Br6-15	10R3/4	...	...	...	...	D08
71CHALL3	B	H	13	21/14	Gy6-13	N5.5/-	Br6-12	10R4/4	...	...	...	...	D09
71DART1[b]	B	RFHB	11313	25/30/14/30/ 14	Gy6-9	N5.5/-	Gy6-18	N4.5/-	Br6-12	10R4/4	Gy6-18	N4.5/-	D10
71FURY7	D	RRF	13	29/18	Gy6-14	N5/-	Br6-12	10R3/2	...	...	...	...	E01
71POLAR11	D	RFHB	113	35/29/18	Gy6-21	N6/-	Gy6-14	N5/-	Br6-12	10R3/2	...	...	E02
71DART2	R	LFHB	1313	20/13/36/18	Gy6-13	...	Br6-10	10R3/4	Gy6-18	N5.5/-	Br6-12	10R3/2	E03
72NPORT3	C	LD	13	37/21	Gy6-13	N5.5/-	Br6-12	10R3/2	...	...	...	...	E04
72SLITE11	F	LFF	13	38/22	Gy6-13	N5/-	Br6-16	10R3/4	...	...	...	...	E05
72SLITE3	R	RFF	13	36/19	Gy6-18	N5.5/-	Br6-13	10R3/2	...	...	...	...	E06
72SLITE10	R	RFF	113	39/40/19	Gy6-	...	Gy6-22	N5/-	Br6-13	10R3/2	...	...	E07
73CHARG4	A	LRF	12	41/7	Gy6-16	N5.5/-	Bk6-5	N3.5/-	...	...	...	...	E08
73DART4	B	RD	12	21/6	Gy6-13	N5.5/-	Bk6-4	N3.5/-	...	...	...	...	E09
73NYORK3	C	LFF	13	42/18	Gy6-16	N5.5/-	Br6-12	10R3/2	...	...	...	...	E10
73NPORT5	C	LFF	13	43/21	Gy6-13	N5.5/-	Br6-12	10R3/2	...	...	...	...	F01
73FURY5	D	LFF	13	30/18	Gy6-18	N4.5/-	Br6-12	10R3/2	...	...	...	...	F02
73FURY4	D	LF	123	41/7/18	Gy6-16	N5.5/-	Bk6-5	N3.5/-	Br6-12	10R3/2	...	...	F03
73FURY8	F	RD	13	38/23	Gy6-13	N5.5/-	Br6-11	10R3/4	...	...	...	...	F04
74SLITE2	A	LD	12	41/6	Gy6-16	N5.5/-	Bk6-4	N3.5/-	...	...	...	...	F05
74SLITE4	A	LFF	13	44/24	Gy6-23	N5/-	Br6-17	10R3/4	...	...	...	...	F06
74CHALL6	B	LFHB	123	41/7/25	Gy6-16	N5.5/-	Bk6-5	N3.5/-	Br6-12	10R3/2	...	...	F07
74DART12	B	RFF	121	41/7/25	Gy6-16	N5.5/-	Bk6-5	N3.5/-	Gy6-9	N5.5/-	...	...	F08
74DART15	B	LRF	13	46/24	Gy6-23	N5/-	Br6-17	10R3/4	...	...	...	...	F09
74NPORT1	C	LFF	13	47/24	Gy6-25	...	Br6-17	10R3/4	...	...	...	...	F10
74NPORT2	C	RFD	13	48/26	Gy6-23	N5/-	Br6-18	10R3/4	...	...	...	...	G01
74MON17	D	RRF	13	49/27	Gy6-26	N5/-	Br6-19	10R3/2	...	...	...	...	G02

74MON13	D	F	121	41/7/50	Gy6-16	N5.5/-	Bk6-5	N3.5/-	Gy6-9	N5.5/-	...	...	G03
74FURY13	D	LFF	21	8/51	Bk6-6	N3.5/-	Gy6-27	7.5YR8/2	...	...	...	...	G04
74GRAN1	D	RRF	1	41	Gy6-16	N5.5/-	...	...	...	...	...	...	G05
74T&C1	D	RFHB	3	25	Br6-12	10R3/4	...	...	...	...	...	...	G06
75DART6	B	LF	131	45/24/25	Gy6-24	N5/-	Br6-17	10R3/4	Gy6-9	N5.5/-	...	...	G07
75VALI5	B	RFF	13	45/24	Gy6-24	N5/-	Br6-17	10R3/4	...	...	...	...	G08
75DART9	B	RRF	1	52	Gy6-28	N5/-	...	...	...	...	...	...	G09
75DART15	B	H	21	9/25	Bk6-2	N3.5/-	Gy6-9	N5.5/-	...	...	...	...	G10
75VALI3	B	RFF	2	9	Bk6-2	N3.5/-	...	...	...	...	...	...	H01
75NPORT8	C	RR	1313	48/24/53/24	Gy6-23	N5/-	Br6-17	10R3/4	Gy6-29	N5/-	Br6-17	10R3/4	H02
75NPORT1	C	LRF	13	48/24	Gy6-23	N5/-	Br6-17	10R3/4	...	...	...	...	H03
75GFURY9	D	T	12	54/10	Gy6-18	N5.5/-	Br6-4	N2/-	...	...	...	...	H04
75MON10	D	H	1	47	Gy6-25	N5/-	...	...	...	...	...	...	H05
75GFURY15	D	F	13	41/28	Gy6-16	N5.5/-	Br6-17	10R3/4	...	...	...	...	H06
75CORNT4	G	FHB	123	56/11/29	Gy6-9	N5/-	Bk6-2	N2.5/-	Br6-17	10R3/2	...	...	H07
75FURY6	G	RFHB	23	11/29	Bk6-2	N2.5/-	Br6-17	10R3/2	...	...	...	...	H08
75DART5	G	LFF	13	55/24	Gy6-25	N5/-	Br6-17	10R3/4	...	...	...	...	H09
75CHARG6	R	H	13	40/19	Gy6-22	N5/-	Br6-13	10R3/2	...	...	...	...	H10
75CORD14	R	FHB	1313	40/19/57/29	Gy6-22	N5/-	Br6-13	10R3/2	Gy6-24	N5.5/-	Br6-17	10R3/2	I01
75CORD22	R	RRF	132	40/19/12	Gy6-22	N5/-	Br6-13	10R3/2	Bk6-7	N2.5/-	...	...	I02
75VALI10	R	R	113	58/40/19	Gy6-30	...	Gy6-22	N5/-	Br6-13	10R3/2	...	...	I03
76FURY2	A	RRF	3	31	Br6-21	10R4/2	...	...	...	...	...	...	I04
76CORNT5	A	LRF	132	59/30/13	Gy6-	N4.5/-	Br6-20	10R3/2	Bk6-8	N2/-	...	...	I05
76FURY8	A	LR	2	14	Br6-1	N2.5/-	...	...	...	...	...	...	I06
76CHARG11	A	FHB	23	15/29	Bk6-9	N2.5/-	Br6-17	10R3/2	...	...	...	...	I07
76FURY1	A	HB	22	15/16	Bk6-9	N2.5/-	Bk6-9	N2.5/-	...	...	...	...	I08
76VOLAR4	B	T	2	15	Bk6-9	N2.5/-	...	...	...	...	...	...	I09
76NYORK3	C	LD	2	17	Bk6-9	N2.5/-	...	...	...	...	...	...	I10
76NPORT3	C	LFHB	3	32	Br6-17	10R3/4	...	...	...	...	...	...	J01
76NPORT1	C	RFHB	23	17/23	Bk6-9	N2.5/-	Br6-17	10R3/4	...	...	...	...	J02
76NYORK6	C	RRF	132	48/26/18	Gy6-23	N5/-	Br6-18	10R3/4	Bk6-10	N2/-	...	...	J03
76GFURY2	D	RD	13	61/26	Gy6-24	N5/-	Br6-18	10R3/4	...	...	...	...	J04
76GFURY12	D	RF	1	62	Gy6-28	N5.5/-	...	...	...	...	...	...	J05
76DART1	F	RRF	1	63	Gy6-	N5/-	...	...	...	...	...	...	J06
76CORD19	R	LFHB	1313	40/34/64/29	Gy6-22	N5/-	Br6-23	10R3/4	Gy6-25	N5.5/-	Br6-17	10R3/2	J07
76CORD22	R	RRF	1	65	Gy6-3	N5.5/-	...	...	...	...	...	...	J08
76CHARG2	R	RFHB	132	40/19/19	Gy6-22	N5/-	Br6-13	10R3/2	Bk6-5	N2/-	...	...	J09
77VOLAR4	B	LFF	2	20	Bk6-11	...	...	...	...	...	...	...	J10
77NYORK1	C	RRF	22	17/21	Bk6-9	N2.5/-	Bk6-12	N2.5/-	...	...	...	...	K01

TABLE 3 (continued)—*Core data for Chrysler Corp.*[a]

SIN	AP	AOV	UCC	Color/ Chemical Descriptor Sequence	UC(1) Data		UC(2) Data		UC(3) Data		UC(4) Data		CBP
					CIR	Munsell Code [2]	CIR	Munsell Code	CIR	Munsell Code	CIR	Munsell Code	
77NYORK4	C	FHB	2	18	Gy6-10	'2/-	...	...	...	...	...	...	K02
77GFURY3	D	RFF	13	60/26	Gy6-25	N5.5/-	Br6-18	10R3/4	...	...	...	...	K03
77NPORT2	D	FHB	132	60/33/15	Gy6-25	N5.5/-	Br6-22	10R3/2	Bk6-9	N2.5/-	...	...	K04
77CORD14	R	LFF	113	66/40/16	Gy6-33	5GY5/1	Gy6-22	N5/-	Br6-13	10R3/2	...	...	K05
77CORD16	R	RD	11	67/68	Gy6-32	N6.5/-	Gy6-34	5GY5/1	...	...	...	...	K06
77CHARG6	R	RD	13	40/16	Gy6-22	N5/-	Br6-13	10R3/2	...	...	...	...	K07
77CHARG1	R	RFHB	132	40/16/22	Gy6-22	N5/-	Br6-13	10R3/2	Bk6-9	N2/-	...	...	K08
76CORD22	R	RRF	1	65	Gy6-3	N5.5/-	...	...	...	...	...	...	J08
76CHARG2	R	RFHB	132	40/19/19	Gy6-22	N5/-	Br6-13	10R3/2	Bk6-5	N2/-	...	...	J09
77VOLAR4	B	LFF	2	20	Bk6-11	...	...	...	...	...	...	...	J10
77NYORK1	C	RRF	22	17/21	Bk6-9	N2.5/-	Bk6-12	N2.5/-	...	...	...	...	K01
77NYORK4	C	FHB	2	18	Bk6-10	N2/-	...	...	...	...	...	...	K02
77GFURY3	D	RFF	13	60/26	Gy6-25	N5.5/-	Br6-18	10R3/4	...	...	...	...	K03
77NPORT2	D	FHB	132	60/33/15	Gy6-25	N5.5/-	Br6-22	10R3/2	Bk6-9	N2.5/-	...	...	K04
77CORD14	R	LFF	113	66/40/16	Gy6-33	5GY5/1	Gy6-22	N5/-	Br6-13	10R3/2	...	...	K05
77CORD16	R	RD	11	67/68	Gy6-32	N6.5/-	Gy6-34	5GY5/1	...	...	...	...	K06
77CHARG6	R	RD	13	40/16	Gy6-22	N5/-	Br6-13	10R3/2	...	...	...	...	K07
77CHARG1	R	RFHB	132	40/16/22	Gy6-22	N5/-	Br6-13	10R3/2	Bk6-9	N2/-	...	...	K08

[a]SIN = sample identification number, AP = assembly plant [*1*], AOV = area on vehicle, UCC = undercoat code, CIR = core infrared spectrum, CBP = core board position [*1*]; L = left, R = right or rear, F = fender or front, H = hood, T = trunk, D = door, EX = extension, and HB = header bar.

[b]This model has a fifth undercoat, core IR Br6-12 and Munsell Code 10R4/4.

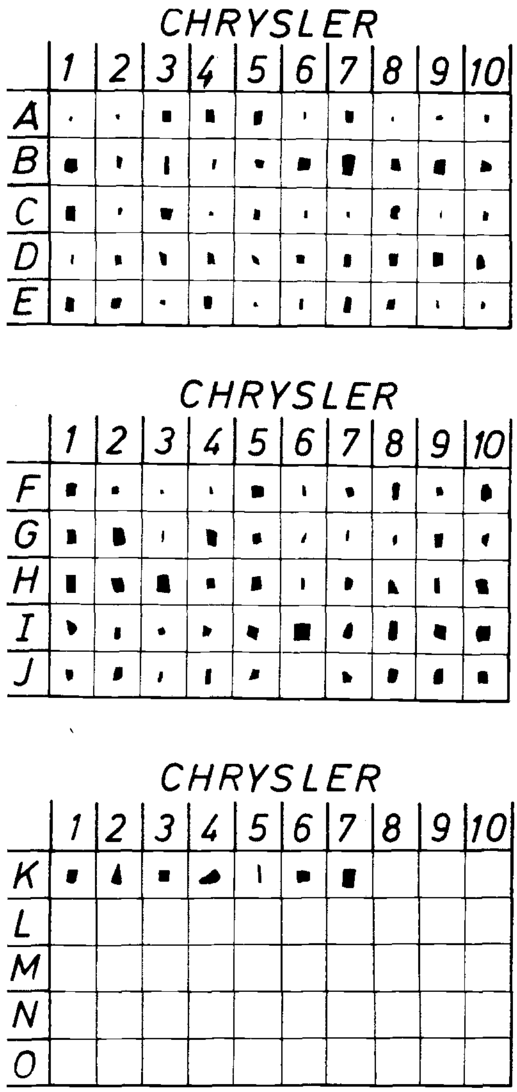


FIG. 4—*Chrysler Corp. core chip boards.*

spectrum. In general, wherever the IRs were different, the corresponding undercoat colors were different. In two circumstances, however, we observed colors that were indistinguishable except by IRs. (These anomalies occurred for the browns of the 62CROWN1 and the 64FURY4 and for the grays represented by the 71FURY7 and the 74 CORNT4, where the last digit indicates the sequential sample number.)

Our undercoat data (Table 3) indicates it would not be possible to distinguish between samples of the same chemistry but different colors with the aid of only the broad Munsell coordinates to describe color. Because other forensic science laboratories will not have copies of our authentic paint chips, a color/chemical descriptor coding system was developed to indicate the color differences with relationship to the chemistry. This was accomplished within each undercoat class (gray [Gy], black [Bk], brown [Br], and white [W]) by assigning a sequential number to every undercoat that possessed a different color or chemistry from other undercoats within the class. The individual color/chemical descriptors were strung together to obtain a sequential number that would individualize that particular undercoat sequence. The undercoat code in conjunction with the color/chemical descriptor sequence would then indicate the specific color sequence. For example, a SIN having an undercoat code of 13 would indicate the sample has a gray over brown layer sequence while the color/chemical descriptor sequence of 10/8 would denote the individual gray (10/) and brown (/8) layers. The grays in SINs 60FURY1 and 60WIND1, as outlined in Table 3, illustrate the color/chemical descriptor code system. These samples have different core IRs and significantly different Munsell coordinates. The color/chemical descriptors 1/ and 2/ indicate these differences.

The significance of the codes becomes apparent when 60WIND1 to 61VAL1 are compared, where the gray IRs are identical and the Munsell codes are the same. The 2/ for both samples indicates that the grays are the identical color. This would not have been ascertainable within the operating error limits of the Munsell coordinates. For the grays in the 65FURY12 and 68DART12 samples, the core IR and Munsell data would have indicated they had the same color and chemistry. However, the grays were different, whereas the browns and IRs were identical; the color/chemical descriptor sequences 9/8 and 19/8 indicate the grays were different while the browns were the same.

While examining the Chrysler undercoats we observed a phenomenon that was not seen for other manufacturers, and appears to be characteristic of Chrysler Corp. vehicles. In some circumstances, the bottom undercoat layer was predominantly brown with circles of gray interspersed throughout it. In other instances, the gray and brown layers were intermixed. We termed this a *mottling effect.* Wherever this mottling occurred we adopted the convention that the predominant color would define that layer; the interspersed layer was neglected for purposes of recording the data in Table 3.

In general, the assembly plants where slight gray mottling was occasionally observed were Lynch Road (1968 to 1970), Hamtramck (1971, 1974, and 1975), Detroit (1968 and 1971), Belvedere (1973 to 1975), and Windsor (1964, 1965, 1970, 1974, and 1976). However, mottling was more prevalent in Hamtramck and Belvedere in 1974 and 1975. In only one instance was it not possible to obtain a distinct separation of the mottled colors for an IR analysis. The brown layer (Br6-19) of the 74MON17 consists of both gray and brown.

Tables 4, 5, and 6 present the core IR data for the gray, brown, and black undercoats, respectively. Each table contains the core IR numbers, the coded chemical data [*1*] from the interpretation of the IR spectra (Figs. 5, 6, and 7), the SIN, the assembly plant code, and the range of model years. Immediately beneath these data all other plants and model years that could be represented by these particular core IR and SIN are listed. (This eliminates, to some extent, the necessity of reproducing all the other secondary undercoat samples that are equivalent to this core sample. In the computer these samples will be identified by their undercoat equivalency number.) The assembly plant and model years they represent are then given. By placing the color/chemical descriptor code next to the SIN within any particular core IR group, one can immediately determine which samples are identical in color and chemistry and which are distinguishable by color. For example, the grays from the 71DART1 and 69MON6 (Table 4, core IR Gy6-9) are identical in color and chemistry. They are, however, different in color from the 66SLITE6, 74MON13 and 75CORNT4.

Figures 5, 6, and 7 reproduce the core IR spectra corresponding to the data in Tables 4 to 6. Comparison between an unknown spectrum and these core IR spectra is essential. For example, from Table 4 the interpreted data from Gy6-1 and Gy6-13 indicate the same pigment constituents. However, the IR spectra clearly indicate differences in the talc between the samples. Subtle but reproducible differences can be seen in the Gy6-24 and Gy6-25 core IR spectra.

In the interpretation of the IR spectra, some difficulties arose concerning standard nomenclature. For instance, for the Bk6-9, Bk6-11, and Bk6-12 IR spectra, U.S. paint vendors classified the resin system as an epoxy acrylic, while Canadian vendors identified it as

TABLE 4—*Gray core infrared data.*

CIR[a]	Undercoat Chemical Data: Resin Descriptor	Undercoat Chemical Data: Pigment Descriptor	SIN	Color/ Chemical Descriptor	Assembly Plant	Years
Gy6-1	R3	1P2	60FURY1	1	E	1960-
	R8	1P17	...	...	...	...
	...	1P18	...	...	...	...
Gy6-2	R1	1P5	60WIND1	2	R	1960
	...	1P18	61VALI1	2	R	1961-1962
	...	...	62VALI2	3	B	1962-1964
Gy6-3	R1	1P2	62CROWN1	4	C	1962
	R8	1P17	...	...	...	...
	...	1P18	...	...	...	...
	...	1P21	...	...	...	...
Gy6-4	R1	1P2	63VALI5	5	E	1963
	R8	1P16	...	...	...	...
	...	1P18	...	...	...	...
Gy6-5	R1	1P5	63POLAR1	7	R	1963-1965
	R8	1P15	...	...	E	1965
	...	1P18	...	...	...	...
Gy6-6	R1	1P2	65FURY12	9	B	1965
	R8	1P17	...	...	F	1965
	...	1P18	...	...	R	1966
	...	...	67VALI13	15	B	1967
	...	...	68DART12	19	B	1968
Gy6-7	R3	1P2	66CORNT2	10	A	1966-1969
	R8	1P7	...	...	C	1965
	...	1P16	...	...	...	1967-1969
	...	1P17	...	...	D	1969
	...	1P18	...	...	E	1968-1969
	...	...	...	...	G	1966-1970
	...	...	66SLITE6	10	A	1966
	...	...	68CORNT4	10	A	1968
	...	...	69NYORK1	10	C	1969
Gy6-8	R7	1P2	65SAVOY2	11	R	1965
	...	1P16	66FURY18	13	B	1966
	...	1P19	66FURY8	14	R	1966
Gy6-9	R7	1P2	66SLITE6	12	A	1966
	...	1P17	69MON6	25	R	1969
	...	1P18	71DART1	25	B	1971
	...	...	74DART12	25	B	1974
	...	...	74MON13	50	D	1974
	...	...	75DART6	25	B	1975
	...	...	75DART15	25	B	1975
	...	...	75CORNT4	56	G	1975
Gy6-10	R7	1P2	67FURY6	16	R	1967-1968
	...	1P7	68FURY9	16	R	1967-1968
	...	1P16	...	...	...	...
	...	1P19	...	...	...	...
Gy6-11	R7	1P2	67FURY6	17	R	1967-1968
	...	1P8	...	...	...	...
	...	1P16	...	...	...	...
	...	1P19	...	...	...	...
	...	1P21	...	...	...	...
Gy6-12	R7	1P16	68CORNT3	18	A	1968
	...	1P18	...	...	...	...
Gy6-13	R7	1P2	68VALI6	20	R	1968
	...	1P17	69BCUDA3	21	B	1969-1970
	...	1P18	71CHALL3	21	B	1969
	...	...	71VALI1	21	B	1971-1973
						1971
	...	...	71DART2	20	R	1971

TABLE 4 (continued)—*Gray core infrared data.*

CIR[a]	Undercoat Chemical Data: Resin Descriptor	Undercoat Chemical Data: Pigment Descriptor	SIN	Color/ Chemical Descriptor	Assembly Plant	Years
	...	...	72NPORT3	37	C	1972
	...	...	72SLITE11	38	F	1972
	...	...	73DART4	21	B	1973
	...	...	73NPORT5	43	C	1973
	...	...	73FURY8	38	F	1973
Gy6-14	R3	1P2	69ROAD3	22	G	1969
	R8	1P15	70NPORT5	28	C	1970
	...	1P17	70ROAD4	31	R	1970
	...	1P18	71CORNT2	26	A	1970-1973
	...	...	71FURY7	29	D	1970-1972
	...	...	71POLAR11	29	D	1971
Gy6-15	R7	1P2	69POLAR8	23	R	1969
	...	1P7	70FURY14	32	R	1970
	...	1P16	70MON2	32	R	1970
	...	1P18	...	...	...	...
	...	1P20	...	...	...	...
Gy6-16	R7	1P1	69FURY2	16	R	1969
	...	1P17	73CHARG4	41	A	1973-1974
	...	1P18	...	...	D	1974
	...	...	...	...	F	1973
	...	...	73NYORK3	42	C	1973
	...	...	73FURY4	41	D	1973
	...	...	74SLITE2	41	A	1973-1974
	...	...	...	...	B	1973-1974
	...	...	...	...	D	1973-1974
	...	...	...	...	F	1974
	...	...	...	...	G	1974
	...	...	74CHALL6	41	B	1974
	...	...	74DART12	41	B	1974
	...	...	74MON13	41	D	1974
	...	...	74GRAN1	41	D	1974
	...	...	75GFURY15	41	D	1975
Gy6-17	R3	1P2	70SLITE6	27	A	1970
	R8	1P7	...	...	...	...
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
Gy6-18	R7	1P2	71DART1	30	B	1971
	...	1P15	71DART2	36	R	1971
	...	1P17	72SLITE3	36	R	1972
	...	1P18	73FURY5	30	C	1971-1973
	...	...	...	...	D	1970
	...	...	...	...	...	1972-1973
	...	...	75GFURY9	54	D	1975
Gy6-19	R7	1P2	70DART10	33	R	1970
	...	1P16	...	...	...	...
	...	1P18	...	...	...	...
Gy6-20	R7	1P2	70GTX3	34	R	1970
	...	1P12	...	...	...	...
	...	1P16	...	...	...	...
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
Gy6-21	R1	1P16	71POLAR11	35	D	1971
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
Gy6-22	R7	1P2	72SLITE10	40	R	1972-1973
	...	1P7	75CHARG6	40	R	1973-1976
	...	1P17	75CORD14	40	R	1975
	...	1P18	75CORD22	40	R	1975
	...	...	75VALI10	40	R	1975

TABLE 4 (continued)—*Gray core infrared data.*

CIR[a]	Undercoat Chemical Data Resin Descriptor	Pigment Descriptor	SIN	Color/ Chemical Descriptor	Assembly Plant	Years
	...	...	76CORD19	40	R	1976
	...	...	76CHARG2	40	R	1976
	...	...	77CORD14	40	R	1977
	...	...	77CHARG6	40	R	1977
	...	...	77CHARG1	40	R	1977
Gy6-23	R3[b]	1P1	74SLITE4	44	A	1974
	R8	1P17	74DART15	46	B	1974
	...	1P18	74NPORT2	48	C	1974
	...	...	75NPORT8	48	C	1975
	...	...	75NPORT1	48	C	1975
	...	...	76NYORK6	48	C	1976
Gy6-24	R3[b]	1P2	75DART6	45	B	1975
	R8	1P17	75VALI5	45	B	1974–1975
	...	1P18	...	45	A	1975
	...	...	75CORD14	57	R	1975
	...	...	76GFURY2	61	D	1976
Gy6-25	R3[b]	1P2	74NPORT1	47	C	1974
	R8	1P17	...	...	D	1975
	...	1P18	75MON10	47	D	1975
	...	...	75DART5	55	G	1975
	...	...	76CORD19	64	R	1976
	...	...	77GFURY3	60	D	1977
	...	...	...	...	C	1976
	...	...	77NPORT2	60	D	1976–1977
Gy6-26	R7	1P2	74MON17	49	D	1974
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
	...	1P21	...	...	...	...
Gy6-27	R3	1P2	74FURY13	51	D	1974
	R8	1P16	...	...	...	...
	...	1P21	...	...	...	...
Gy6-28	R3[b]	1P2	75DART9	52	B	1975
	R8	1P17	76GFURY12	62	D	1976
	...	1P18	...	...	...	...
	...	1P21	...	...	...	...
Gy6-29	R7	1P2	75NPORT8	53	C	1975
	...	1P16	...	...	...	...
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
Gy6-30	R7	1P2	75VALI10	58	R	1975
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
Gy6-31	R7	1P2	76CORD22	65	R	1976
	...	1P16	...	...	...	...
	...	1P18	...	...	...	...
Gy6-32	R1[c]	1P2	77CORD16	67	R	1977
	...	1P16	...	...	...	...
Gy6-33	R7	1P2	77CORD14	66	R	1977
	...	1P8	...	...	...	...
	...	1P16	...	...	...	...
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
	...	1P21	...	...	...	...
Gy6-34	R3[c]	1P1	77CORD16	68	R	1977
	R8	1P16	...	...	...	...

[a]CIR = core infrared spectrum number.
[b]Modifier descriptor M1 (styrene).
[c]Modifier descriptor M4 (benzoguanamine formaldehyde).

TABLE 5—*Brown core infrared data.*

	Undercoat Chemical Data					
CIR[a]	Resin Descriptor	Pigment Descriptor	SIN	Color/ Chemical Descriptor	Assembly Plant	Years
Br6-1	R1	1P3	60WIND1	2	R	1960
	...	1P12	...	...	...	...
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
Br6-2	R7	1P3	61VALI1	3	R	1961-1962
	...	1P15	63POLAR1	3	R	1963-1965
	...	1P17	...	...	E	1965
	...	1P18	65SAVOY2	3	R	1965
Br6-3	R1	1P3	62VALI2	4	B	1962-1964
	...	1P7	...	...	...	...
	...	1P18	...	...	...	...
	...	1P21	...	...	...	...
Br6-4	R1	1P3	62CROWN1	5	C	1962
	R8	1P8	...	...	...	...
	...	1P15	...	...	...	...
	...	1P18	...	...	...	...
	...	1P21	...	...	...	...
Br6-5	R1	1P5	63VALI1	6	E	1963
	R8	1P7	...	...	...	...
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
Br6-6	R1	1P3	64FURY4	7	A	1964
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
Br6-7	R1	1P3	65FURY12	8	B	1965
	R8	1P8	...	...	F	1965
	...	1P17	...	...	R	1966
	...	1P18	67VALI3	8	B	1967
	...	1P21	68DART12	8	B	1968
Br6-8	R3	1P3	66CORNT2	9	A	1966-1969
	R8	1P7	...	...	C	1965
	...	1P17	...	...	...	1967-1969
	...	1P18	...	...	D	1969
	...	...	...	...	E	1968-1969
	...	...	...	...	G	1966-1970
	...	...	66SLITE6	9	A	1966
	...	...	68CORNT4	9	A	1968
	...	...	69NYORK1	9	C	1969
	...	...	70SLITE6	9	A	1970
Br6-9	R7	1P3	66FURY18	10	B	1966
	...	1P8	66FURY8	10	R	1966
	...	1P12	67FURY6	10	R	1967-1968
	...	1P15	68FURY9	10	R	1967-1968
	...	1P17	69POLAR8	10	R	1969
	...	1P18	70FURY14	10	R	1970
	...	...	70MON2	10	R	1970
Br6-10	R7	1P3	68VALI6	12	R	1968
	...	1P8	77DART2	12	R	1971
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
Br6-11	R7	1P3	69BCUDA3	...	B	1969-1970
	...	1P8	73FURY8	23	F	1973
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
	...	1P21	...	...	...	...
Br6-12	R7	1P3	69ROAD3	15	G	1969
	...	1P17	70SLITE6	18	A	1970

TABLE 5 (continued)—*Brown core infrared data.*

	Undercoat Chemical Data					
CIR[a]	Resin Descriptor	Pigment Descriptor	SIN	Color/ Chemical Descriptor	Assembly Plant	Years
	...	1P18	70NPORT5	18	C	1970
	...	...	70ROAD4	18	R	1970
	...	...	71CORNT2	18	A	1970–1973
	...	...	71CHALL3	14	B	1969 1971–1973
	...	...	71DART1	14	B	1971
	...	...	71FURY7	18	D	1970–1972
	...	...	71POLAR11	18	D	1971
	...	...	71DART1	18	R	1971
	...	...	72NPORT3	21	C	1972
	...	...	73FURY5	18	C	1971–1973
	...	...	73NYORK3	18	C	1973
	...	...	73NPORT5	21	C	1973
	...	...	73FURY5	18	D	1970 1972–1973
	...	...	73FURY4	18	D	1973
	...	...	74CHALL6	25	B	1974
	...	...	74T&C1	25	D	1974
Br6-13	R7	1P3	69FURY12	16	R	1969
	...	1P8	70GTX3	19	R	1970–1971
	...	1P12	72SLITE3	19	R	1972
	...	1P15	72SLITE10	19	R	1972–1973
	...	1P17	75CHARG6	19	R	1973–1976
	...	1P18	75CORD14	19	R	1975
	...	1P21	75CORD22	19	R	1975
	...	...	75VALI10	19	R	1975
	...	...	76CHARG2	19	R	1976
	...	...	77CORD14	16	R	1977
	...	...	77CHARG6	16	R	1977
	...	...	77CHARG1	16	R	1977
Br6-14	R7	1P3	69MON6	17	R	1969
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
	...	1P21	...	...	...	...
Br6-15	R3	1P3	71VALI1	20	B	1971
	R8	1P8	...	...	...	...
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
	...	1P21	...	...	...	...
Br6-16	R7	1P3	72SLITE11	22	F	1972
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
	...	1P21	...	...	...	...
Br6-17	R3[b]	1P3	74SLITE4	24	A	1974
	R8	1P17	74DART15	24	B	1974
	...	1P18	74NPORT1	24	C	1974
	...	...	...	...	D	1975
	...	...	75VALI5	24	B	1974–1975
	...	...	...	...	A	1974
	...	...	75DART6	24	B	1975
	...	...	75NPORT8	24	C	1975
	...	...	75NPORT1	24	C	1975
	...	...	75GFURY15	28	D	1975
	...	...	75CORNT4	29	G	1975
	...	...	75DART5	24	G	1975
	...	...	75FURY6	29	G	1975
	...	...	75CORD14	29	R	1975

TABLE 5 (continued)—*Brown core infrared data.*[a]

	Undercoat Chemical Data					
CIR[a]	Resin Descriptor	Pigment Descriptor	SIN	Color/ Chemical Descriptor	Assembly Plant	Years
	...	...	76CHARG11	29	A	1976
	...	...	76NPORT3	32	C	1976
	...	...	76NPORT1	32	C	1976
	...	...	76CORD19	29	R	1976
Br6-18	R3[b]	1P3	74NPORT2	26	C	1974
	R8	1P17	76NYORK6	26	C	1976
	...	1P18	76GFURY2	26	D	1976
	...	1P21	77FURY3	26	D	1977
					C	1976
Br6-19	R7	1P17	74MON17	27	D	1974
	...	1P18	...	...	...	...
	...	1P21	...	...	...	...
Br6-20	R3	1P16	76CORNT5	30	A	1976
	R8	...	...	...	...	...
Br6-21	R3[c]	1P3	76FURY2	31	A	1976
	...	1P8	...	...	...	...
	...	1P15	...	...	...	...
	...	1P18	...	...	...	...
Br6-22	R3[b]	1P3	77NPORT2	33	D	1976–1977
	R8	1P17	...	...	...	...
	...	1P18	...	...	...	...
Br6-23	R7	1P3	76CORD19	34	R	1976
	...	1P8	...	...	...	...
	...	1P17	...	...	...	...
	...	1P18	...	...	...	...
Br6-24	R7	1P3	68CORNT3	11	A	1968
	...	1P16	...	...	...	...
	...	1P18	...	...	...	...

[a]CIR = core infrared spectrum number.
[b]Modifier descriptor M1 (styrene).
[c]Modifier descriptor M2 (melamine).

an epoxy ester. To avoid confusion, we adopted the convention that if the percent transmittance value of the 1730 cm^{-1} carbonyl peak was less than or equal to that for the 1510 cm^{-1} epoxy peak, the resin system was defined as an epoxy ester. Where the carbonyl peak was greater than the epoxy peak, the resin system was defined as an epoxy acrylic, unless the carbonyl ester stretching band indicated the ester modification was an alkyd (1270 cm^{-1}) type.

To avoid problems arising in the positive identification of pigment constituents, we identified only those that were well resolved. In some instances, zinc oxide and titanium dioxide may be present; however, other pigment constituents such as china clay interfere in the positive identification of these components. Difficulties also arose in the interpretations where there was an indication of orthophosphate or chromate. In those circumstances only the anion was identified. For instance, the 74MON17 (Gy6-26 and Br6-19), 75DART9 (Gy6-28), and the 75CORD22 (Bk6-7) spectra all contain strong orthophosphate peaks, but from the IR spectra it is hard to confirm whether it is zinc orthophosphate or another orthophosphate. The exact chemical nature of the chromate present in 66FURY18 (Br6-9) and 76FURY2 (Br6-21) provides a similar example. However, the chromate in Br6-21 is probably strontium chromate. In the case of the 67FURY6 (Gy6-11) and 77CORD14 (Gy6-33) samples it is difficult to understand why an undercoat next to the topcoat contains orthophosphate and chromate. In addition, it is impossible to determine from these core IR whether zinc

TABLE 6—*Black core infrared data.*

CIR[a]	Undercoat Chemical Data: Resin Descriptor	Undercoat Chemical Data: Pigment Descriptor	SIN	Color/ Chemical Descriptor	Assembly Plant	Years
Bk6-1	R3[b]	1P17	68DART8	1	B	1968
	R8	1P18	76FURY8	14	A	1976
	...	1P21	...	...	...	...
Bk6-2	R7[b]	1P17	70DART4	3	R	1970
	...	1P18	75DART15	9	B	1975
	...	...	75VALI3	19	B	1975
	...	...	75CORNT4	11	G	1975
	...	...	75FURY6	11	G	1975
Bk6-3	R3	1P15	70DART10	4	R	1970
	...	1P16	...	...	...	...
	...	1P18	...	...	...	...
Bk6-4	R7	1P17	73DART4	6	B	1973
	...	1P18	74SLITE2	6	A	1973-1974
	...	1P21	...	6	B	1973-1974
	...	...	...	6	D	1973-1974
	...	...	...	6	F	1974
	...	...	...	6	G	1974
	...	...	75GFURY9	10	D	1975
Bk6-5	R7	1P17	73CHARG4	7	A	1973
	...	1P18	...	...	D	1974
	...	...	...	...	F	1973
	...	...	73FURY4	7	D	1973
	...	...	74CHALL6	7	B	1974
	...	...	74DART12	7	B	1974
	...	...	74MON13	7	D	1974
	...	...	76CHARG2	19	R	1976
Bk6-6	R1	1P2	74FURY13	8	D	1974
	...	1P13	...	...	...	...
Bk6-7	R7	1P17	75CORD22	12	R	1975
	...	1P18	...	...	...	...
	...	1P21	...	...	...	...
Bk6-8	R3[b]	1P21	76CORNT5	13	R	1976
	R8	...	...	...	...	...
Bk6-9	R3[b]	1P2	76CHARG11	15	A	1976
	R8	1P17	76FURY1	16	A	1976
	...	1P18	...	15	A	1976
	...	...	76VOLAR4	15	B	1976-1977
	...	...	...	...	A	1977
	...	...	76NYORK3	17	C	1976-1977
	...	...	...	...	F	1976-1977
	...	...	...	...	G	1976
	...	...	76NPORT1	17	C	1976
	...	...	77NYORK1	17	C	1977
	...	...	77NPORT2	15	D	1976-1977
	...	...	77CHARG1	22	R	1977
Bk6-10	R3[b]	1P17	76NYORK6	18	C	1976
	R8	1P18	77NYORK4	18	C	1977
Bk6-11	R3[b]	1P2	77VOLAR4	20	B	1977
	R8	1P17	...	...	A	1977
	...	1P18	...	...	...	...
	...	1P21	...	...	...	...
Bk6-12	R3[b]	1P2	77NYORK1	21	C	1977
	R8	1P17	...	...	...	...
	...	1P18	...	...	...	...
	...	1P21	...	...	...	...

[a]CIR = core infrared spectrum number.
[b]Modifier descriptor M1 (styrene).

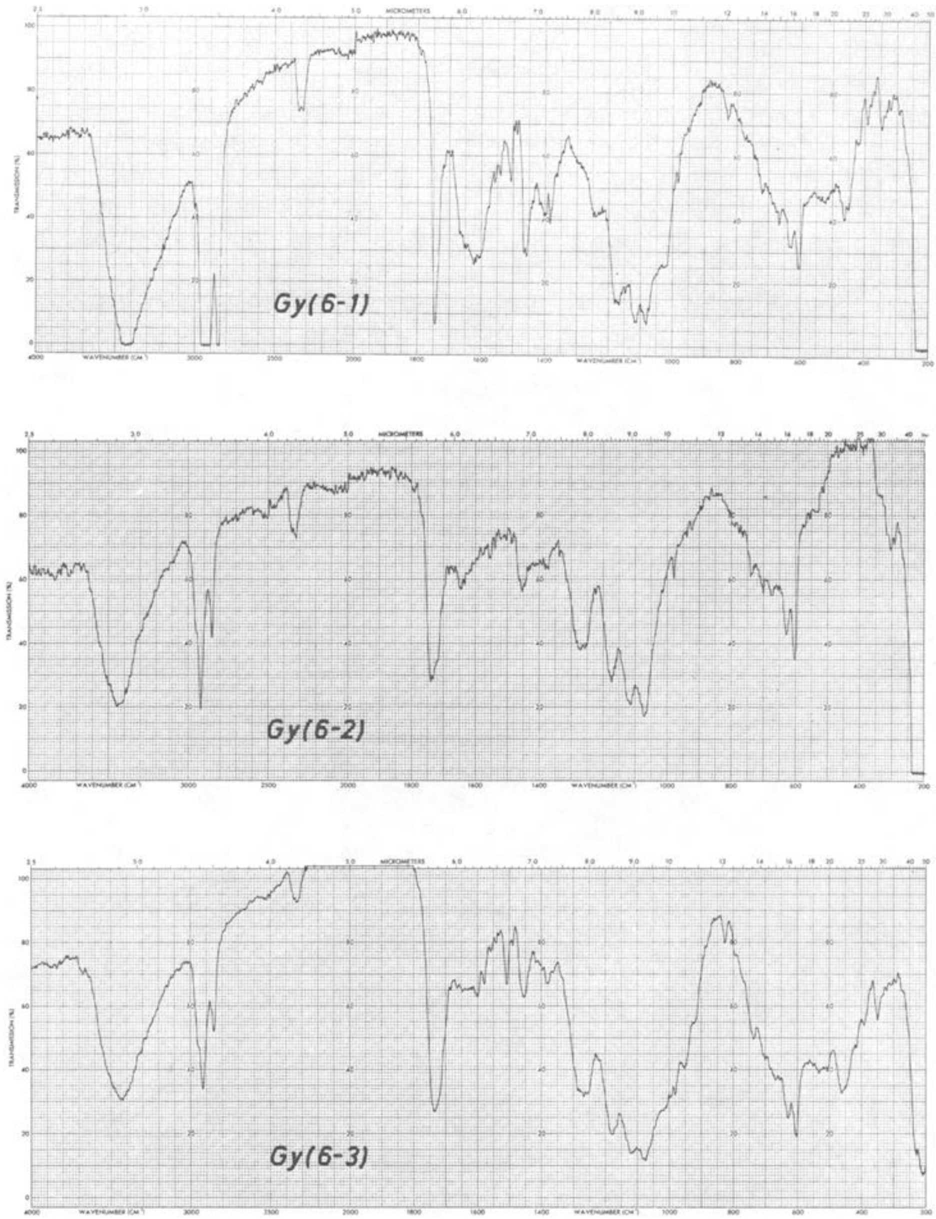


FIG. 5—*Gray core infrared spectra.*

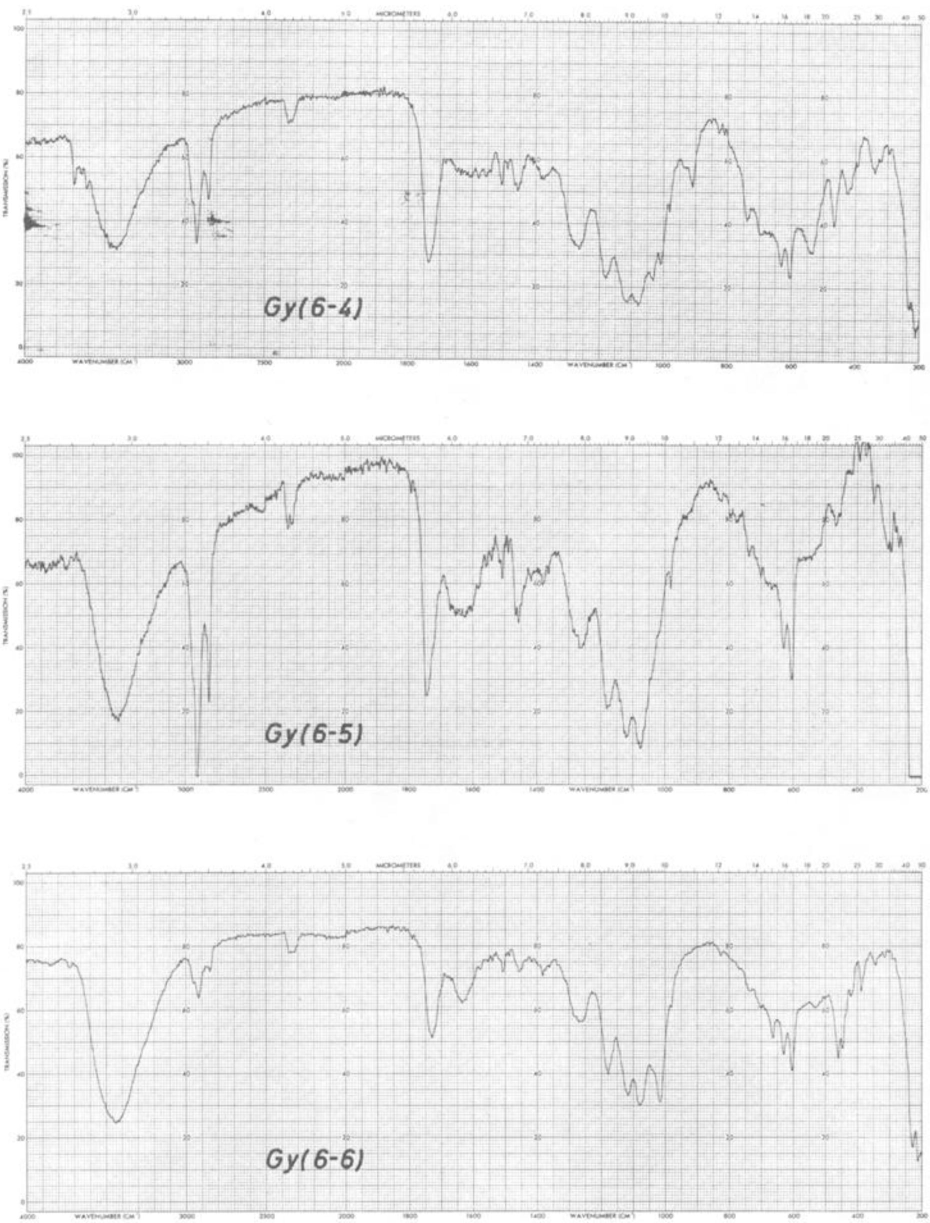


FIG. 5—*continued.*

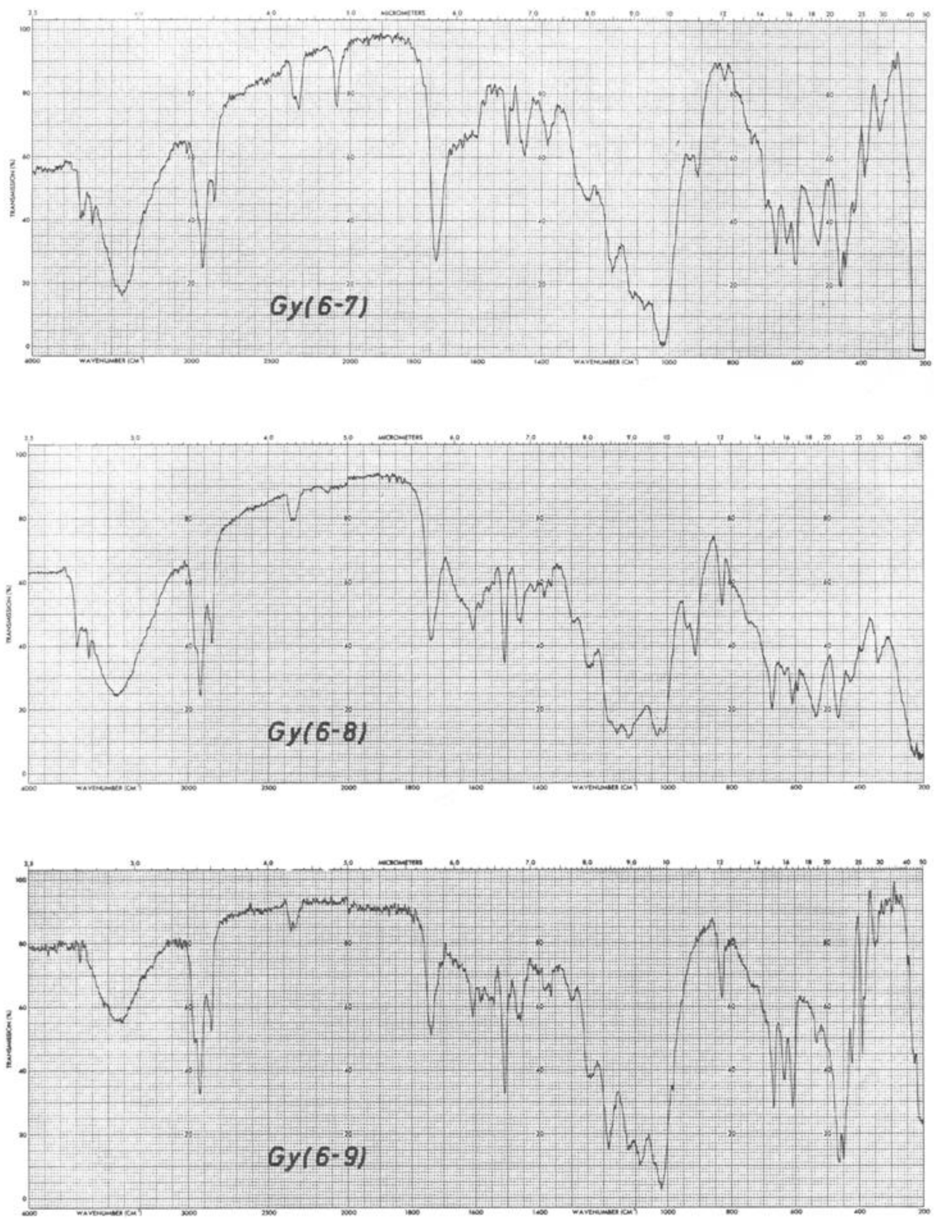


FIG. 5—*continued.*

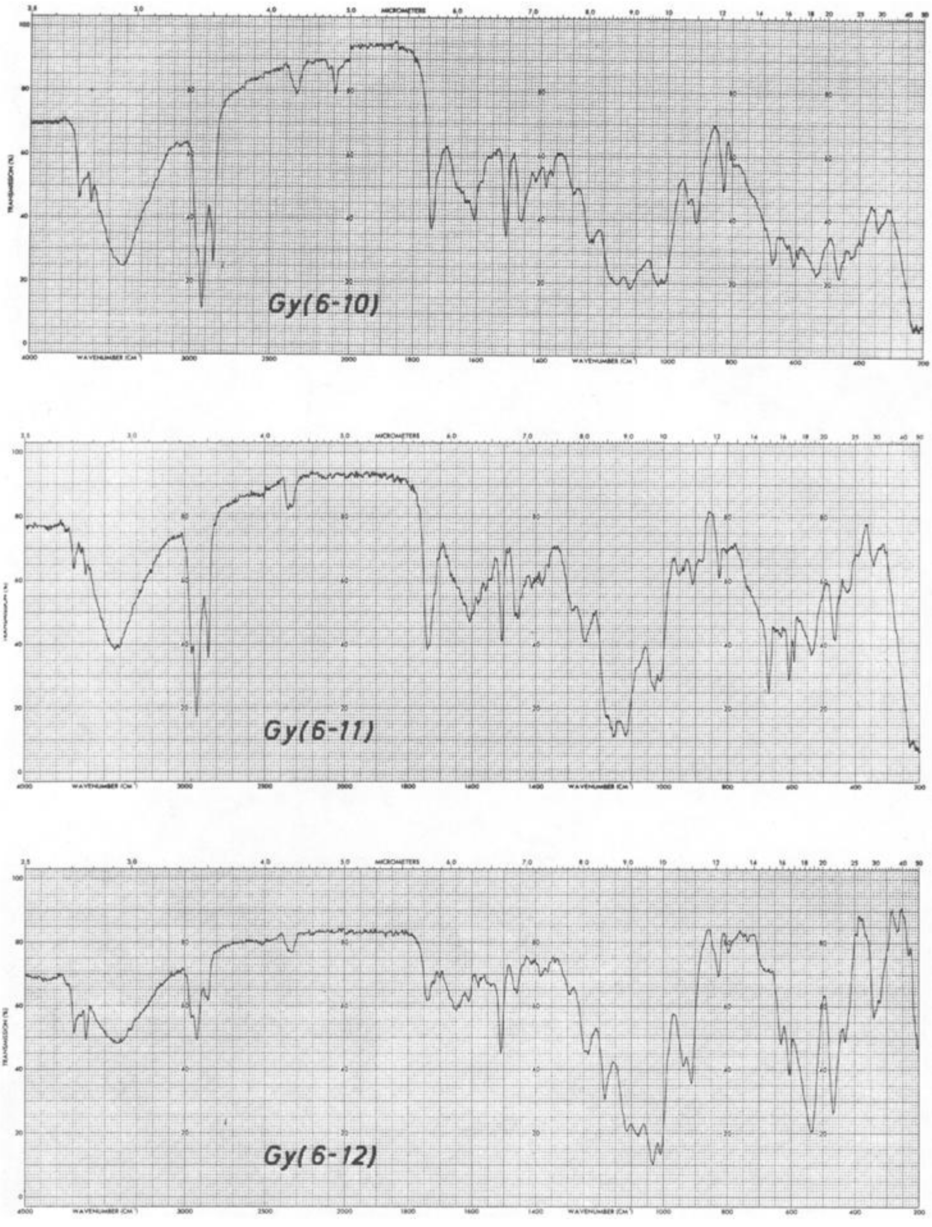


FIG. 5—*continued.*

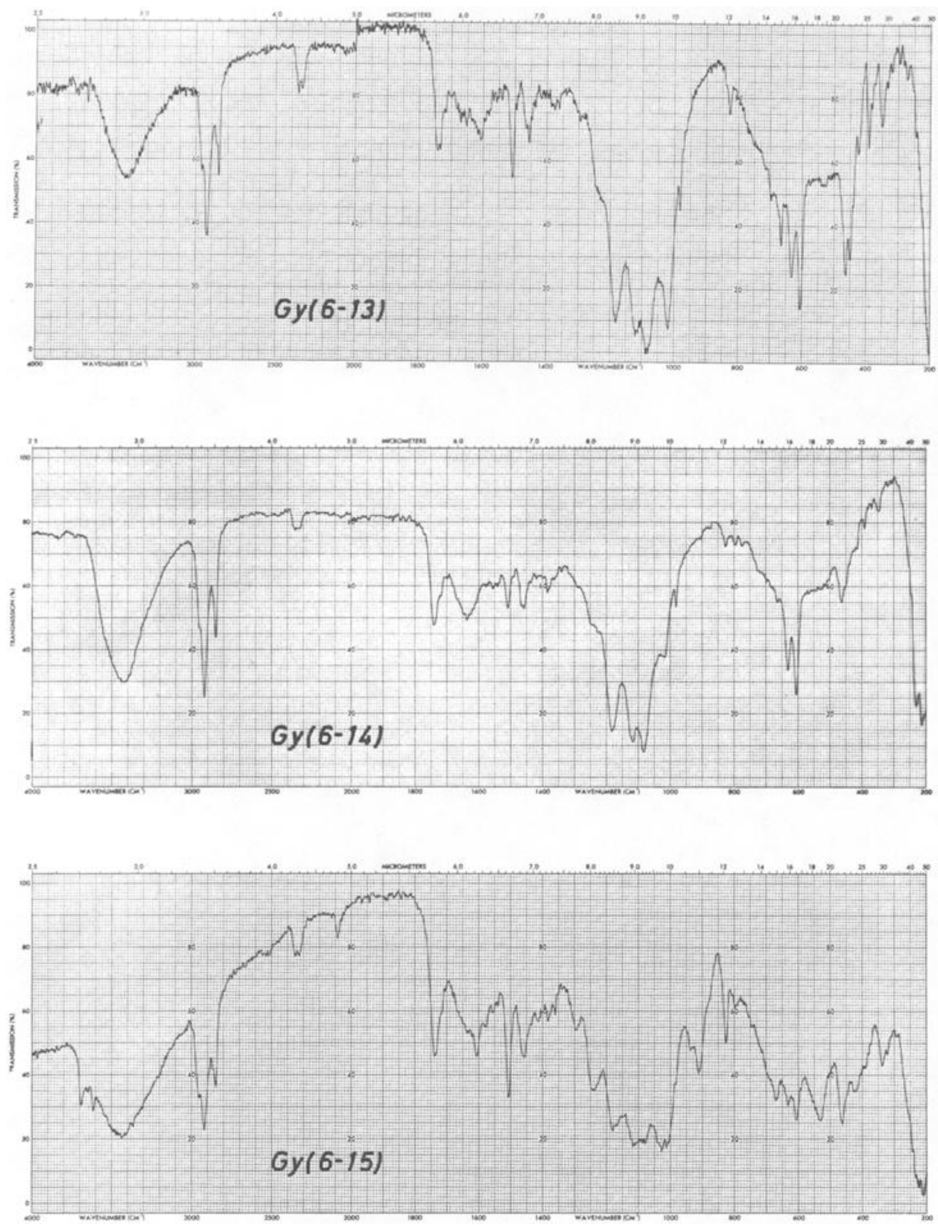


FIG. 5—*continued.*

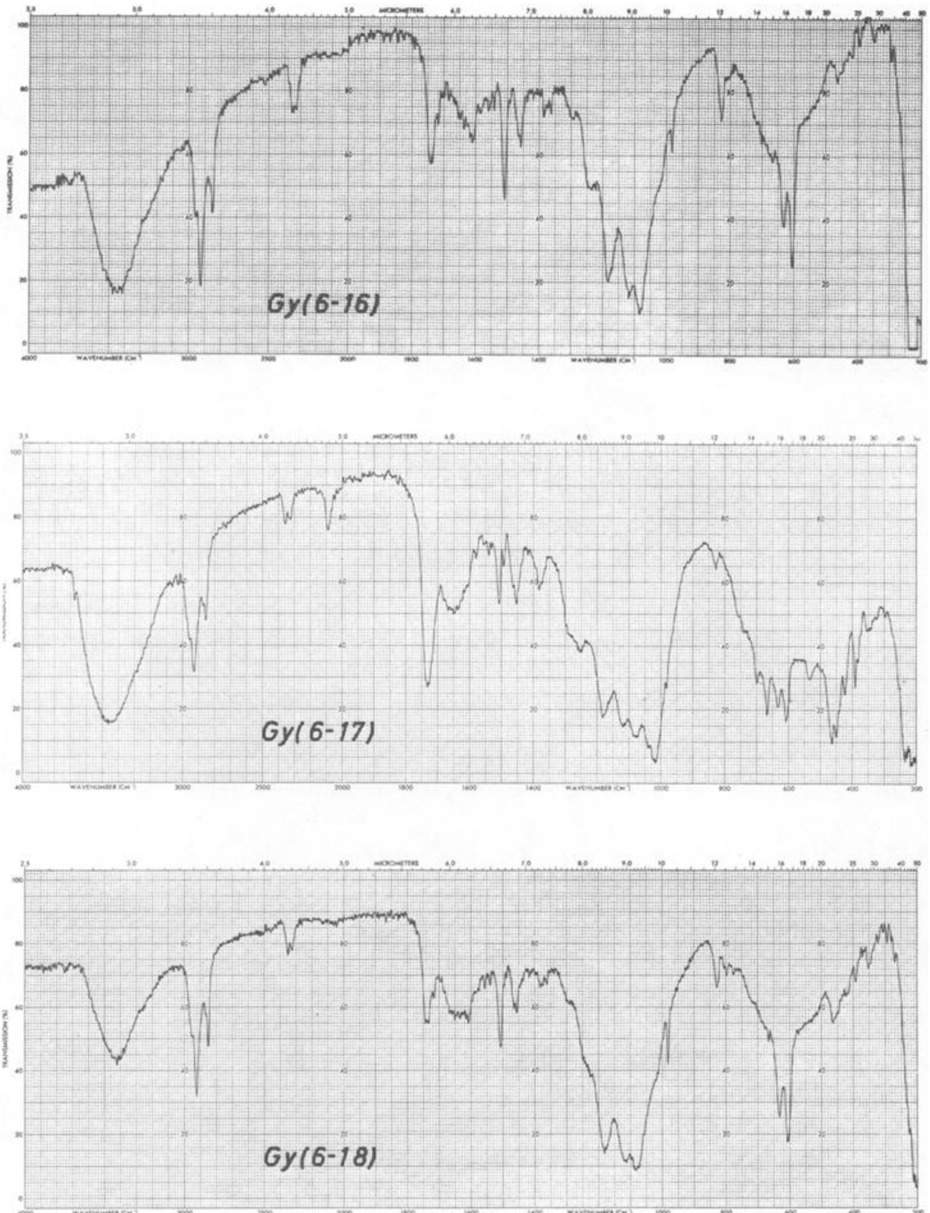


FIG. 5—*continued.*

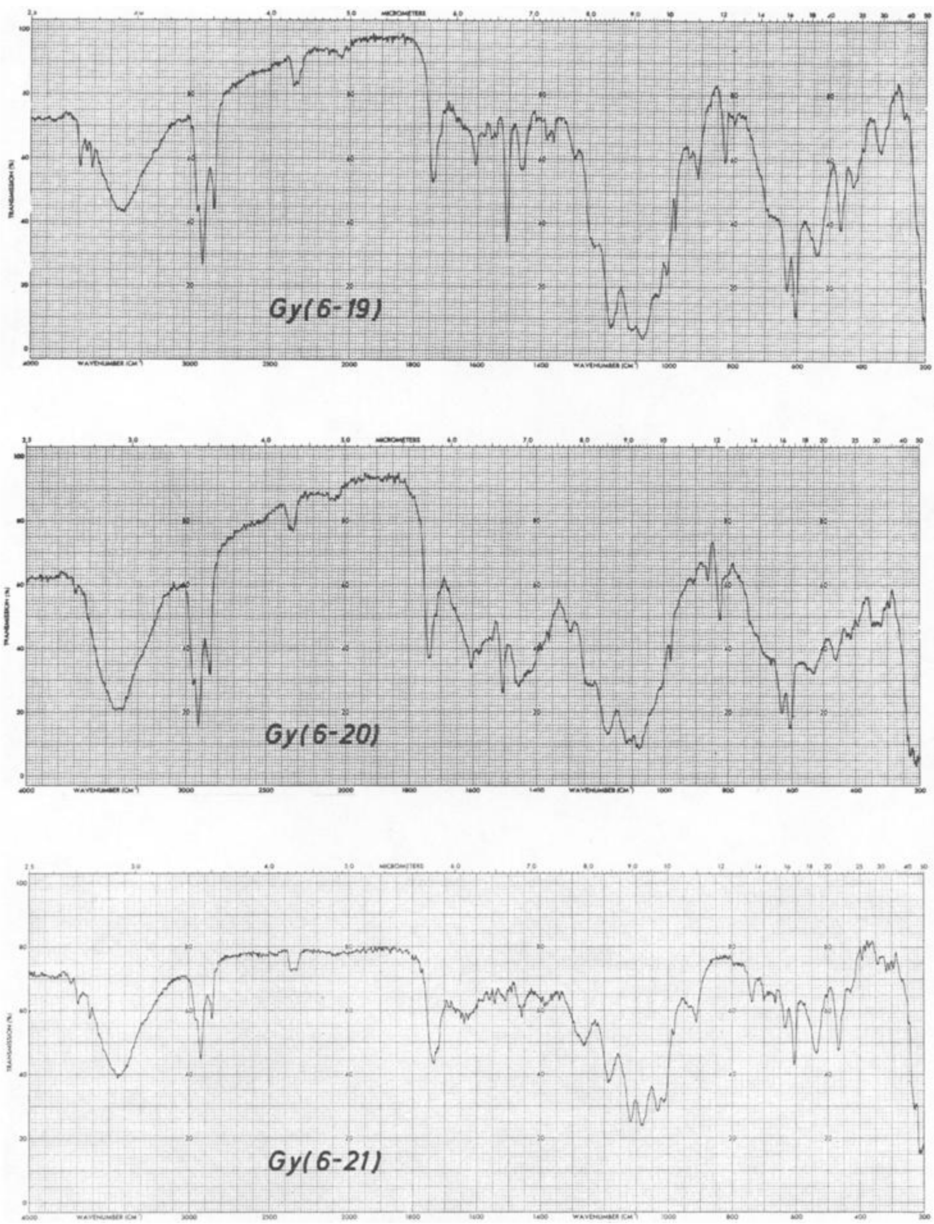


FIG. 5—*continued.*

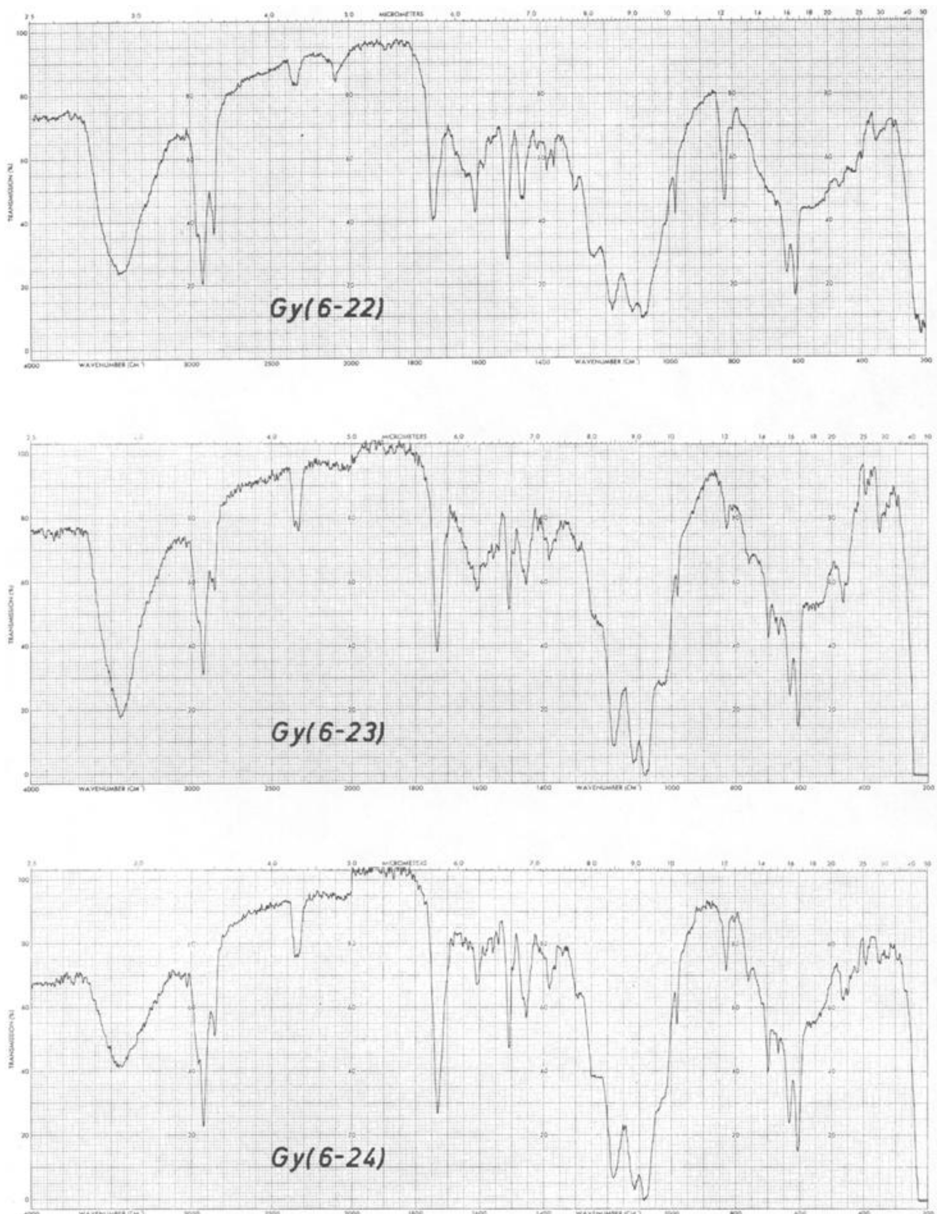


FIG. 5—*continued.*

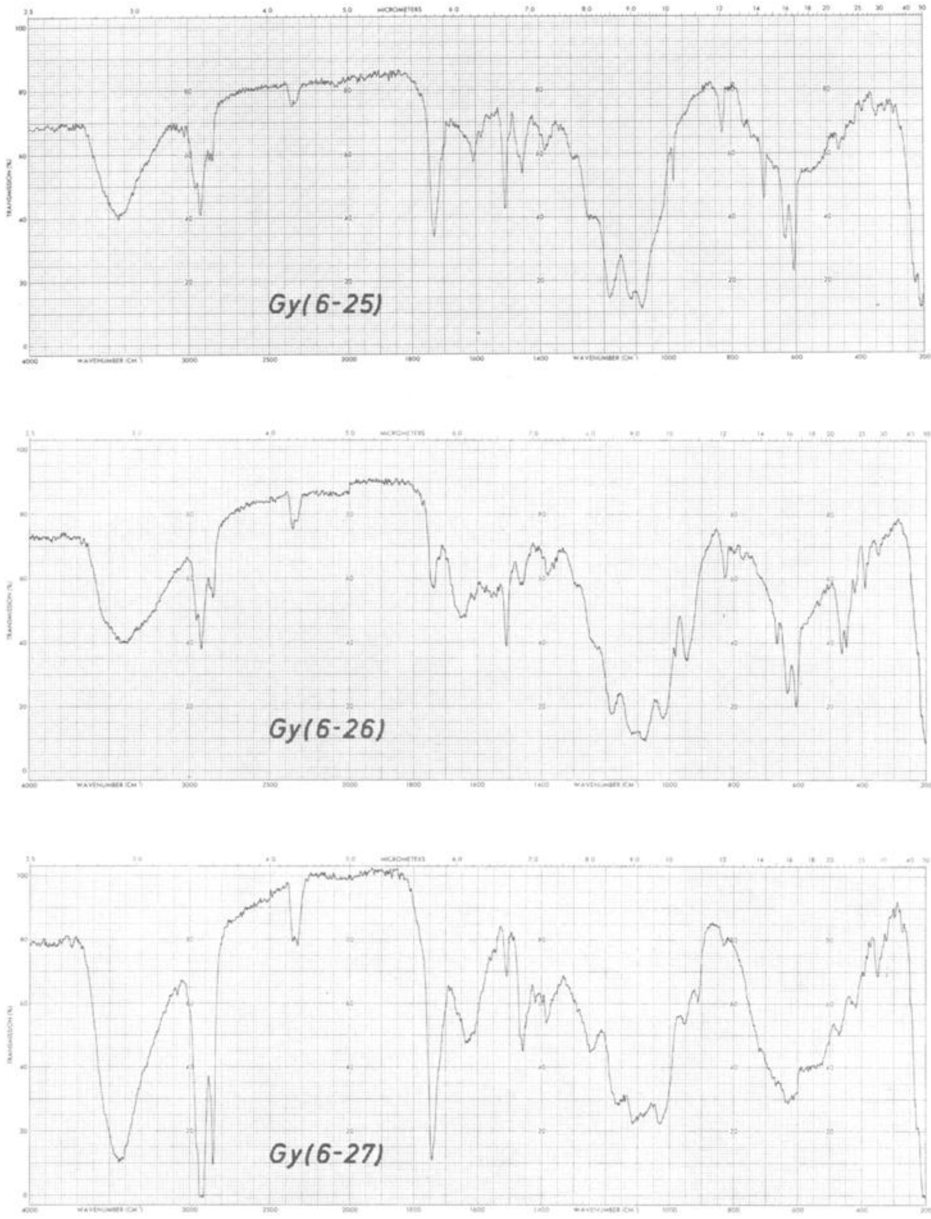


FIG. 5—*continued.*

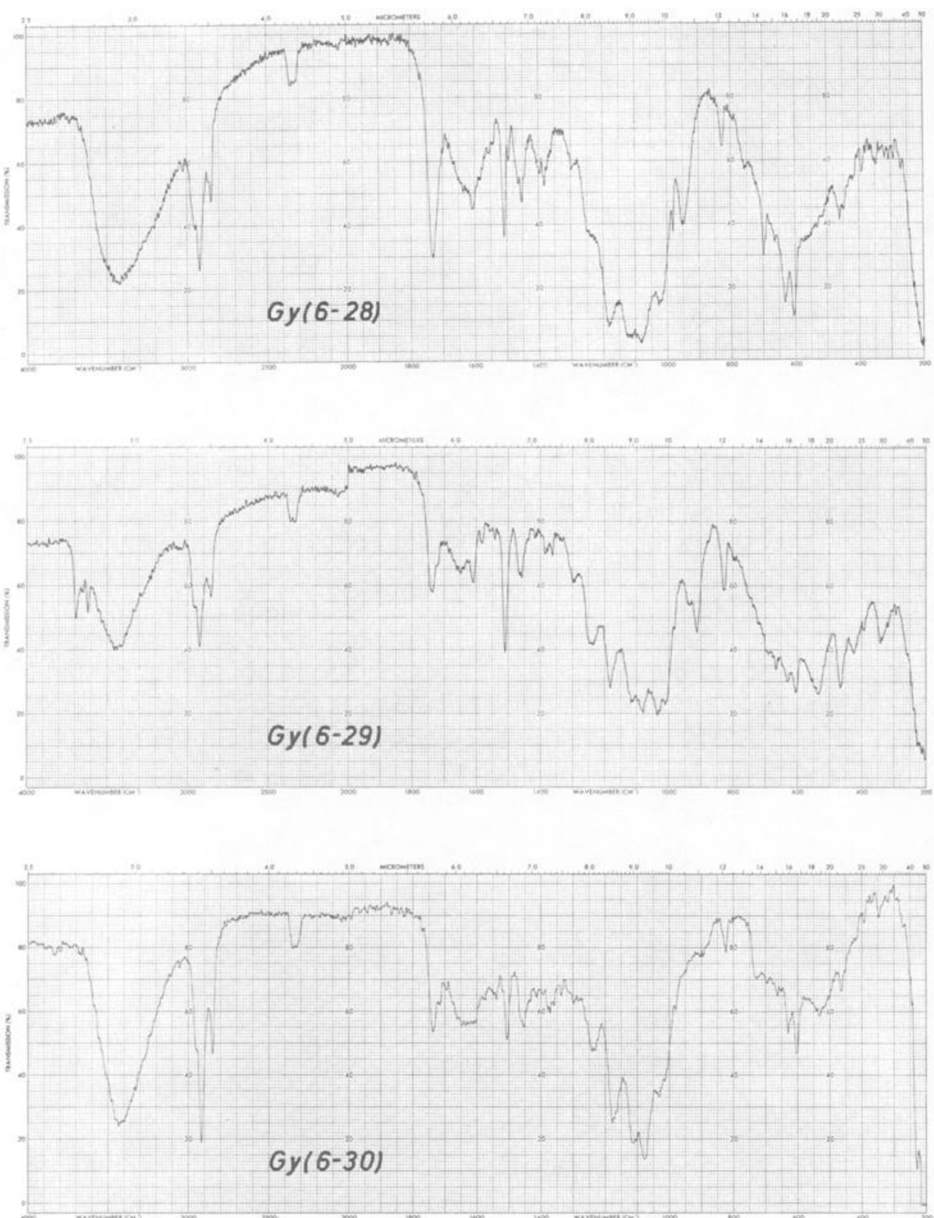


FIG. 5—*continued.*

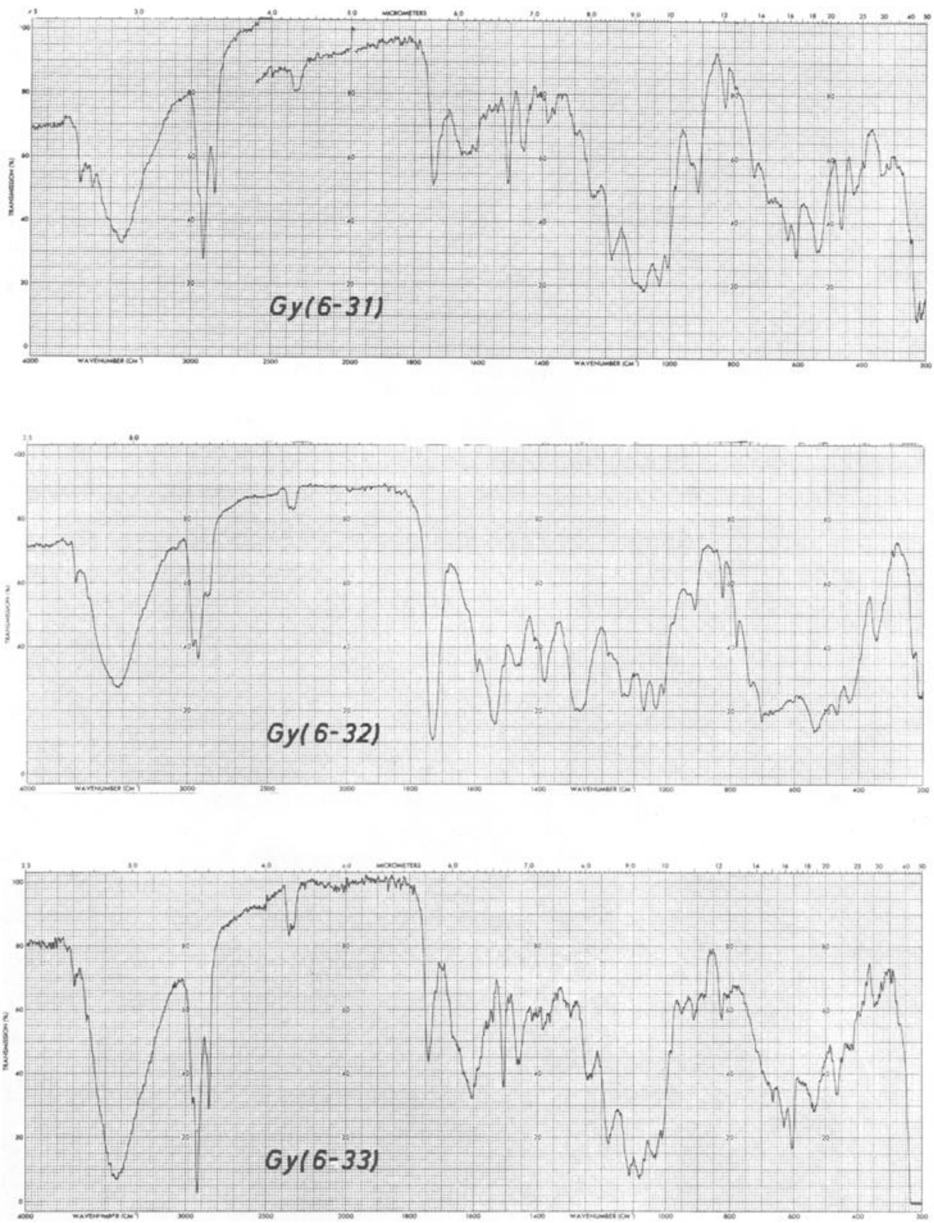


FIG. 5—*continued.*

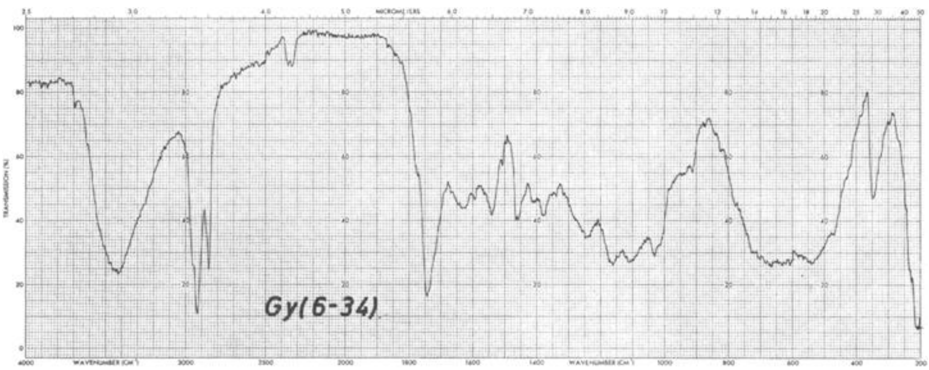


FIG. 5—*continued.*

chromate and not orthophosphate is present. Elemental analysis and X-ray diffraction data will be necessary to completely individualize all pigment components.

Judging from the analysis of the topcoat IRs, alkyd melamine formaldehyde formulations were employed in the U.S. assembly plants until 1964 and in the Canadian plant until 1965. In the 1965 production year, the U.S. plants converted to acrylic melamine formaldehyde formulations, with the exception of the Detroit and Los Angeles plants, which appeared to convert in 1969 and 1966, respectively. Although our data are limited, they indicate that the Hamtramck (1965 to 1967), Newark (1965 to 1966), and St. Louis (1965 to 1966) plants used straight acrylic melamine formaldehyde formulations, while Lynch Road and Windsor used a styrene-modified formulation on conversion from alkyds to acrylics. All assembly plants converted to the styrene-modified fomulations in 1969 and styrene-modified nonaqueous dispersion acrylic melamine formaldehyde formulations in 1973. Acrylonitrile-modified formulations were observed in all plants in 1974 and 1975 and as early as 1973 in Lynch Road. However, analysis of a greater number of topcoats would have to be conducted before a definite correlation between the color and the presence of acrylonitrile could be made.

We have found it useful to produce a series of flow charts of the color and chemical information contained in Table 3. Figure 8 is a flow chart of the undercoat systems we consider to be the "normal" (most frequently observed) systems used on Chrysler Corp. passenger vehicles. This chart identifies the model years and assembly plants where a particular undercoat sequence was observed. The undercoat sequences indicated in Fig. 8 consist of the color/chemical descriptor codes with the corresponding undercoat codes within the brackets. The bold border lines outline the range that particular sequence was employed on, while the blank squares within the lighter borders indicate we have no undercoat information. One can quite rapidly determine some general undercoat trends. For example, at the Windsor plant from 1966 to 1969, the brown undercoats (/10) in these four years were identical, while the trend in the change of the grays (14/, 16/, and 23/) is quite evident.

Figure 8 does not contain all the pertinent undercoat data. A similar flow chart containing all the color/chemical descriptor sequences should be constructed from, and used in conjunction with, the data in Tables 3 to 6. We have found our flow chart to be useful. For example, it can readily be determined from the flow charts that the first black undercoat on a Chrysler product was observed in 1968 out of the Hamtramck plant. This cannot be determined from Fig. 8.

The paint sequences on the header bars can also indicate trends. All the samples from header bars contained the undercoat sequence on top of the fiberglass. Not only were the fiberglass substrate colors different, the undercoat sequences also varied substantially. The sequences on 70MON2 and 74T&C1, for instance, showed no resemblance to the normal

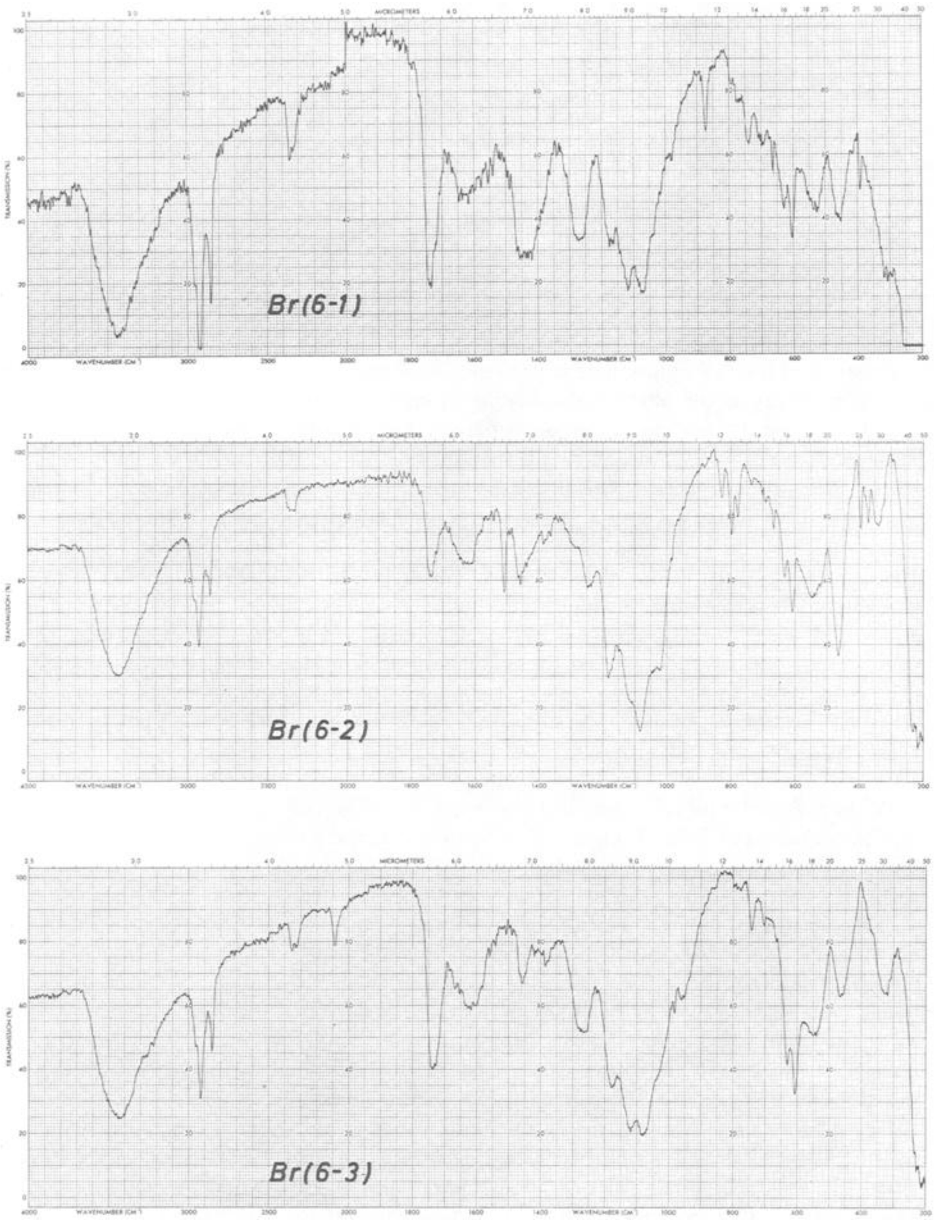


FIG. 6—*Brown core infrared spectra.*

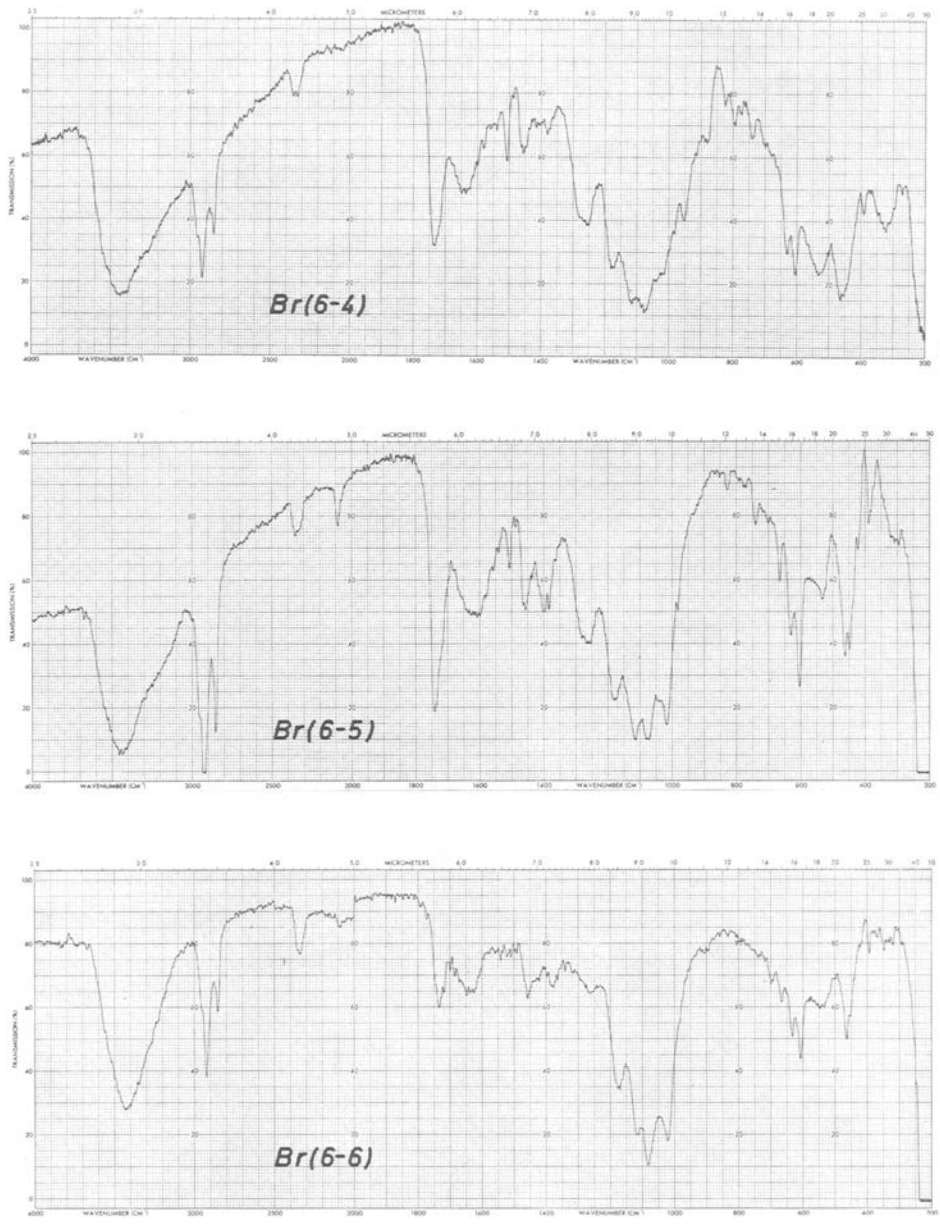


FIG. 6—*continued.*

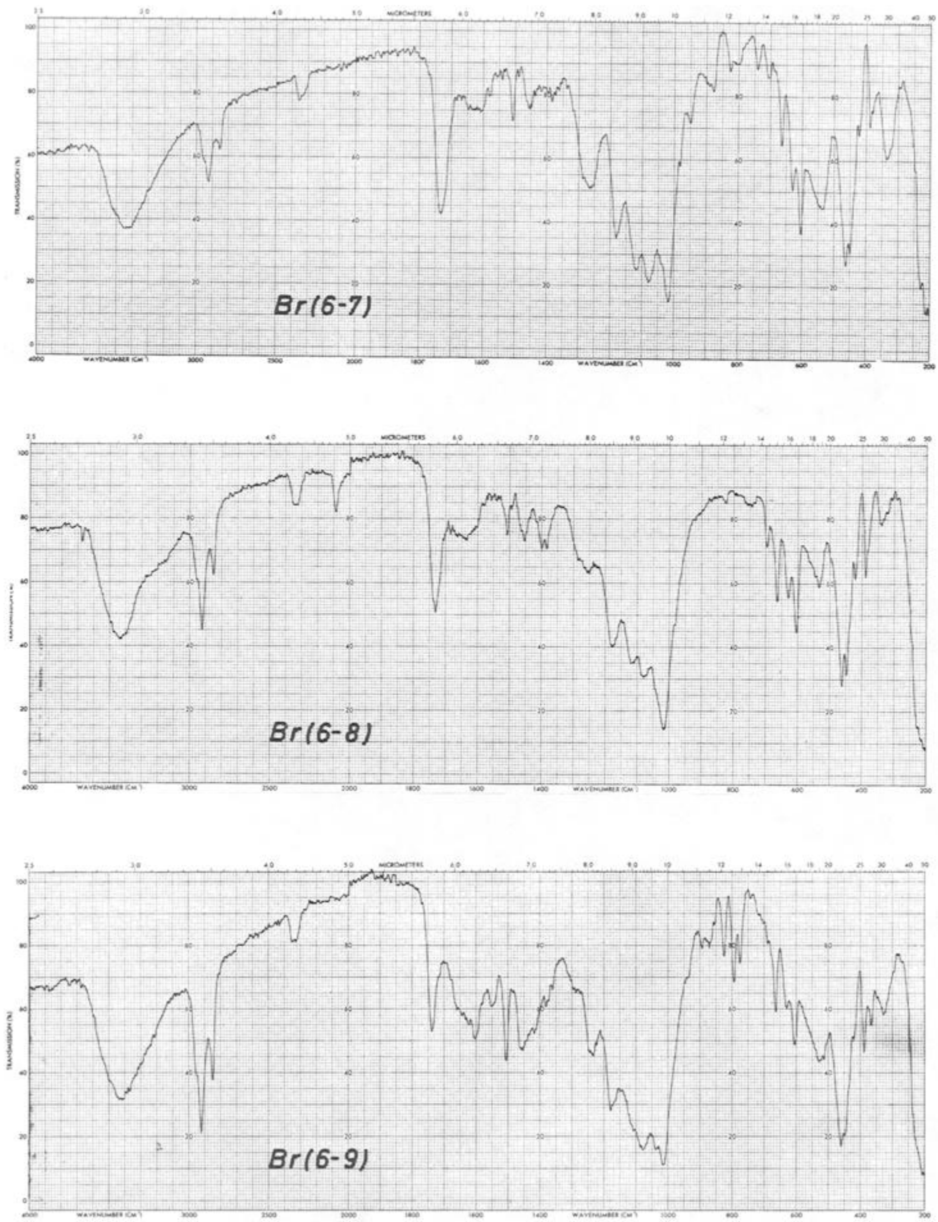


FIG. 6—*continued.*

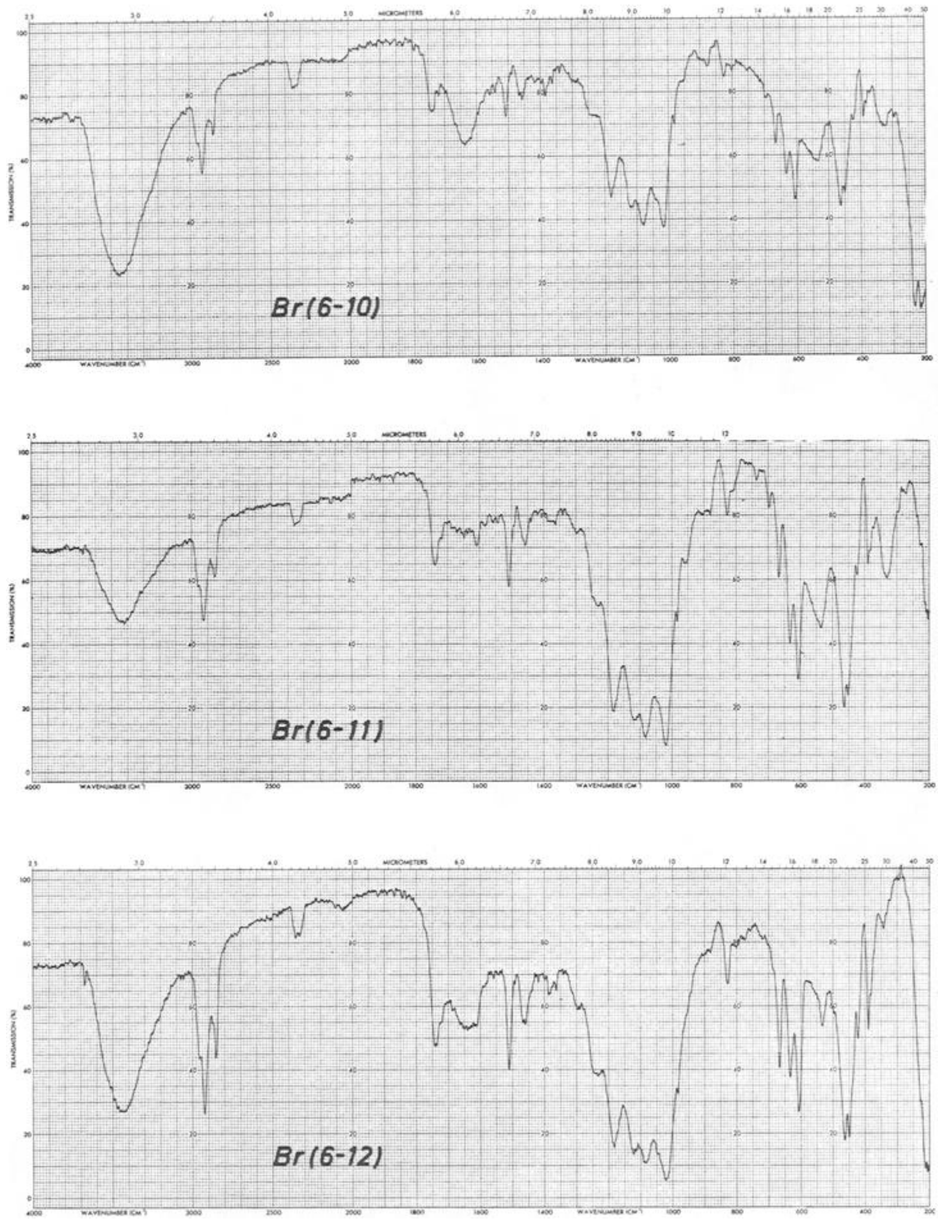


FIG. 6—*continued.*

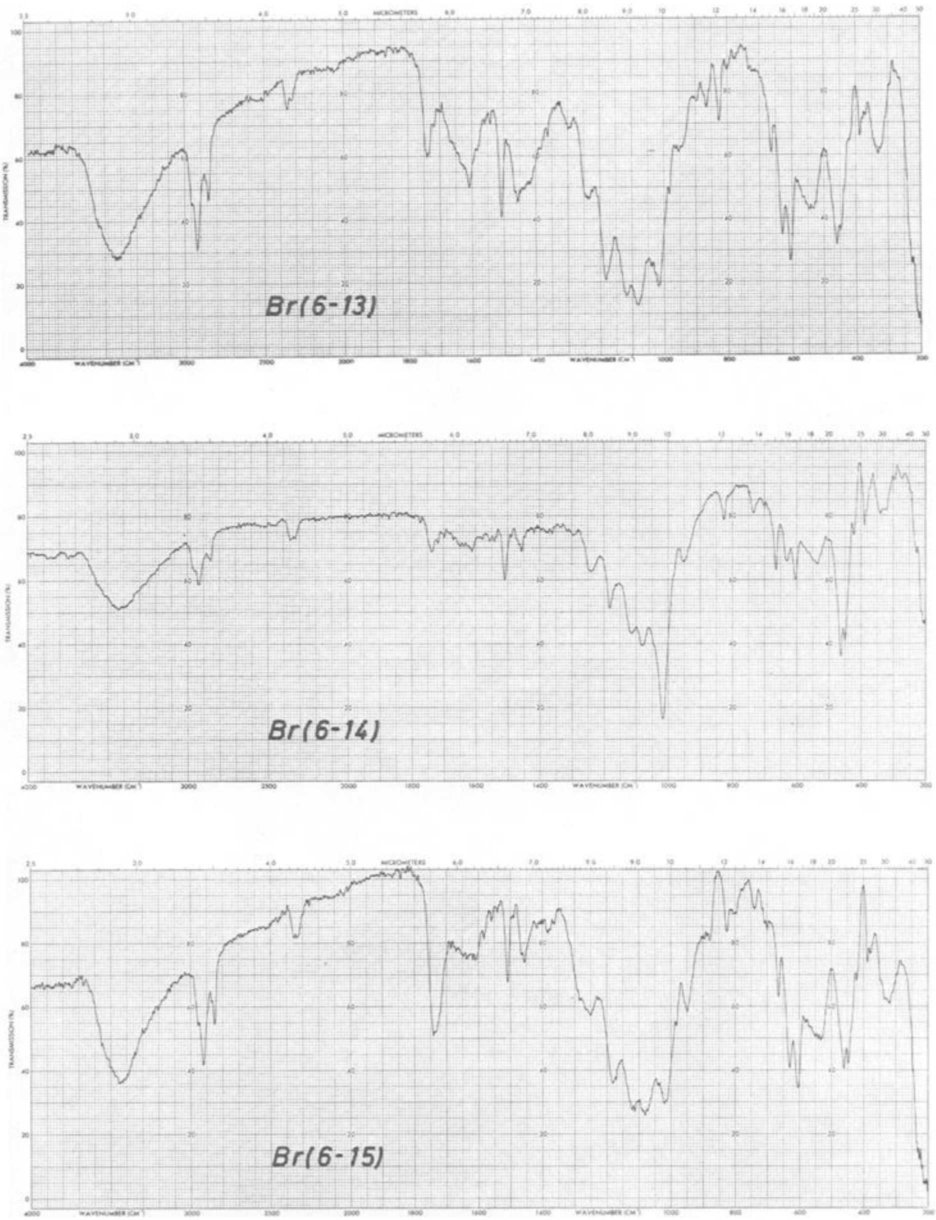


FIG. 6—*continued.*

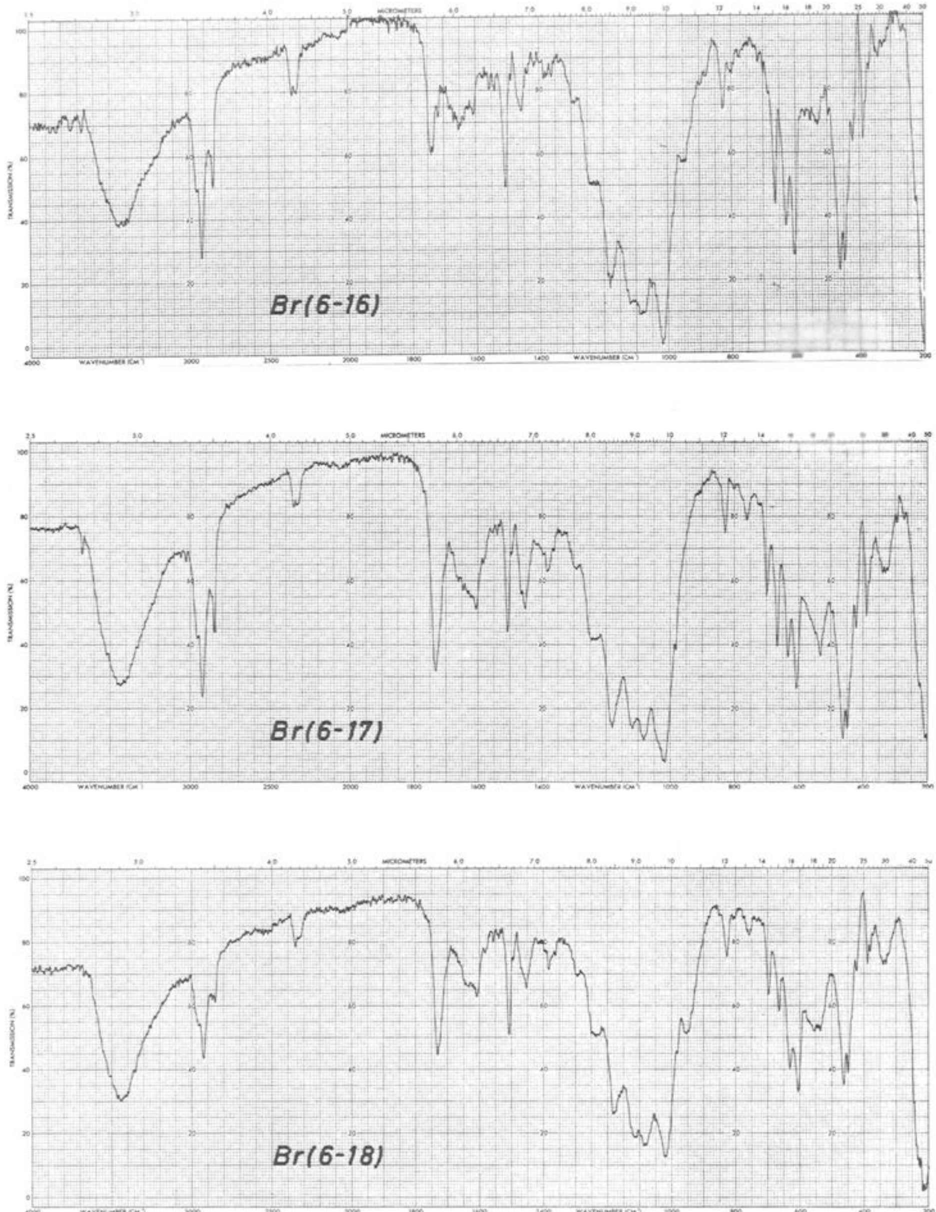


FIG. 6—*continued.*

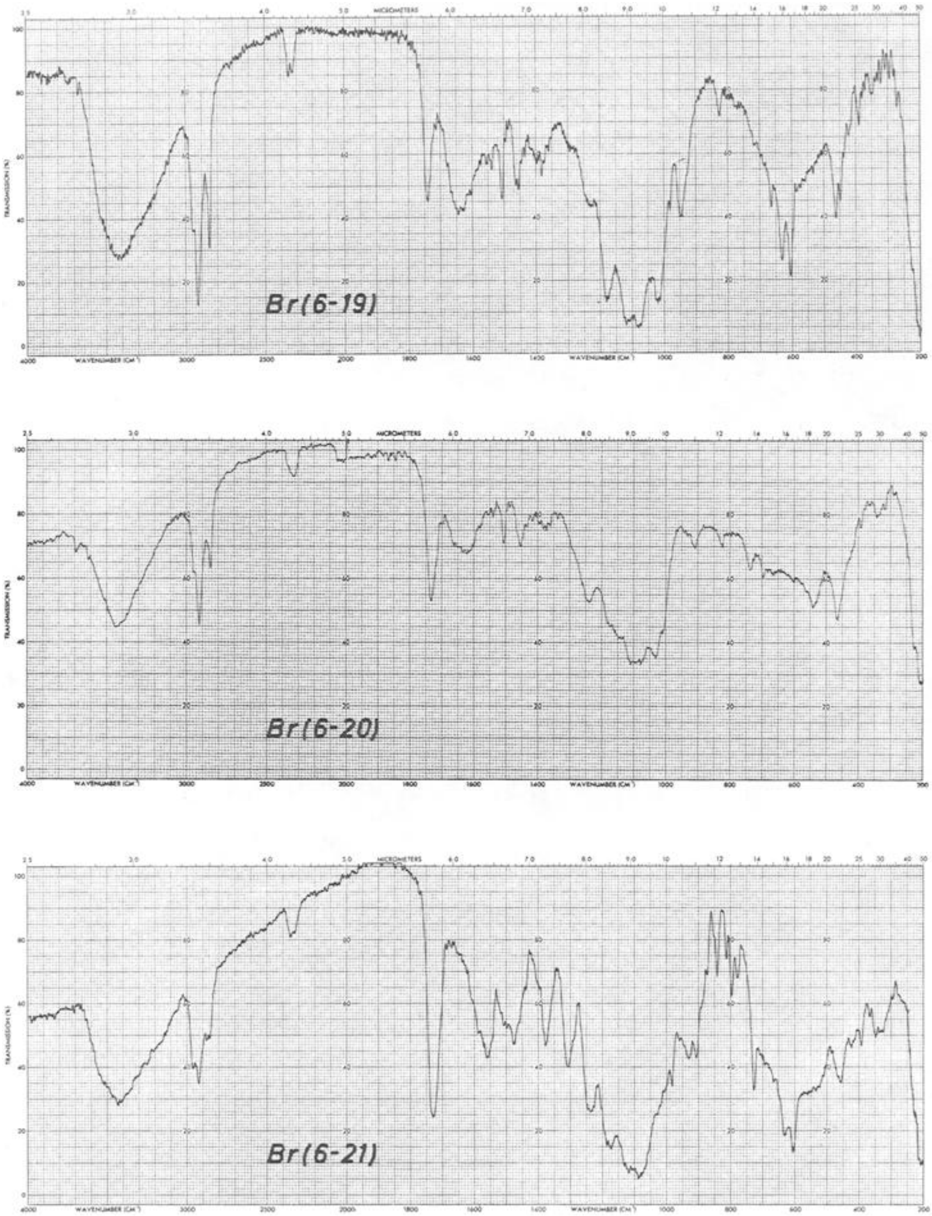


FIG. 6—*continued.*

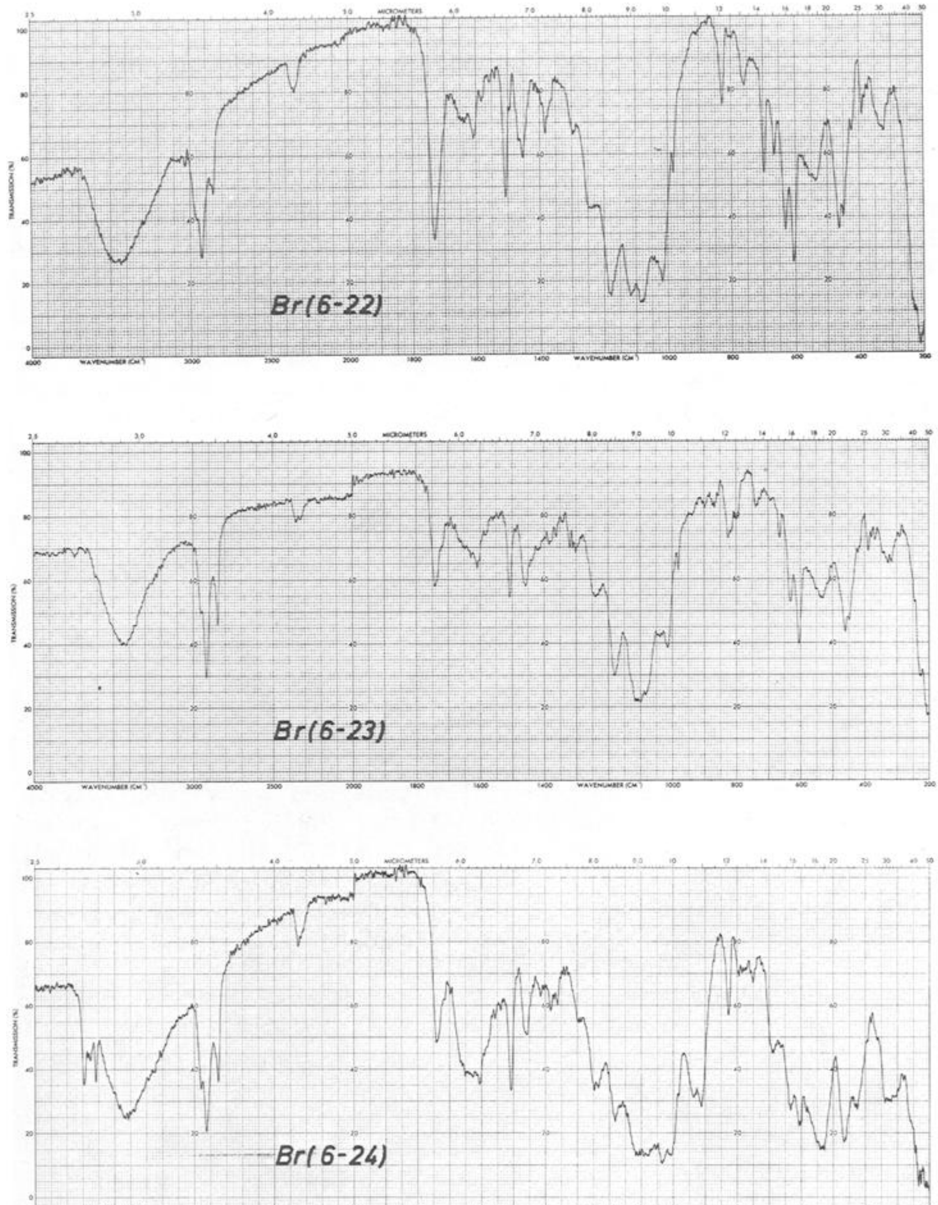


FIG. 6—*continued.*

undercoat sequences found on the body of these vehicles, while the 75FURY6 and 77NPORT2 sequences were identical to those found on their bodies. In some cases it was apparent that the header bars arrived prepainted at the factory, whereupon they were bolted onto the vehicle and subsequently received the same undercoat treatment as the rest of the vehicle (74CHALL6, 76CHARG1, 76CHARG2 and 77CHARG1). In these instances the undercoats observed under the normal sequences were not found on any other portions of the sheet metal. In other circumstances (71DART1), the normal brown undercoat was observed but the normal gray was not. Precisely what the initial painting sequence was on this header bar could not be determined.

The tables and figures have been designed to interrelate chemical and relative color information to production information without requiring an authentic paint chip. One method of the data can be illustrated by considering an unknown paint sample composed of a Br*/Gy/Br layer sequence, where the asterisk indicates a metallic finish. The identification of the source of this paint chip without authentic paint standards must be done on the basis of chemistry, topcoat color, and relative undercoat colors as defined by the Munsell coordinates. Assume that from the chemical analysis of each layer it was determined that the Br* topcoat consisted of an acrylic melamine formaldehyde resin system, the gray consisted of an ester-modified epoxy resin system containing titanium dioxide, talc, and barium sulfate, and the brown was composed of an ester- or alkyd-modified epoxy resin system containing iron oxide, chromate, silica, talc, barium sulfate, and phosphate.

The information from the topcoat chemistry indicates that this paint sequence is an original factory finish used since about 1966. The absence of an acrylonitrile peak, although not definitive, should be kept in mind, as it was a common modification in the mid-1970s.

By comparing the data from the gray undercoat with the undercoat chemical data column in Table 4, several possible spectra for comparison can be identified (core IRs Gy6-9 and Gy6-13 being direct matches). Assume that after comparing the IR spectra for the gray a direct match was found to exist between the unknown and Gy6-13 (Fig. 5). The information in Table 4 indicates that this particular gray chemistry was used in Hamtramck, Detroit, Newark, and Windsor in various years. It is not possible to determine whether the gray is actually a color/chemical descriptor code 20, 21, 37, 38, or 43 without an authentic color standard. However, by using the SIN information from Table 4, Table 3 can be searched to identify those undercoats associated with Gy6-13. This search would identify the SIN's 68VALI6 (Br6-10), 69BCUDA3 (Br6-11), 71VALI1 (Br6-15), 71CHALL3 (Br6-12), 71DART2 (Br6-10 and Br6-12), 72NPORT3 (Br6-12), 72SLITE11 (Br6-16), 73DART4 (Bk6-4), 73NPORT5 (Br6-12), and 73FURY8 (Br6-11). The chemical information already obtained would indicate that the samples probably were not Br6-12 or Br6-16 (Table 5). The 73DART4 (Table 3) can be eliminated from the search as it is a Gy/Bk undercoat layer sequence. Assume the brown matched Br6-15 (Fig. 6). Table 5 would then cross-index the fact that the sample was a 71VALI1. From Table 2 it can be determined that in 1971 Hamtramck manufactured the vehicle lines DART, DEMON, CHALL, VALI, and BCUDA. By correlating this information with Figs. 2 and 3, it is possible to determine which vehicle series were manufactured and the vehicles most likely to be found in our area.

However, if the unknown brown spectra had matched the Br6-11, then another very significant step would have to be taken. The topcoat color, when compared with the National Bureau of Standards or Du Pont of Canada automotive topcoat color standard system, may differentiate between the 69BCUDA3 and the 73FURY8. After the Br* topcoat is compared to the Du Pont standards it may match, for instance, the "chestnut metallic" (T8) used in 1973 and not the "dark bronze metallic" (T7) used in 1969. Where a topcoat color was used in both years, such as the "light gold" (Y3) or "white" (W1), then other factors, such as the wheel base obtained from skid marks, if available, may assist in determining whether the car was a compact (69BCUDA) or a full-size vehicle (73FURY).

Once a vehicle line has been identified from a core SIN, for instance the 73FURY8, a par-

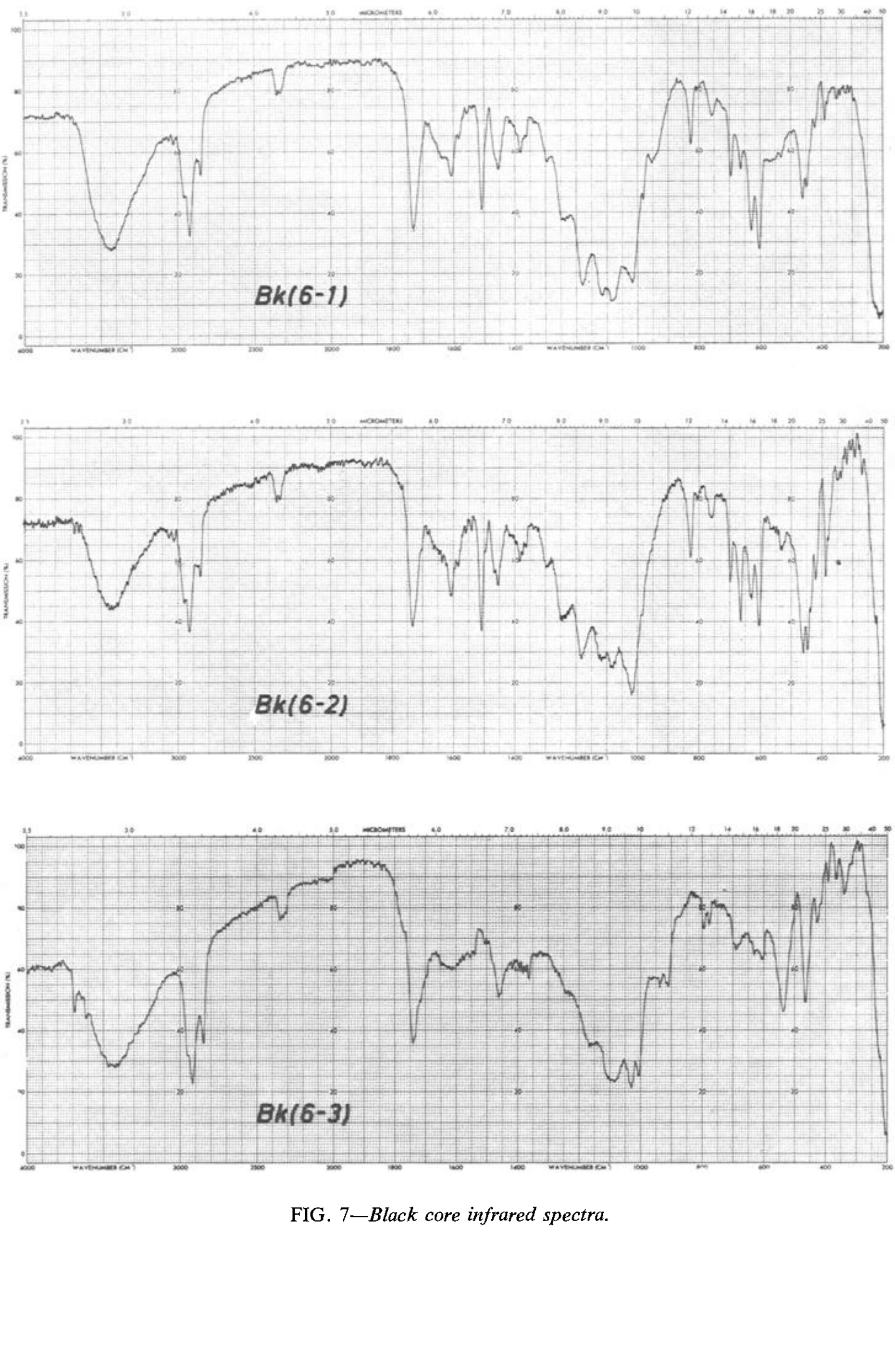


FIG. 7—*Black core infrared spectra.*

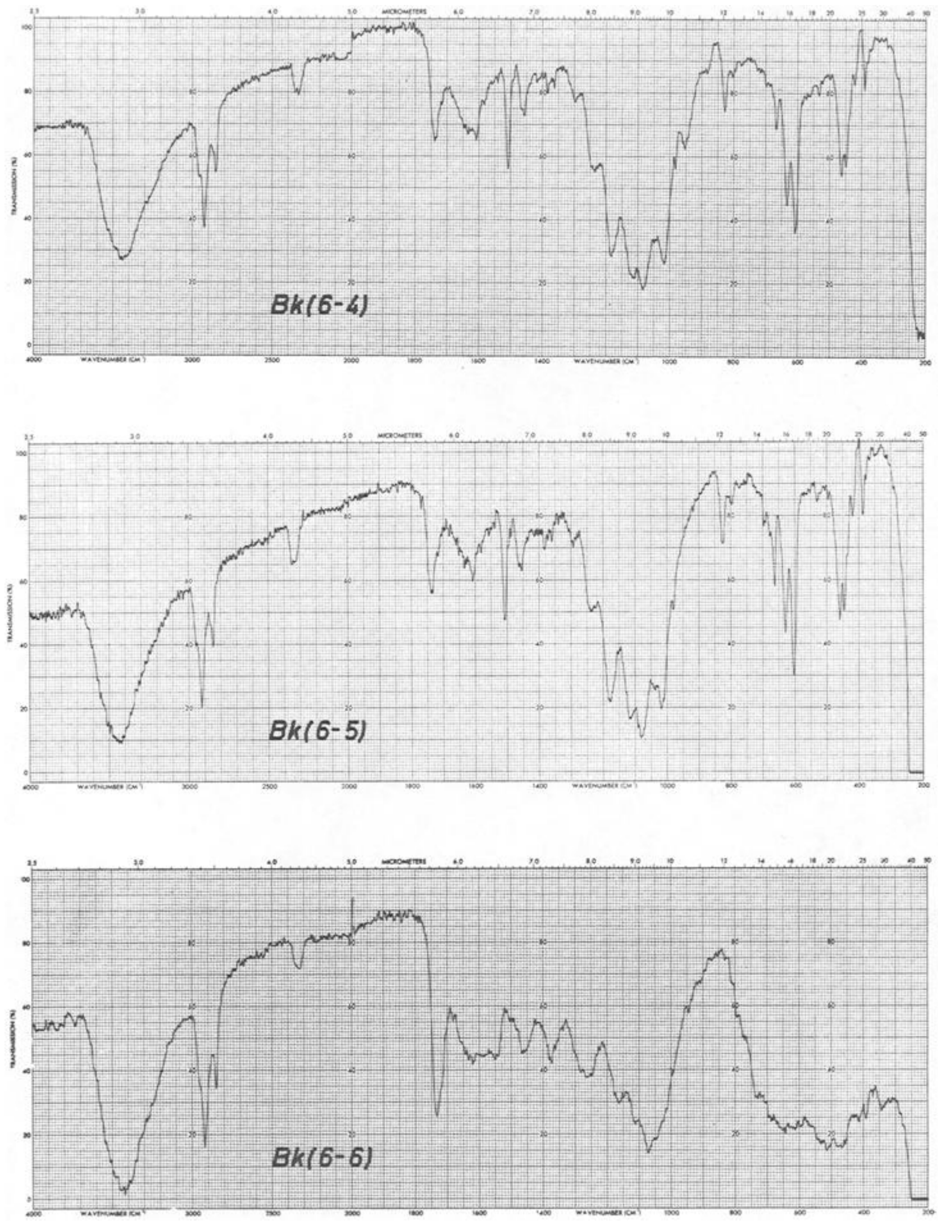
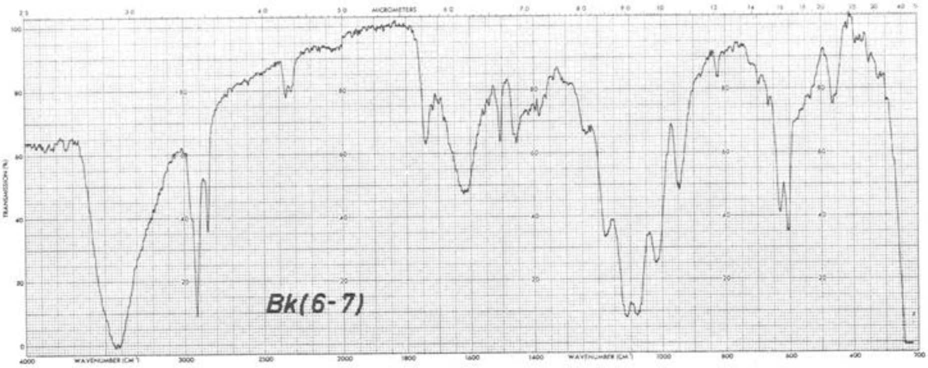
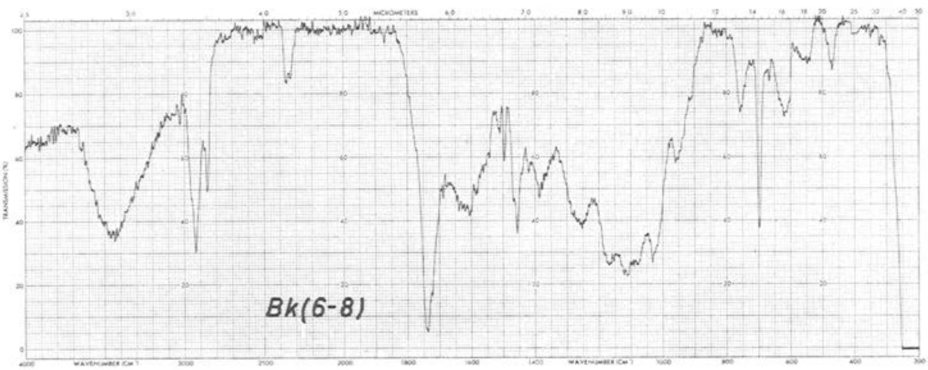


FIG. 7—*continued.*





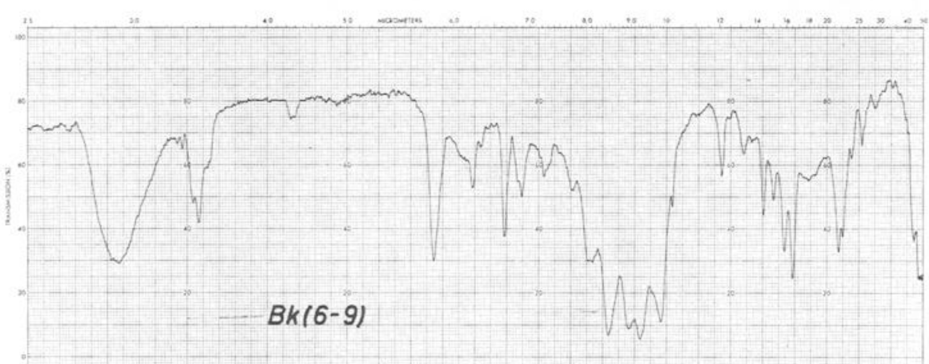


FIG. 7—*continued.*

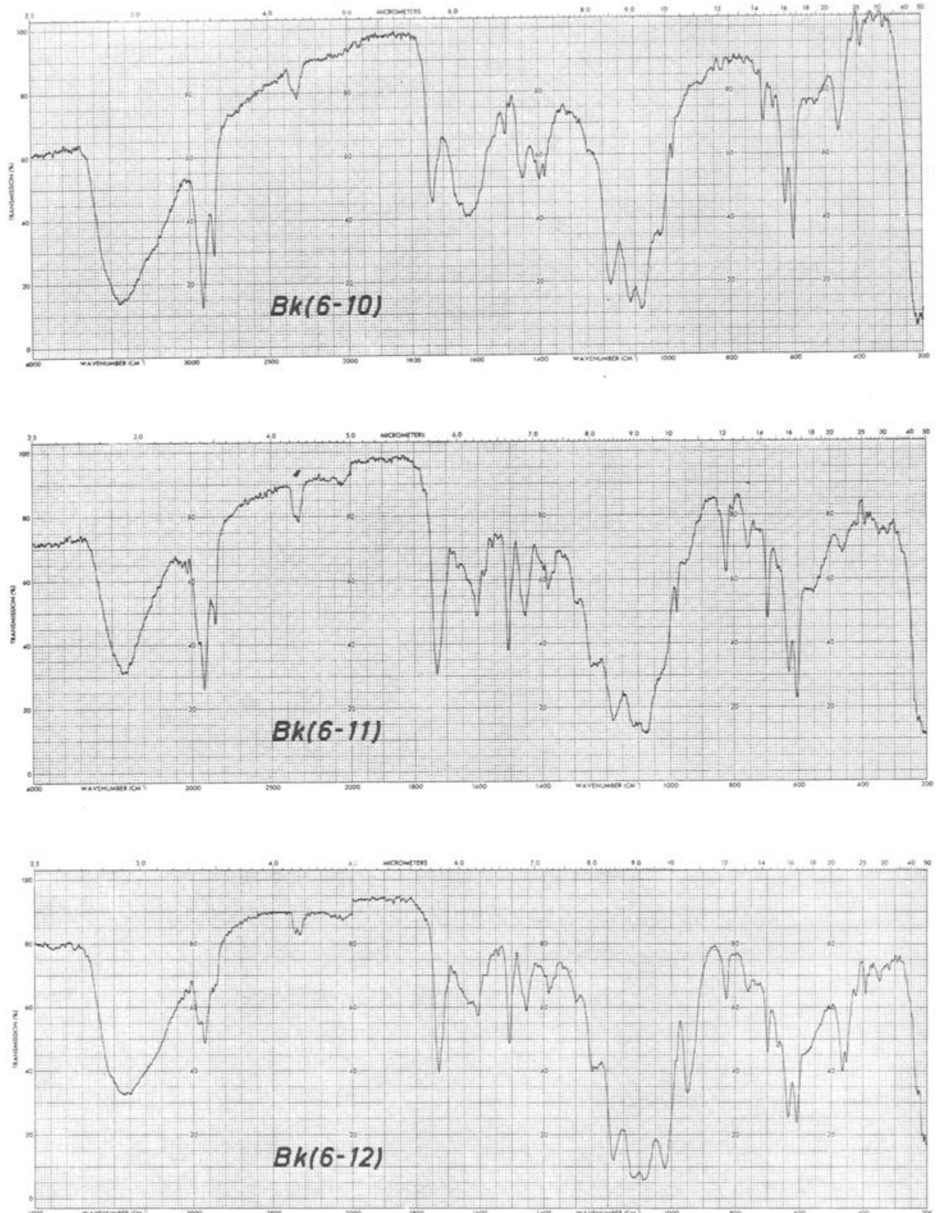


FIG. 7—*continued.*

<table>
<tr><th rowspan="2">MODEL YEAR</th><th colspan="8">CHRYSLER ASSEMBLY PLANTS</th><th rowspan="2">MODEL YEAR</th></tr>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>G</th><th>R</th></tr>
<tr><td>1960</td><td></td><td></td><td></td><td rowspan="6"></td><td>1/1 (13)</td><td></td><td></td><td>2/2 (13)</td><td>1960</td></tr>
<tr><td>1961</td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="2">2/3 (13)</td><td>1961</td></tr>
<tr><td>1962</td><td></td><td rowspan="3">3/4 (13)</td><td>4/5 (13)</td><td></td><td></td><td></td><td>1962</td></tr>
<tr><td>1963</td><td></td><td></td><td>65/6 (13)</td><td></td><td></td><td rowspan="3">7/3 (13)</td><td>1963</td></tr>
<tr><td>1964</td><td>8/7 (13)</td><td></td><td></td><td></td><td></td><td>1964</td></tr>
<tr><td>1965</td><td></td><td>9/8 (13)</td><td></td><td>7/3 (13)</td><td>9/8 (13)</td><td></td><td>1965</td></tr>
<tr><td>1966</td><td rowspan="4">10/9 (13)</td><td>13/10 (13)</td><td colspan="5" rowspan="4">10/9 (13)</td><td>14/10 (13)</td><td>1966</td></tr>
<tr><td>1967</td><td>15/8 (13)</td><td rowspan="2">16/10 (13)</td><td>1967</td></tr>
<tr><td>1968</td><td>19/8 (13)</td><td>1968</td></tr>
<tr><td>1969</td><td rowspan="2">21/13 (13)</td><td>23/10 (13)</td><td>1969</td></tr>
<tr><td>1970</td><td rowspan="3">26/18 (13)</td><td>28/18 (13)</td><td rowspan="2">29/18 (13)</td><td></td><td></td><td></td><td rowspan="2">34/19 (13)</td><td>1970</td></tr>
<tr><td>1971</td><td rowspan="2">21/14 (13)</td><td rowspan="3">30/18 (13)</td><td></td><td></td><td></td><td>1971</td></tr>
<tr><td>1972</td><td></td><td></td><td>38/22 (13)</td><td></td><td rowspan="5">40/19 (13)</td><td>1972</td></tr>
<tr><td>1973</td><td colspan="2" rowspan="2">41/7 41/6 (12)</td><td rowspan="2">41/7 41/6 (12)</td><td rowspan="5"></td><td colspan="2" rowspan="2">41/7 41/6 (12)</td><td>1973</td></tr>
<tr><td>1974</td><td>47/24 (13)</td><td>1974</td></tr>
<tr><td>1975</td><td colspan="2">45/24 (13)</td><td>48/24 (13)</td><td>47/24 (13)</td><td></td><td>11/29 (13)</td><td>1975</td></tr>
<tr><td>1976</td><td colspan="2" rowspan="2">15 (2)</td><td rowspan="2">17 (2)</td><td rowspan="2">60/33/15 (132)</td><td colspan="2" rowspan="2">17 (2)</td><td>1976</td></tr>
<tr><td>1977</td><td>40/16 (13)</td><td>1977</td></tr>
</table>

FIG. 8—*Normal undercoat color/chemical descriptor sequences.*

tial vehicle identification number (VIN) for a computer search could be constructed from the *National Auto Theft Books*. From Table 2 we could determine that the POLAR, MON, FURY, and GRAN vehicle lines were manufactured in Newark. However, the POLAR and GRAN lines were not normally imported into our area and, from the apparent marketing trends, the most likely vehicle series would be either a Monaco or a Fury III (Figs. 2 and 3). Thus, the most likely partial VIN for the initial search would have the first and second digits "DP" or "PH," indicating the vehicle series, the sixth digit "3," indicating the model year, and the seventh digit "F," indicating the assembly plant.

Summary

Microscopic and chemical analysis of 1452 collected 1960 to 1977 Chrysler Corp. paint samples has identified 108 core samples that can be employed for the identification and comparison of Chrysler passenger vehicle paint samples. The pertinent information necessary to identify a paint chip bearing an original Chrysler paint system has been discussed.

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References

[1] Audette, R. J. and Percy, R. F. E., "A Rapid, Systematic, and Comprehensive Classification System for the Identification and Comparison of Motor Vehicle Paint Samples. I: The Nature and Scope of the Classification System," *Journal of Forensic Sciences*, Vol. 24, No. 4, Oct. 1979, pp. 790-807.

[2] *Munsell Book of Color*, Matte Finish Collection, Macbeth Div. of Kollmorgan Corp., Baltimore, MD, 1976.

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