constant-temperature bath. The products were chromatographed on the 10-ft 15% Carbowax column mentioned earlier, using *n*-butyl acetate as an internal standard. 2-Hexanone was identified by collecting the eluted material with the retention time of 2-hexanone from several 50-μl injections and comparing its infrared spectrum with that given by an authentic specimen of 2-hexanone.

Reaction of Cyclobutyl Phenyl Ketone with 2-Butanol and DTBP.—Cyclobutyl phenyl ketone (2.79 mmoles), DTBP (1.42 mmoles), and 2-butanol (30.8 mmoles) were sealed in a Pyrex tube and heated to 125° for a period of 24 hr. At the end of this period the tube was opened and the products were analyzed by vapor phase chromatography, using acetophenone and *n*-butyl acetate internal standards as previously mentioned.

Relative Reactivities of Cycloalkyl Aryl Ketones with DTBP and 2-Butanol.—Weighed quantities of the two ketones totaling 1 mmole, DTBP (0.5 mmole), and 2-butanol (30 mmoles) were sealed in Pyrex tubes and heated to 125° in a constant-temperature bath. After 6–12 hr the sample tubes were opened and a weighed quantity of an appropriate aryl alkyl ketone was added as an internal standard. Analysis for residual cycloalkyl aryl ketone was accomplished using the 5-ft 10% Carbowax 4000 column at temperatures from 125 to 150° and 15 psi of helium. Relative reactivities were calculated from $k/k_0 = (\log A_0/A)/(\log B_0/B)$ where A_0 and A are initial and final concentrations of cycloalkyl aryl ketone A, and B_0 and B are initial and final concentrations of isobutyrophenone.[16]

(16) E. S. Huyser and D. C. Neckers, *J. Am. Chem. Soc.*, **85**, 3641 (1963).

The Direct Synthesis of Phenylacetylenes from Monohydrazones

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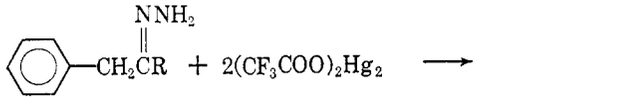
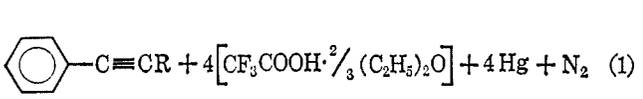
The oxidation of α,β-dihydrazones with various mercury and silver salts to produce acetylenes has long been known.[1-3] However, it is believed that the following is the first reported direct synthesis of acetylenes from monohydrazones.

The reaction involves oxidation of substituted benzyl ketone hydrazones with mercurous trifluoroacetate in refluxing ether or in dioxane at 40–50° according to the eq 1. Oxygenated solvents which



$$\text{C}_6\text{H}_5\text{CH}_2\overset{\overset{\text{NNH}_2}{\|}}{\text{C}}\text{R} + 2(\text{CF}_3\text{COO})_2\text{Hg}_2 \longrightarrow$$



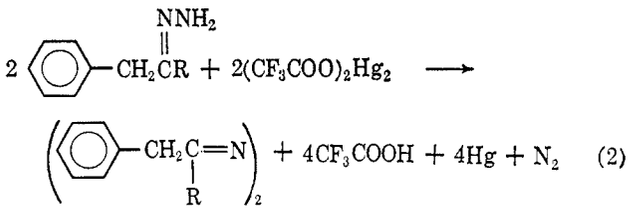
$$\text{C}_6\text{H}_5\text{C}{\equiv}\text{CR} + 4\left[\text{CF}_3\text{COOH}\cdot{}^2\!/_3(\text{C}_2\text{H}_5)_2\text{O}\right] + 4\,\text{Hg} + \text{N}_2 \quad (1)$$

form addition compounds with trifluoroacetic acid must be employed to prevent the addition of trifluoroacetic acid to the acetylenes. Diethyl ether and *p*-dioxane form 2:3 and 3:4 addition complexes with trifluoroacetic acid, respectively.[4,5] Bases cannot be employed to neutralize the acid formed, since they disproportionate the mercurous salt.

(1) T. Curtius, *Ber.*, **22**, 2161 (1889).
(2) T. Curtius and K. Thun, *J. Prakt. Chem.*, **44**, 168 (1891).
(3) M. S. Newman and D. E. Reid, *J. Org. Chem.*, **23**, 665 (1958).
(4) M. Hauptscheim and A. von Grosse, *J. Am. Chem. Soc.*, **73**, 5139 (1951).
(5) J. Lichenberger, *Bull. Soc. Chim. France*, 687 (1954).

The solvent and reactants employed must be thoroughly dried and the reaction run under anhydrous conditions. The presence of water lowers the yield considerably, owing to hydrolysis of the hydrazone.

The principle side reaction observed is the formation of azines from the reaction of 1 equiv of hydrazone with 1 equiv of mercurous trifluoroacetate. This



$$2\,\text{C}_6\text{H}_5\text{CH}_2\overset{\overset{\text{NNH}_2}{\|}}{\text{C}}\text{R} + 2(\text{CF}_3\text{COO})_2\text{Hg}_2 \longrightarrow \left(\text{C}_6\text{H}_5\text{CH}_2\text{C}(\text{R})=\text{N}\right)_2 + 4\text{CF}_3\text{COOH} + 4\text{Hg} + \text{N}_2 \quad (2)$$

reaction is minimized by dropwise addition of a hydrazone solution to a stirring slurry of the mercurous salt.

When R = phenyl or alkyl, the yields were 60 ± 10% based on the ultraviolet spectra of the reaction solution. Yields were considerably lower in the cases where R = α-naphthyl and ferrocenyl. Table I summarizes the results obtained.

Attempted oxidation of hydrazones which lacked the benzyl moiety, *e.g.*, acetophenone and propiophenone hydrazones, did not yield any acetylene products. Phenylacetaldehyde hydrazone, where R = H, likewise failed to yield any phenylacetylene. With 1 equiv of mercurous trifluoroacetate, the above hydrazones reacted to produce the respective azine. With 2 equiv of mercurous trifluoroacetate, azine was formed first, followed by a further slow reaction with mercurous trifluoroacetate to give products which could not be identified. One attempt was made to synthesize a heterocyclic acetylene using this route. When R = 3-pyridyl, the basic nitrogen caused disproportionation of the mercurous salt. Oxidation of deoxybenzoin hydrazone with mercuric oxide, mercurous chloride, thallic chloride, ferric chloride, and silver trifluoroacetate yielded only the azine. When mercuric trifluoroacetate and mercurous nitrate were employed as the oxidizing agent, only trace amounts of diphenylacetylene were produced. The oxidation potential of the metal does not appear to be an important factor. Silver and mercury(I) have nearly identical oxidation potentials, yet silver trifluoroacetate does not yield any diphenylacetylene in the oxidation of deoxybenzoin hydrazone. Since the general concensus of opinion appears to be that HgO oxidation of hydrazones yields diazo intermediates, the $(\text{Hg}^{\text{I}}\text{O}_2\text{CCF}_3)_2$ oxidation must involve some new factor.

The mechanism of the hydrazone oxidation reaction is at present unknown. Several analogous derivatives of deoxybenzoin were synthesized and reacted with mercurous trifluoroacetate under the same conditions. The hydroxylamine, phenylhydrazone, and N,N-dimethylhydrazone did not yield any diphenylacetylene. However, oxidation of the monomethylhydrazone of deoxybenzoin did produce diphenylacetylene in 5–10% yield. This fact also argues against a diazo compound as an intermediate in the production of the acetylene.

TABLE I

Hydrazone	Mp or bp (mm), °C	Acetylene	Mp or bp (mm), °C	% yield of pure product
$PhCH_2C(=NNH_2)Ph$[a]	57–58	PhC≡CPh	58–59[i]	43
p-$ClPhCH_2C(=NNH_2)Ph$[a,b]	66–67	p-ClPhC≡CPh	80–81[i]	55
$PhCH_2C(=NNH_2)CH_2Ph$[a]	35–36	$PhC≡CCH_2Ph$	143–145 (2)[c]	43
	172–174 (0.9)			
$PhCH_2C(=NNH_2)CH_3$[d]	81 (0.17)	$PhC≡CCH_3$	71–72 (11)[e]	48
$PhCH_2C(=NNH_2)$-α-naphthyl[f]	77–78	PhC≡C-α-naphthyl[g]		22
$PhCH_2C(=NNH_2)$-ferrocenyl[h]	122–124	PhC≡C-ferrocenyl[h]	123–124[i]	15

[a] The hydrazones were prepared essentially as indicated in the experimental section. [b] p-Chlorobenzylphenyl ketone was prepared according to the method of S. S. Jenkins [*J. Am. Chem. Soc.*, **56**, 683 (1934)]. [c] T. Jacobs and D. Dankner, *J. Org. Chem.*, **22**, 1424 (1957). [d] Prepared according to the method of J. H. Biel, *et al.* [*J. Am. Chem. Soc.*, **81**, 2805 (1959)]. [e] J. Dudkowski and E. I. Becker, *J. Org. Chem.*, **17**, 204 (1952). [f] Benzyl-α-naphthyl ketone was prepared by the addition of α-naphthonitrile to a benzyl Grignard solution, mp 65–66°; P. Ruggli and M. Reinert [*Helv. Chim. Acta*, **9**, 71 (1926)] reported mp 66–67°. Preparation of the hydrazone required pressure tube conditions for 48 hr at 140°. [g] Molecular weight and ultraviolet spectra were identical with a sample prepared in 85% yield from 1-iodonaphthalene and copper phenylacetylide: R. E. Dessy and S. A. Kandil, *J. Org. Chem.*, **30**, 3857 (1965). [h] The authors wish to thank Dr. M. D. Rausch for generous samples of benzylferrocenyl ketone and ferrocenylphenyl acetylene. [i] P. L. Pauson and W. E. Walts, *J. Chem. Soc.*, 2994 (1963). [j] See ref 3.

Experimental Section

Mercurous trifluoroacetate was prepared according to the method of Swarts[6] and dried for 5–6 hr under vacuum at room temperature. Mallinckrodt anhydrous ether was used as the solvent for the reactions. The hydrazones listed below were stored at 0° and oxidized as soon as possible, since most of them slowly decompose to azines. All hydrazones were characterized by nitrogen analysis. All acetylenes were characterized by correlation of melting point or boiling point and ultraviolet spectra with authentic samples.

Typical Preparation.—Deoxybenzoin hydrazone, when prepared according to the method previously described in the literature, contained a considerable amount of azine.[7] It was alternatively prepared by heating 25 g of deoxybenzoin and 20 g of 99–100% hydrazine hydrate at reflux for 6 hr with stirring to keep the two phases well mixed. On cooling, the reaction mixture was extracted with 100 ml of ether. The ether extract was washed with water and dried over potassium carbonate. The ether was removed under vacuum (to avoid air oxidation to azine) and the residue was recrystallized from alcohol to give colorless needles, mp 57–58° (lit.[7] mp 62°).

Mercurous trifluoroacetate (37.6 g, 0.06 mole) and 100 ml of dry ether were warmed to a slow reflux with stirring. Deoxybenzoin hydrazone (6.30 g, 0.03 mole) in 100 ml of ether was added over a period of 1.5 hr. The reaction mixture was stirred an additional 30 min, filtered, extracted with 5% ammonium hydroxide (to neutralize acid and destroy unreacted mercurous salt), then washed with water, and dried over potassium carbonate. The ether was removed and the residue was dissolved in a minimum amount of 50:50 benzene–petroleum ether (bp 40–60°) and placed on an 8 × 5/8 in. column of Woelm neutral alumina, eluting with petroleum ether (bp 40–60°). Diphenylacetylene was present in the first 400 ml of eluent which, after evaporation, yielded 2.3 g (43%) of colorless crystals, mp 58–59° (lit mp 58–60°,[8] 60°[7]).

Deoxybenzoin Monomethylhydrazone.—Deoxybenzoin (19.6 g), 13.8 g of methylhydrazine, and 3 drops of glacial acetic acid were placed in a pressure flask and heated in an oven at 100° for 12 hr. The excess methylhydrazine was extracted with water, and the organic layer was taken up in ether and dried over potassium carbonate. Vacuum distillation yielded 14.6 g (65%) of the monomethylhydrazone,[8] a yellow oil, bp 154–155° (0.3–0.4 mm).

Anal. Calcd: N, 12.49. Found: N, 12.39.

Oxidation of Deoxybenzoin Monomethylhydrazone.—Deoxybenzoin monomethylhydrazone (2.24 g, 0.01 mole) in 25 ml of dry ether was added dropwise to 12.5 g of mercurous trifluoroacetate in 20 ml of ether. The reaction mixture was worked up as in the case of diphenylacetylene. The first 50 ml of eluent from the alumina column contained 0.07–0.1 g of diphenylacetylene.

(6) F. Swarts, *Bull. Soc. Chim. Belges*, **48**, 179 (1939).

(7) T. Curtius and A. Blumer, *J. Prakt. Chem.*, [2] **52**, 136 (1895).

(8) T. Kauffmann, *et al.* [*Angew. Chem.*, **72**, 752 (1960)] reported this compound as the product of the addition of sodium methylhydrazide to diphenylacetylene; however, no physical constants are given.

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A Simple Preparation for Some Hydroxyphenothiazines[1]

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Various pure 3- and 7-hydroxyphenothiazines were required as intermediates in the synthesis of possible metabolites of the phenothiazine tranquilizing drugs. The few known 3- and 7-hydroxyphenothiazines have been made, with some difficulty, using the following methods: (A) oxidation of phenothiazines and reduction of the resulting phenothiazones;[2,3] (B) dealkylation of alkoxyphenothiazines;[4] and (C) thionation of hydroxydiphenylamines.[5] These syntheses required lengthy preparation of precursors or involved tedious removal of stubborn impurities. In all instances the reaction scale was quite small and with a single exception[4] no yields were reported.

The need for a simpler synthesis for 3- and 7-hydroxyphenothiazines which could be carried out in good yield on a relatively large scale, with minimal formation of troublesome congeners, has led to the improved preparation outlined in Scheme I. To permit easy comparison with the older techniques we have utilized the new procedure in the preparation of the known compounds, 2-chloro-7-hydroxyphenothiazine (VII)[4] and 3-hydroxyphenothiazine (VI).[2,4,5]

Commercial 2-aminobenzenethiol was converted to its zinc salt (I) in 81% yield by a simplification of the

(1) This investigation was supported by the Psychopharmacology Service Center, National Institutes of Mental Health, Bethesda, Md., under Contract SA-43-ph-3758.

(2) R. P. Harpur, W. E. Swales, and O. F. Denstedt, *Can. J. Res.*, **D28**, 143 (1950).

(3) C. Bodea and M. Raileanu, *Ann.*, **614**, 171 (1958).

(4) P. K. Kadaba and S. P. Massie, *J. Org. Chem.*, **24**, 986 (1959).

(5) D. F. Houston, E. B. Kester, and F. De Eds, *J. Am. Chem. Soc.*, **71**, 3816 (1949).