CONVENTION APPLICATION FOR A PATENT

4/We (a) GENERAL ELECTRIC COMPANY

(b) 1 RIVER ROAD, SCHENECTADY, NEW YORK, U.S.A.

(c) CURABLE COMPOSITIONS AND METHOD FOR CURING SAME

which is described in the accompanying complete specification. This application is a convention application and is based on the application applications for patents or similar protection made in the following country on the following dates:

in U.S.A. on 14 October, 1976 No. (f) 732,421
in U.S.A. on 9 July 1976 No. (f) 703,860

Our address for service is care of ARTHUR S. CAVE & CO., Patent and Trade Mark Attorneys, 1 Alfred Street, Sydney, New South Wales, Australia 2000.

Dated this 25th day of MAY, 1977.

(h) GENERAL ELECTRIC COMPANY

To: THE COMMISSIONER OF PATENTS,
COMMONWEALTH OF AUSTRALIA

ARTHUR S. CAVE & CO.
PATENT AND TRADE MARK ATTORNEYS
SYDNEY

JAMES G. SIELY. F.I.P.A.A.
COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952-1969

DECLARATION IN SUPPORT OF A CONVENTION APPLICATION
FOR A PATENT

In support of the Convention Application made by
GENERAL ELECTRIC COMPANY, a corporation of the State of New
York, United States of America, for a Patent for an invention
entitled: "CURABLE COMPOSITIONS AND METHOD FOR CURING SAME"

I, SAMSON HELFGOTT, of 570 Lexington Avenue,
New York, 10022, United States of America, do solemnly and
sincerely declare as follows:

1. I am authorised by GENERAL ELECTRIC COMPANY the
Applicant for the Patent, to make this Declaration on its
behalf.

2. The basic application(s) as defined by Section 141 of
the Act (were) made in the United States of America on
the fourteenth day of October 1976
by JAMES VINCENT CRIVELLO, and in the United States of America
on the ninth day of July 1976 by JAMES VINCENT CRIVELLO

3. JAMES VINCENT CRIVELLO of R.D. # 1, Carlot Road, Elnora,
New York, U.S.A.

is (were) the actual inventor(s) of the invention(s) and the
facts upon which GENERAL ELECTRIC COMPANY is entitled to make
the Application are as follows:

GENERAL ELECTRIC COMPANY is the Assignee of the
invention from JAMES VINCENT CRIVELLO

by virtue of Assignment(s) dated the eleventh day of October
1976 and the seventh day of July 1976

4. The basic application(s) referred to in paragraph 2
of this Declaration (were) the first application(s) made
in a Convention country in respect of the Invention, the
subject of the Application.

DECLARED at New York, New York, United States of
America, this 16th day of May 1977

To: Counsel, Portfolio Administration,
THE COMMISSIONER OF PATENTS
International Patent Operation
ABSTRACT

The compositions have use as photoresists in the making of printing plates and printed circuits. A method for making a circuit board and a method for making a printing plate are also claimed.

CLAIM

1. A curable composition which comprises by weight,

(A) 0.5% to 98% of epoxy resin,

(B) 0.5% to 98% of polyvinyl acetal,

(C) 0.1% to 10% of aromatic onium salt,

where the sum of (A), (B) and (C) is 100% and (C) is selected from an aromatic halonium salt or mixtures thereof of the formula,

\[ [(R)_a (^1R)_b D] [MQ_d] \]

an aromatic onium salt of a Group Va element of the formula

\[ [(R)_f (^2R)_g (^3R)_h E] [MQ_d] \]

and an aromatic onium salt of a Group VIa element of the formula,

\[ [(R)_j (^4R)_k (^5R)_m G] [MQ_d] \]
where R is a monovalent aromatic organic radical, \( R^1 \) is a
divalent aromatic organic radical, \( R^2 \) and \( R^4 \) are monovalent
organic aliphatic radicals selected from alkyl, cyclo alkyl and
substituted alkyl, \( R^3 \) and \( R^5 \) are polyvalent organic radicals
selected from aliphatic radicals and aromatic radicals forming
a heterocyclic or fused ring structure with E or G, such as
I, E is a Group Va element selected from N, P, As, Sb and Bi,
G is a group VIa element selected from S, Se and Te, M is a
metal or metalloid, Q is a halogen radical,
"a" is a whole number equal to 0 or 2,
"b" is a whole number equal to 0 or 1
and the sum of "a" + "b" is equal to 2
or the valence of D,
"f" is a whole number equal to 0 to 4 inclusive,
"g" is a whole number equal to 0 to 2 inclusive,
"h" is a whole number equal to 0 to 2 inclusive
and the sum of "f" + "g" + "h" is a value
equal to 4 or the valence of E,
"j" is a whole number equal to 0 to 3 inclusive,
"k" is a whole number equal to 0 to 2 inclusive,
and
"m" is a whole number equal to 0 or 1, where the
sum of "j" + "k" + "m" is a value equal to 3
or the valence of G,
c = d - e,
e is equal to the valence of M and is an
integer equal to 2-7 inclusive, and
d>e and is an integer having a value up to 8.
TO BE COMPLETED BY APPLICANT

Name of Applicant: GENERAL ELECTRIC COMPANY
Address of Applicant: 1 RIVER ROAD, SCHENECTADY, NEW YORK, U.S.A.
Actual Inventor: JAMES VINCENT CRIVELLO
Address for service: c/- ARTHUR S. CAVE & CO., 1 ALFRED STREET, SYDNEY

Complete Specification for the invention entitled

"CURABLE COMPOSITIONS AND METHOD FOR CURING SAME"

The following statement is a full description of this invention, including the best method of performing it known to me:
CURABLE COMPOSITIONS AND METHOD FOR CURING SAME

The present invention relates to curable compositions useful as or for making dry film photoresist, and insulating coating on various substrates in the cured state.

The curable compositions of the present invention comprise by weight,

(A) 0.5% to 98% of epoxy resin,
(B) 0.5% to 98% of polyvinyl acetal,
(C) 0.1% to 10% of aromatic onium salt, and

where the sum of (A), (B) and (C) is 100% and (C) is selected from an aromatic halonium salt of the formula,

\[(R)\ a\ (R^1)\ b\ D\] + \[(MQ_d)^{(d-e)}\]

an aromatic onium salt of a Group Va element of the formula,

\[(R)f\ (R^2)\ g\ (R^3)\ h\ E\] + \[(MQ_d)^{-(d-e)}\]

and an aromatic onium salt of a Group VIa element of the formula,

\[(R)j\ (R^4)\ k\ (R^5)\ m\ G\] + \[(MQ_d)^{-d-e}\]

where R is a monovalent aromatic organic radical, R^1 is a divalent aromatic organic radical, R^2 and R^4 are monovalent organic aliphatic radicals selected from alkyl, cycloalkyl and substituted alkyl, R^3 and R^5 are polyvalent organic radicals forming a heterocyclic or fused ring structure with E or G, D is a halogen radical, such as I, E is a Group Va element selected from N, P, As, Sb and Bi, G is a group VIa element selected from S, Se and Te, M is a metal or metalloid, Q is a halogen radical,
"a" is a whole number equal to 1 or 2, "b" is a whole number equal to 0 or 1 and the sum of "a" + "b" is equal to 2 or the valence of D, "f" is a whole number equal to 0 to 4 inclusive, "g" is a whole number equal to 0 to 2 inclusive, "h" is a whole number equal to 0 to 2 inclusive and the sum of "f" + "g" + "h" is a value equal to 4 or the valence of E, "j" is a whole number equal to 0 to 3 inclusive, "k" is a whole number equal to 0 to 2 inclusive and "m" is a whole number equal to 0 or 1, where the sum of "j" + "k" + "m" is a value equal to 3 or the valence of G, 

\[ c = d - e, \]

e is equal to the valence of M and is an integer equal to 2-7 inclusive, and d>e and is an integer having a value up to 8.

Radicals included by R can be the same or different, aromatic carbocyclic or heterocyclic radicals having from 6 to 20 carbon atoms, which can be substituted with from 1 to 4 monovalent radicals selected from \( \text{C}_{(1-8)} \) alkoxy, \( \text{C}_{(1-8)} \) alkyl, nitro, chloro, etc., R is more particularly phenyl, chlorophenyl, nitrophenyl, methoxyphenyl, pyridyl, etc. Radicals included by \( \text{R}^1 \) are divalent radicals, such as
$R^2$ and $R^4$ radicals include $C_{(1-8)}$ alkyl, such as methyl, ethyl, etc., substituted alkyl, such as $-C_2H_4OCH_3$, $-CH_2COOC_2H_5$, $-CH_2COCH_3$, etc. $R^3$ and $R^5$ radicals include such structures as

![Diagrams of various radical structures including cyclic and linear structures with substituents.]

where $Q'$ is selected from $0$, CH$_2$, N R and S; Z is selected from $R'$ -O-, -S- and -N-, and $R'$ is a monovalent radical selected from hydrogen and hydrocarbon.

Metal or metalloids included by M of formula 1 are transition metals such as Sb, Fe, Sn, Bi, Al, Ga, In, Ti, Zr, Sc, V, Cr, Mn, Cs, rare earth elements such as the lanthanides, for example, Cd, Pr, Nd, etc., actinides, such as Th, Ta, U, Np, etc., and metalloids such as B, P, As, etc. Complex anions included by $MQ_d^{(d-e)}$ are, for example, BF$_4^-$, PF$_6^-$, AsF$_6^-$, SbF$_6^-$, FeCl$_4^-$, SnCl$_6^-$, SbCl$_6^-$, BiCl$_5^-$, etc.
Halonium salts included by formula 1 are, for example,

\[ \text{CH}_3 \text{O}^+\text{BF}_4^- \]

\[ \text{CH}_3 \text{Cl}^+\text{BF}_4^- \]

Group Va onium salts included by formula 2 are, for example,

\[ \text{CH}_3 \text{O}^+\text{N}^+\text{-CH}_2\text{-C}^+\text{BF}_4^- \]

\[ \text{CH}_3 \text{O}^+\text{N}^+\text{-CH}_2\text{-C}^+\text{SbF}_6^- \]
Group VIa onium salts included by formula (1) are, for example,

\[
\text{[Structural formula]}
\]
\[ \begin{align*}
\text{PF}_6^- , \\
\text{AsF}_6^- , \\
\text{SbF}_6^- , \\
\text{FeCl}_4^- , \\
\text{SnCl}_6^- , \\
\text{SbCl}_6^- 
\end{align*} \]
The onium salts of formulas 1-3 can be made by different methods. In formula 1, the photoinitiator can be made by effecting contact under aqueous conditions between an arylhalonium bisulfate and the corresponding hexafluoro acid or salt, such as Y\(^{-1}\)MF\(_6\), where Y\(^{-1}\) can be hydrogen, an alkali metal ion, alkaline earth metal ion or transition metal ion.

In addition to the above-described metathesis for making the corresponding halonium salts, the halonium salts of the present invention, also can be prepared by using silver compounds, such as silver oxide, or silver tetrafluoroborate, which were reacted with the appropriate diarylhalonium salt, as shown by M. C. Caserio et al., J. Am. Chem. Soc. 81, 336 (1959) or M. C. Beringer et al., J. Am. Chem. Soc. 81, 342 (1959). Methods for making Group VIa compounds, such as sulfonium, selenium and tellurium compounds can be made by procedures shown in J. W. Knapczyk and W. E. McEwen, J. Am. Chem.
Among the procedures which can be used to make Group Vaonium salts, arsonium, antimonium and bismuthonium salt can be found in Goerdeler, Methoden der Organischen Chemie 11/2, 591-640 (1958) and K. Sasse, idid, 12/1 79-112 (1963).

The term "epoxy resin" as utilized in the description of the curable compositions of the present invention, includes any monomeric, dimeric or oligomeric or polymeric epoxy material containing one or a plurality of epoxy functional groups. For example, those resins which result from the reaction of bisphenol-A (4,4'-isopropylidenediphenol) and epichlorohydrin, or by the reaction of low molecular weight phenol-formaldehyde resins (Novolak resins) with epichlorohydrin, can be used alone or in combination with an epoxy containing compound as a reactive diluent. Such diluents as phenyl glycidyl ether, 4-vinylcyclohexene dioxide, limonene dioxide, 1,2-cyclohexene oxide, glycidyl acrylate, glycidyl methacrylate, styrene oxide, allyl glycidyl ether, etc., may be added as viscosity modifying agents.

In addition, the range of these compounds can be extended to include polymeric materials containing terminal or pendant epoxy groups. Examples of these compounds are vinyl copolymers containing glycidyl acrylate or methacrylate as one of the comonomers. Other classes of epoxy containing polymers amenable to cure using the above catalysts are epoxy-siloxane resins, epoxy-polyurethanes and epoxy-polyesters. Such polymers
usually have epoxy functional groups at the ends of their chains. Epoxy-siloxane resins and method for making are more particularly shown by E. P. Plueddemann and G. Fanger, J. Am. Chem. Soc. 80 632-5 (1959). As described in the literature, epoxy resins can also be modified in a number of standard ways such as reactions with amines, carboxylic acids, thiols, phenols, alcohols, etc., as shown in patents 2,935,488; 3,235,620; 3,369,055; 3,379,653; 3,398,211; 3,403,199; 3,563,850; 3,567,797; 3,677,995; etc.

Further examples of epoxy resins which can be used are shown in the Encyclopedia of polymer science and technology, Vol. 6, 1967, Interscience Publishers, New York, pp 209,271.

The polyvinyl acetals which can be used in the curable compositions of the present invention can be mixtures of units, e.g.,

\[
\begin{align*}
\text{CH-CH}_2\text{-CH-CH}_2 \\
\text{OH} & \quad \text{OH}
\end{align*}
\]

and

\[
\begin{align*}
\text{CH-CH}_2\text{-CH-CH}_2 \\
\text{O} & \quad \text{O} \\
\text{CH} & \quad \text{R}_6
\end{align*}
\]

chemically combined with

\[
\begin{align*}
\text{CH}_2\text{-CH-CH-CH}_2 \\
\text{O} & \quad \text{O} \\
\text{CH} & \quad \text{R}_6
\end{align*}
\]

where the polymers can have an average of from about 5 to 5000 units and \( R_6 \) is selected from hydrogen, C\((1-8)\) alkyl, such as methyl, ethyl, butyl and mixtures thereof. Additional polyvinyl
acetals which can be used in the practice of the invention are shown in the Encyclopedia of Polymer Science and Technology, H. F. Mark and N. G. Gaylord, Vol. 14, 149 (1971).

The curable compositions of the present invention can be cast from organic solvent solutions to produce dry film photoresists. Suitable organic solvents which can be employed include, for example, methylene chloride, chloroform, methyl ethyl ketone, cellosolve acetate, tetrahydrofuran, acetonitrile, etc., at from 0 to 80% by weight of the curable composition. The curable compositions can be heat cured at temperatures of from 100°C to 200°C.

Preferably, the curable compositions of the present invention can be converted to the solvent resistant state when exposed to ultraviolet light as cast films. When used as dry film photoresist, the film can be patterned with a mask using UV irradiation having a wavelength of from 1849 Å to 4000 Å and an intensity of at least 5,000-60,000 microwatts per cm². The lamp systems used to generate such radiation can consist of ultraviolet lamps such as from 1 to 50 discharge lamps, for example, xenon, metallic halide, metallic arc, such as a low, medium or high pressure mercury vapor discharge lamp, etc., having an operating pressure of from a few millimeters to about 10 atmospheres, etc., can be employed. The lamps can include envelopes capable of transmitting light of a wavelength of from
about 1849 Å to 4000 Å, and preferably 2400 Å to 4000 Å. The lamp envelope can consist of quartz, such as Spectrociil, or of Pyrex, etc. Typical lamps which can be employed for providing ultraviolet radiation are, for example, medium pressure mercury arcs, such as the GE HT37 arc and the Hanovia 450 W arc lamp. The cures may be carried out with a combination of various lamps, some or all of which can operate in an inert atmosphere. When using UV lamps, the irradiation flux on the substrate can be at least 0.01 watts per square inch to effect cure of the dry film photoresist.

The curable compositions may contain inactive ingredients, such as inorganic fillers, dyes, pigments, extenders, viscosity control agents, process aids, UV-screens, etc., in amounts of up to 100 parts filler per 100 of epoxy resin. The curable compositions can be applied to such substrates as metal, rubber, plastic, molded parts of films, paper, wood, glass, cloth, concrete, ceramic, etc.

In order that those skilled in the art will be better able to practice the invention, the following examples are given by way of illustration and not by way of limitation. All parts are by weight.

Example 1.

A solution of 10 parts of polyvinylformal (Monsanto Formvar 12/85), 2.5 parts of Ciba-Geigy Araldite ECN1299 cresol-novolac epoxy resin, 0.3 part of triphenylsulfonium herafluoroantimonate, and about 80 parts of chloroform was cast as a 5 mil film onto a glass plate. The film was removed and exposed through a glass contact mask to ultraviolet light from a GE HT37 medium pressure mercury arc lamp for 3 minutes at a distance of 6 inches. After irradiation, a visible image was
observed in the film. The latent image was developed by immersing the film in chloroform. A clear upraised negative image of the mask in the film resulted.

Example 2.

A solution was prepared consisting of 10 parts of Formvar 15/95E polyvinylformal, 5 parts of the epoxy resin of Example 1 (ECN 1299), 0.3 part of triphenyl sulfonium hexafluoroantimonate, 80 parts of methylene chloride was cast as a 5 mil film onto a polyethylene terephthalate substrate. A contact mask was then placed on top of the resulting composite, which was then exposed for 3 minutes under ultraviolet light as described in Example 1. The resulting composite was then developed by immersing it in 2-ethoxyethylacetate. There was obtained a polyethylene terephthalate substrate having a negative image of the mask on its surface, which was useful as a printing plate.

Example 3.

A curable composition was prepared by dissolving 10 parts of Formvar 15/95E, 0.3 part of triphenylsulfonium hexafluoroarsenate and 5 parts of Araldite ECN 1299 and about 80 parts of methylene chloride. The resulting solution was then cast onto a glass plate. A translucent film was obtained from the resulting solution upon evaporation of the solvent. The film was then removed from the glass substrate and placed in contact with a mask. The film was then irradiated as described in Example 1, for a period of about 1.5 minutes. The film was then heated in an oven at 100°C for 5 minutes. There was obtained a clear negative reproduction of the mask when the film was developed using chloroform.
Example 4.

A film was cast onto a glass plate of a curable composition consisting of 10 parts of the reaction product of polyvinyl alcohol and butyraldehyde (Butvar B-74), 2.5 parts of Araldite ECN 1299, 0.3 part of triphenylsulfonium hexafluoroarsenate and about 90 parts of methylene chloride. The film was removed from the glass plate and then laminated onto a copper-clad epoxy-glass circuit board at 130°C under pressure. The laminated board was then exposed to ultraviolet light as in Example 1, using a contact mask. The laminate was then developed using chloroform to produce a negative image of the curable resin on copper. The copper laminate was then etched using ferric chloride. There was obtained a copper-clad laminate having a positive image of the mask in copper on the surface of the epoxy glass substrate.

Example 5.

A curable composition was prepared as described in Example 4, except there was employed triphenyl sulfonium hexafluoroantimonate as the photoinitiator and there was utilized in the composition 0.1 part of Dayglo T-13 pigment. A film was cast onto a sheet of polyethyleneterephthalate. After the film dried, it was covered with a contact mask and exposed to ultraviolet light as described in Example 1. The irradiated photosensitive film-polyethyleneterephthalate composite was then contacted to plain white paper and heated to 130°C under pressure. There was obtained a clear negative image of the mask on the white paper. It was found that the composite could be used to transfer sharp negative images of the mask to several additional pieces of paper following the same procedure.

Based on the above results, the curable compositions
of the present invention can be employed as dry film photo-resist to produce printing plates, copper-clad laminates, etc.

The following examples show the use of a diarylhalonium salt in combination with certain organic dyes as visible light photoinitiators for an epoxy resin.

**Example 6.**

A methylene chloride solution was cast onto a Mylar film consisting of 10 parts of Formvar 15/95E, 2.5 parts of Araldite ECN 1299, 0.3 part of diphenyliodonium hexafluoroarsenate, 0.1 part of benzoflavin and about 80 parts of methylene chloride. When the film was dry it was subjected to image-wise exposure using a GE 375W photoflood lamp, which is a visible light source. Irradiation for 5 minutes produced a clear image in the film. The latent image was developed using chloroform, 2-ethoxyethyleacetate or methylene chloride, resulting in a clear upraised reproduction of the mask.

The above procedure was repeated except that in place of benzoflavin, there was used acridine orange. In addition, a third film was cast using phosphene-R dye in place of the benzoflavin. It was found that substantially equivalent results were obtained with each of the aforementioned dyes, which were substituted for benzoflavin.

A curable composition was prepared as described above in which Formvar 15/95E was substituted with an equivalent weight of ethylcellulose. A film was cast from this mixture and subjected to image-wise exposure using a contact mask. It was
found that the resulting exposed film dissolved completely in chloroform when development of the film was attempted. This indicated that no cross-linking had occurred in the absence of the polyvinylacetal which was required to make a dry film photoresist.

In addition to the above shown dyes employed in the visible light curable compositions of the present invention, other dyes which can be used in combination with the diphenyliodonium salts, used in the practice of the invention, are cationic dyes, such as shown in volume 20, page 194-7 of the Kirk-Othmer Encyclopedia, second edition 1965, John Wiley & Sons, New York. In addition to the aforementioned cationic dyes, basic dyes also can be used which are shown in volume 7, pages 532-4 of the Kirk-Othmer Encyclopedia as cited above. Some of the cationic dyes which can be used are, for example,

- Acridine orange C.I. 46005
- Acridine yellow C.I. 46025
- Setoflavin T C.I. 49005.

In addition, some of the basic dyes which can be used are, for example,

- Haematoporphyrin
- 4,4'-bisdimethylaminobenzophenone
- 4,4'-bisdiethylaminobenzophenone, etc.
The claims defining the invention are as follows:

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A curable composition which comprises by weight,
   (A) 0.5% to 98% of epoxy resin,
   (B) 0.5% to 98% of polyvinyl acetal,
   (C) 0.1% to 10% of aromatic onium salt,
where the sum of (A), (B) and (C) is 100% and (C) is selected from an aromatic halonium salt or mixtures thereof of the formula,

\[(\text{R})_a \ (\text{R}^1)_b \text{D]} [\text{MQ}_d]^{-(d-e)} \]

an aromatic onium salt of a Group Va element of the formula

\[(\text{R})_f \ (\text{R}^2)_g \ (\text{R}^3)_h \text{E]} [\text{MQ}_d]^{-(d-e)} \]

and an aromatic onium salt of a Group Via element of the formula,

\[(\text{R})_x \ (\text{R}^4)_i \ (\text{R}^5)_j \text{G]} [\text{MQ}_d]^{-(d-e)} \]

where \( \text{R} \) is a monovalent aromatic organic radical, \( \text{R}^1 \) is a divalent aromatic organic radical, \( \text{R}^2 \) and \( \text{R}^4 \) are monovalent organic aliphatic radicals selected from alkyl, cyclo alkyl and substituted alkyl, \( \text{R}^3 \) and \( \text{R}^5 \) are polyvalent organic radicals selected from aliphatic radicals and aromatic radicals forming a heterocyclic or fused ring structure with \( \text{E} \) or \( \text{G} \), such as \( \text{I} \), \( \text{E} \) is a Group Va element selected from N, P, As, Sb and Bi, \( \text{G} \) is a group Via element selected from S, Se and Te, \( \text{M} \) is a metal or metalloid, \( \text{Q} \) is a halogen radical.

"a" is a whole number equal to 0 or 2,
"b" is a whole number equal to 0 or 1
and the sum of "a" + "b" is equal to 2
or the valence of \( \text{D} \).
"f" is a whole number equal to 0 to 4 inclusive,
"g" is a whole number equal to 0 to 2 inclusive,
"h" is a whole number equal to 0 to 2 inclusive and the sum of "f" + "g" + "h" is a value equal to 4 or the valence of E,
"j" is a whole number equal to 0 to 3 inclusive,
"k" is a whole number equal to 0 to 2 inclusive, and
"m" is a whole number equal to 0 or 1, where the sum of "j" + "k" + "m" is a value equal to 3 or the valence of G,
\[ c = d - e, \]
e is equal to the valence of M and is an integer equal to 2-7 inclusive, and
d>e and is an integer having a value up to 8.

2. An organic solvent solution of the curable composition of claim 1.

3. The curable composition of claim 1, in the form of a film.

4. A curable composition in accordance with claim 1, where the polyvinyl acetal consists essentially of a mixture of from about 5 to about 5000 units selected from,
\[
\text{-CH-CH}_2\text{-CH-CH}_2\text{-}, \quad \text{and}
\]
\[
\text{-CH}_2\text{-CH-CH-CH}_2\text{-}, \quad \text{and}
\]
chemically combined with
where R₆ is a C₈ alkyl radical.

5. A curable composition in accordance with claim 4, where R is methyl.

6. A curable composition in accordance with claim 4, where R is butyl.

7. A curable composition in accordance with claim 1, where the aromatic onium salt is an aromatic iodonium salt.

8. A curable composition in accordance with claim 1, where the aromatic onium salt is a salt of a Group Va element.

9. A curable composition in accordance with claim 1, where the aromatic onium salt is a salt of a Group VIa element.

10. A curable composition in accordance with claim 1, where the aromatic onium salt is a triphenylsulfonium hexafluoroantimonate.

11. A curable composition in accordance with claim 1, where the aromatic onium salt is diphenyliodonium hexafluoroarsenate.

12. A curable composition in accordance with claim 1, where the aromatic onium salt is triphenylsulfonium hexafluoroarsenate.

13. A curable composition in accordance with claim 1, where the vinylacetal is polyvinylformal.

14. A curable composition in accordance with claim 1, where the vinylacetal is a reaction product of polyvinyl alcohol and butyraldehyde.

15. A curable composition in accordance with claim 1, comprising a chloroform solution of polyvinylformal, a Cresol-Novolac epoxy resin and triphenylsulfonium hexafluoroantimonate.
16. A methylene chloride solution of a composition in accordance with claim 1, comprising a reaction product of polyvinyl alcohol and butyraldehyde, a cresol-novolac epoxy resin and triphenylsulfonium hexafluoroarseninate.

17. A film cast from the composition of claim 15.

18. A method for making a circuit board which comprises,

(1) contacting a film made by casting a solution of the composition of claim 1, to a copper-clad laminate to produce a composite structure,

(2) placing a contact mask onto the cast film of the composite structure of (1),

(3) exposing the composite structure of ultraviolet light to effect the cure of exposed areas of the cast film of the composite structure of (1),

(4) developing the resulting exposed composite structure of (1) to produce a copper-clad laminate protected by a negative photoresist of the contact mask used in (2),

(5) etching the copper-clad laminate to effect the removal of exposed areas of copper therefrom, and

(6) removing the negative photoresist from the resulting copper-clad laminate to produce a circuit board comprised of copper patterned as a positive image of the mask used in (2).

19. A method for making a printing plate which comprises,

(1) contacting a mask to a film made by casting the curable composition of claim 1,
(2) exposing the resulting composite structure of (1) to ultraviolet light to effect the cure of exposed areas of the cast film, and (3) developing the resulting film to produce a raised image of the mask of (1).

20. A visible light curable composition in accordance with claim 1, having an aromatic iodonium salt and an organic dye.

DATED this 25th day of MAY, 1977

GENERAL ELECTRIC COMPANY

BY THEIR PATENT ATTORNEYS,

ARTHUR S. CAVE & CO.