APPLICATION FOR A STANDARD PATENT OR A STANDARD PATENT OF ADDITION

We (a) GENERAL ELECTRIC COMPANY

of (b) 1 River Road, Schenectady, New York, USA

hereby apply for the grant of a (c) Standard Patent for an invention entitled (d) AN IMPROVED COMPOSITION

which is described in the accompanying (optional) specification.

(e) For a Convention application — details of basic application(s) —

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>COUNTRY</th>
<th>DATE OF APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>508,550</td>
<td>U.S.A.</td>
<td>28th June 1983</td>
</tr>
</tbody>
</table>

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

I/we request that the main invention or so much of the invention as is claimed in the Patent applied for be included in the specification.

PATENT OFFICE

[Stamp]

The date on which the application is lodged is 21st June 1984.

To:

Commissioner of Patents

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

JAMES G. SIELY F.I.P.A.A.
The blend compositions of this invention comprise an amount, preferably major, of an ABS resin. The term "ABS resin" is employed throughout this disclosure in its conventional sense to designate an established family of materials most commonly represented by a terpolymer or blend of acrylonitrile, butadiene and styrene polymers, but which also encompasses blends of terpolymers of homologous or analogous polymers. Thus, instead of acrylonitrile, the resin which constitutes component (a) of the present compositions can be based on other alkenyl cyanides, such as methacrylonitrile or ethacrylonitrile, or the like. Instead of polybutadiene, the latter can be replaced partly or entirely by other conjugated diolefin polymers, such as isoprene; pentadiene-1,3; the methyl, 1,3-pentadienes; dimethyl butadiene-1,3; the 1,3 and 2,4-hexadienes, and the like. Likewise, in the preparation of the ABS resin, the styrene may be replaced in whole or in part by such vinyl aromatic compounds as alpha-methyl styrene, para-methyl styrene, vinyl toluenes, alpha-methyl vinyl toluenes, and the like.
1. A thermoplastic composition comprising an admixture of:

(a) a resin comprised of an alkenyl cyanide polymer, a conjugated diolefin polymer and a vinyl aromatic polymer; and

(b) an effective amount of a flame retardant agent, comprising (i) a polyphenylene ether resin, (ii) an organic phosphate, and (iii) a brominated bis-phenoxy alkane or an oligomeric tetrabromobisphenol-A polycarbonate or a mixture of both.

5. A composition according to Claim 1, in which the organic phosphate is an aromatic phosphate compound of the formula

```
RO = P = OR
```

wherein R is the same or different and is alkyl, cyclo-alkyl, aryl, alkyl substituted aryl, halogen substituted alkyl, halogen, or a combination of any of the foregoing, provided at least one R is aryl.
Short Title:  

Int. Cl.:  

Application Number: 29843/64  
Lodged:  

Complete Specification - Lodged:  
Accepted:  
Lapsed:  
Published:  

Priority:  
Related Art:  

-To be completed by Applicant-

Name of Applicant: GENERAL ELECTRIC COMPANY
Address of Applicant: 1 River Road, Schenectady, New York, USA
Actual Inventor: Visvaldis ABOLINS, Fred Frank HOLUB and Joseph Elwood BETTS
Address for Service: ARTHUR S. CAVE & CO., Patent and Trade Mark Attorneys, 1 Alfred Street, Sydney, New South Wales, Australia, 2000.

Complete Specification for the invention entitled: AN IMPROVED COMPOSITION

The following statement is a full description of this invention, including the best method of performing it known to me:

ASC. 48 & 49
BACKGROUND OF THE INVENTION

The polyphenylene ether resins are a known class of engineering thermoplastic polymers which can be molded into articles characterized by good properties. These resins and methods for their preparation are described in U.S. Patent Nos. 3,306,874 and 3,306,875 (to Allan Hay), and U.S. Patent Nos. 3,257,357 and 3,257,358 (to Gelu Stamatoff).

It is also known that polyphenylene ether resins can be admixed with styrene homopolymers or copolymers to produce blends which are moldable into articles having properties superior to those of each of the two polymers alone. Blends of this type are described by Cizek in U.S. Patent No. 3,383,435.

Compositions of polyphenylene ether resin and styrene resins are normally flammable, and to improve the flame retardancy there have been many proposals for adding flame retardant agents to such blends. Haaf discloses the usefulness of aromatic phosphate compounds and aromatic halogen compounds together as a flame retardant agent for compositions of polyphenylene ether resin and styrene resin, in U.S. Patent No. 3,639,506. Cooper and Katchman, in U.S. Patent No. 4,101,503, disclose impact modified polyphenylene ether resin compositions a preferred feature of which is the inclusion of a flame retardant agent which can be a halogenated organic compound in admixture with a phosphorous compound. Compositions of polyphenylene ether and styrene copolymers containing a flame retardant combination of an aromatic phosphate and an aromatic halogen compound are described in U.S. Patent No. 4,191,685 (to William R. Haaf). Robert Axelrod discloses flame retardant compositions of polyphenylene ether resin, styrene resin and cyclic phosphate having
excellent appearance and physical properties after molding, in U.S. Patent No. 4,154,775.

**SUMMARY OF THE INVENTION (non-limiting)**

The present invention comprises thermoplastic compositions useful for preparation into shaped flame retardant articles, and which comprise (a) an amount of an ABS resin and (b) a flame retardant amount of an agent comprising a combination of (i) a polyphenylene ether resin, (ii) an organic phosphate, and (iii) a brominated bisphenoxy alkane, or a tetrabromobisphenol-A oligomeric polycarbonate, or a mixture of both.

The combined presence of the three components of the flame retardant agent in the compositions provides good self-extinguishing and drip retardant behavior. The agents of the invention improve the properties of the compositions.

**EXAMPLE 13**

The ingredients were mixed at 25
DESCRIPTION OF THE INVENTION (preferred)

The blend compositions of this invention comprise an amount, preferably major, of an ABS resin. The term "ABS resin" is employed throughout this disclosure in its conventional sense to designate an established family of materials most commonly represented by a terpolymers or blend of acrylonitrile, butadiene and styrene polymers, but which also encompasses blends or terpolymers of homologous or analogous polymers. Thus, instead of acrylonitrile, the resin which constitutes component (a) of the present compositions can be based on other alkenyl cyanides, such as methacrylonitrile or ethacrylonitrile, or the like. Instead of polybutadiene, the latter can be replaced partly or entirely by other conjugated diolefin polymers, such as isoprene; pentadiene-1,3; the methyl,1,3-pentadiene; dimethyl butadiene-1,3; the 1,3 and 2,4-hexadienes, and the like. Likewise, in the preparation of the ABS resin, the styrene may be replaced in whole or in part by such vinyl aromatic compounds as alpha-methyl styrene, para-methyl styrene, vinyl toluenes, alpha-methyl vinyl toluenes, and the like.

As is known to those skilled in the art, there are principal methods of preparation for ABS resins. One of these involves generally the mechanical blending of the dry polymeric ingredients or mixing latexes of acrylonitrile-styrene copolymer resin and butadiene-based rubber. Resins made by the foregoing procedures are sometimes referred to as "Type A". In one procedure, described in U.S. Patent No. 2,439,202, a tough molding composition is prepared by blending a butadiene-acrylonitrile rubber with an acrylonitrile-styrene resin. Variants of this procedure are also known, in which the acrylonitrile content of the rubber is reduced or replaced with polybutadiene rubber, styrene-butadiene rubber, acrylic elastomers or natural rubber, and these too are described in

EXAMPLES 14-15

The following compositions were prepared by

A second method involves polymerization of a styrene-acrylonitrile mixture in the presence of a polybutadiene latex, or in the presence of other elastomers or mixtures of an acrylonitrile-styrene copolymer latex and a polybutadiene latex, to produce a resin which is sometimes referred to as "Type B". This polymerization procedure is usually carried out in an emulsion, but suspension techniques are also sometimes employed. For a further description of these types of procedures, reference may be made to the ENCYCLOPEDIA OF POLYMER SCIENCE AND TECHNOLOGY, supra, and the patent literature cited therein.

The polyphenylene ether resin component of the flame retardant is preferably a homo- or copolymer having units of the formula

\[
\begin{array}{c}
\text{Q'''} \\
\text{Q'} \\
\text{Q''} \\
\text{Q}
\end{array}
\]

\[\text{n}\]

wherein Q, Q', Q'' and Q''', are independently selected from the group consisting of hydrogen, halogen, hydrocarbon radicals, halohydrocarbon radicals, hydrocarboxy radicals, and halohydrocarboxy radicals; and n represents the total number of monomer units and is an integer at least about 20, and preferably at least 50.

In general, the polyphenylene ether resins are self-condensation products of monohydric monocyclic phenols produced by reacting the phenols with oxygen in the presence of complex metal catalysts, with molecular weight being controlled by reaction time, longer times providing
a higher average number of repeating units. Particular procedures are known to those skilled in the art and are described in the patent literature, including U.S. 3,306,874 and 3,306,875, and U.S. Patent Nos. 3,257,357 and 3,257,358, which have been referred to above.

Illustrative polymers which can be produced by such procedures and which are within the above general formula are: poly(2,6-dilauryl-1,4-phenylene)ether; poly(2,6-diphenyl-1,4-phenylene)ether; poly(2,6-dimethoxy-1,4-phenylene)ether; poly(2,6-diethoxy-1,4-phenylene)ether; poly(2-methoxy-6-ethoxy-1,4-phenylene)ether; poly(2-ethyl-6-stearloxy-1,4-phenylene)ether; poly(2,6-dichloro-1,4-phenylene)ether; poly(2-methyl-6-phenyl-1,4-phenylene)ether; poly(2,6-dibenzyl-1,4-phenylene)ether; poly(2-ethoxy-1,4-phenylene)ether; poly(2-chloro-1,4-phenylene)ether; poly(2,6-dibromo-1,4-phenylene)ether; and the like. Examples of polyphenylene ethers corresponding to the above formula can be found in the above mentioned patents of Hay and Stamatoff.

Also included are polyphenylene ether copolymers, such as copolymers of 2,6-dimethylphenol with other phenols, for example, with 2,3,6-trimethylphenol or 2-methyl-6-butylphenol, etc.

For purposes of the present invention, an especially preferred family of polyphenylene ethers include those having alkyl substitution in the two positions ortho to the oxygen ether atom, i.e., those of the above formula wherein Q and Q' are alkyl, preferably having from 1 to 4 carbon atoms. Illustrative members of this class are: poly(2,6-dimethyl-1,4-phenylene)ether; poly(2,6-diethyl-1,4-phenylene)ether; poly(2-methyl-6-ethyl-1,4-phenylene)ether; poly(2-methyl-6-propyl-1,4-phenylene)ether; poly(2,6-dipropyl-1,4-phenylene)ether; poly(2-ethyl-6-propyl-1,4-phenylene)ether; and the like.
The most preferred polyphenylene ether resin for purposes of the present invention is poly(2,6-dimethyl-1,4-phenylene)ether.

The organic phosphate of the flame retardant agent, component (b)(ii), is preferably an aromatic phosphate compound having the formula

\[
\begin{align*}
\text{RO} & \quad \text{P} \quad \text{OR} \\
\text{OR} & \quad \text{OR}
\end{align*}
\]

where \( R \) is the same or different and is alkyl, cycloalkyl, aryl, alkyl substituted aryl, halogen substituted aryl, aryl substituted alkyl, halogen, or a combination of any of the foregoing, provided at least one \( R \) is aryl.

Examples include phenylbisdecyl phosphate, phenylbisneopentyl phosphate, phenyl-bis(3,5,5'-trimethylhexyl phosphate), ethylidiphenyl phosphate, 2-ethyl-hexyldiphenyl (p-tolyl) phosphate, bis-(2-ethylhexyl) p-tolylphosphate, tritolyl phosphate, bis-(2-ethylhexyl) phenyl phosphate, tri-(methylphenyl) phosphate, di(dodecyl) p-tolylphosphate, tri-cresyl phosphate, tributylphenyl phosphate, 2-chloroethylidiphenylphosphophate, p-tolyl bis (2,5,5'-trimethylhexyl) phosphate, 2-ethylhexylidiphenyl phosphate, and the like. The preferred phosphates are those in which each \( R \) is aryl. Especially preferred is triphenylphosphate, which may be either unsubstituted or substituted, for example, isopropylated triphenyl phosphate.

Alternatively, the aromatic phosphate can be a di- or polyfunctional compound or polymer having the formula

\[
\begin{align*}
\text{R}_1 \text{O} & \quad \text{P} \quad \text{OR}_1 \\
\text{R}_2 & \quad \text{O} \quad \text{P} \\
\text{OR}_2 & \quad \text{OR}_1
\end{align*}
\]

The Claims defining the invention are as follows:
and mixtures thereof, wherein $R_1$, $R_2$, and $R_5$ are, independently, hydrocarbon, $R_2$, $R_4$, $R_6$, and $R_7$ are, independently, hydrocarbon or hydrocarbonoxy, $X^1$, $X^2$, and $X^3$ are halogen, $m$ and $i$ are 0 or integers from 1 to 4, and $n$ and $p$ are from 1 to 30.

Examples include the bis diphenyl phosphates of resorcinol, hydroquinone or bisphenol-A, respectively, or their polymeric higher molecular weight counterparts.

These phosphates and methods of their preparation are described in British Patent No. 2,043,083.

In preferred embodiments, the polyphenylene ether resin is present in amounts equivalent to or greater than the organic phosphate, and especially in a weight ratio of polyphenylene ether: organic phosphate of between 1:1 and 20:1.

In general, components (b)(i) and (b)(ii) are supplied in amounts sufficient to provide between about 5 and about 70 parts by weight of the former and between about 1 and about 20 parts by weight of the latter, based
on 100 parts of resin in the composition, i.e., the ABS
and polyphenylene ether resins combined.

Small amounts of a brominated bisphenoxy
alkane, component (b)(iii), can further enhance the
flame retardancy of the present compositions. This com-
 pound should be reasonably stable at elevated tempera-
tures above 100°C., and relatively non-volatile, e.g.,
having a low volatility at temperatures of 100 to 150°C.

More specifically, the compound has the formula

where \( R' \) is alkylene, straight or branched, having from
1 to 10 carbon atoms, and more preferably from 1 to about
6 carbon atoms; and \( q \) and \( s \) represent the total number
of bromine atoms of each ring and are independently in-
tegers from 1 to 5.

The brominated bisphenoxy alkane is typically
employed in minor proportions in the compositions. Amounts
of between about 1 and about 20 parts by weight, based on
the total resin weight, of this component are normally suf-
ficient to decrease the average quenching time and/or to
retard the tendency of the composition to drip molten resin,
and such amounts are preferred.

Examples of brominated bis-phenoxy alkane com-
 pounds useful in the practice of this invention are 1,2-
bis(2,4,6-tribromophenoxy)ethane; 1,3-bis(2,4,6-tribromo-
phenoxy)propane; 1,4-bis(2,4,6-tribromophenoxy)butane;
2,2-bis(4-bromophenoxy)propane, and 1,2-bis(2,3,4,5,6-
pentabromophenoxy)ethane. Preferred are 1,2-bis(2,4,6-
tribromophenoxy)ethane and 1,2-bis(2,3,4,5,6-pentabromo-
phenoxy)ethane.
Preparation of component (b)(iii) may be accomplished by following the procedure described in U.S. Patent No. 4,016,138 (Anderson).

Also useful are flame retardant brominated polymers, especially tetrabromobisphenol-A oligomeric polycarbonate.

The compositions of this invention can also be formulated to include one or more supplementary ingredients to improve the chemical or physical properties of the moldings or to facilitate the processing during the molding cycle. These can be selected from among conventional additives for such purposes, including mineral fillers (e.g., clay), reinforcing fillers, strengthening fibers (e.g., glass fibers), plasticizers, stabilizers, antioxidants, melt viscosity reducers, pigments, dyes, and so forth. Such ingredients are generally added in amounts ranging from 1 to about 50% by weight, or more, based on the total composition weight.

For other property modification, it may be helpful to add a modifying polymer selected from among polymers having elastomeric properties. These may be copolymers of an elastomeric material, such as polybutadiene, polyisoprene or other rubbery polyolefin. Examples include polystyrene-polybutadiene block copolymers, polystyrene-polyisoprene block copolymers, polystyrene-polybutadiene-polystyrene block copolymers, polystyrene-polyisoprene-polybutadiene block copolymers, polystyrene-polyethylene/polybutylene-polystyrene block copolymers, and so forth.

Preparation of the compositions may be accomplished by milling the ingredients at a temperature in the range between 310 and 450°F. (154 and 232°C), and molding the milled material at a temperature of 370 to 460°F. (188 to 238°C). Other methods of preparation are possible, however, as shown in some of the examples.
I) may be described in

Plant brominated

ol-A oligomeric

Invention can also be supplemented in physical properties by additional processing during preparation from among components, including mineral fillers, strengthening agents, stabilizers, pigments, dyes, etc., generally added in parts by weight, or more, if required. It may be cured from among materials such as polyethylene, polypropylene, ethylene oxide copolymers, etc. The compositions may be accommodated in a temperature range of 310 to 320°F. (154 to 160°C.) and molded at 370°F. (188°C.) for ten minutes or more. The results are shown in Table 2, below.

### TABLE 1

<table>
<thead>
<tr>
<th>Table 2 below:</th>
</tr>
</thead>
</table>

- **Example 1**: The ingredients noted below were milled on a two roll mill at a temperature of 320 to 360°F. (160 to 182°C.), and molded to 440°F. (227°C.) for ten minutes to provide moldings of the composition shown, which were then evaluated for flame retardancy.

**TABLE 1**

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylonitrile-butadiene-styrene resin</td>
<td>80</td>
<td>70</td>
<td>100</td>
</tr>
<tr>
<td>Poly(2,6-dimethyl-1,4-phenylene)ether resin</td>
<td>20</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Isopropylated triphenyl phosphate</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>1,2-bis(2,4,6-tribromophenoxy)ethane</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Vertical Burn Test, 1/8 inch, (3/10 cm.) thick specimen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drip Characteristics</td>
<td>ND, ND, ND</td>
<td>ND, ND, ND</td>
<td>ND, ND, ND</td>
</tr>
<tr>
<td>Seconds to quench</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st ignition</td>
<td>0,0,0</td>
<td>0,0,0</td>
<td>&gt;30,&gt;30,&gt;30</td>
</tr>
<tr>
<td>2nd ignition</td>
<td>0,0,0</td>
<td>0,0,0</td>
<td>Burns</td>
</tr>
</tbody>
</table>

**Example 2**: The compositions were prepared by milling the ingredients (two roll mill) at 310 to 320°F. (154 to 160°C.) and molding at 370°F. (188°C.) for ten minutes. The results are shown in Table 2, below.
<table>
<thead>
<tr>
<th>Ingredients</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylonitrile-butadiene-styrene resin</td>
<td>100</td>
<td>70</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Poly(2,6-dimethyl-1,4-phenylene)ether resin</td>
<td>--</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Isopropylated triphenyl phosphate</td>
<td>--</td>
<td>--</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>1,2-bis(2,3,4,5,6-pentabromophenoxy)ethane</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>4</td>
</tr>
</tbody>
</table>

Vertical Burn Test, 1/8 inch (3/10 cm.)

- **Drip Characteristics**
  - ND, ND
  - ND, ND
  - ND, ND
  - ND, ND

- **Seconds to Quench**
  - 1st ignition
  - >30, >30
  - >30, >30
  - >30, >30
  - 3, 3

ND = No Drip
### TABLE 2

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylonitrile-butadiene-styrene resin</td>
<td>100</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Poly(2,6-dimethyl-1,4-phenylene)ether resin</td>
<td>--</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Isopropylated triphenyl phosphate</td>
<td>--</td>
<td>--</td>
<td>10</td>
</tr>
<tr>
<td>1,2-bis(2,3,4,5,6-pentabromophenoxy)ethane</td>
<td>--</td>
<td>--</td>
<td>10</td>
</tr>
</tbody>
</table>

Vertical Burn Test, 1/8 inch (3/10 cm.) thick specimen

Drip Characteristics

<table>
<thead>
<tr>
<th>Seconds to Quench</th>
<th>1st ignition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ND,ND</td>
<td>ND,ND</td>
</tr>
<tr>
<td>ND,ND</td>
<td>ND,ND</td>
</tr>
<tr>
<td>ND,ND</td>
<td>ND,ND</td>
</tr>
<tr>
<td>&gt;30,&gt;30</td>
<td>&gt;30,&gt;30</td>
</tr>
<tr>
<td>&gt;30,&gt;30</td>
<td>&gt;30,&gt;30</td>
</tr>
</tbody>
</table>

ND = No Drip
<table>
<thead>
<tr>
<th></th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
</tr>
</thead>
<tbody>
<tr>
<td>2e ne resin</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>2ene)ether resin</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>phosphate</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>phenox)ethane</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>4</td>
</tr>
</tbody>
</table>

(3/10 cm.)

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ND,ND</td>
<td>ND,ND</td>
<td>ND,ND</td>
<td>ND,ND</td>
<td>ND,ND</td>
</tr>
<tr>
<td></td>
<td>&gt;30,&gt;30</td>
<td>&gt;30,&gt;30</td>
<td>&gt;30,&gt;30</td>
<td>3,3</td>
<td></td>
</tr>
</tbody>
</table>
EXAMPLES 8-9

Additional compositions according to the invention, containing antimony oxide synergistic agent, were prepared by milling the ingredients at 310-320°F. (154-160°C.) and compression molding at 370°F. (188°C.).

The results are shown in Table 3.

<table>
<thead>
<tr>
<th>TABLE 3</th>
</tr>
</thead>
</table>

| Ingredients                                                                 | 8   | 9   |
| Acrylonitrile-butadiene-styrene resin                                      | 50  | 30  |
| Poly(2,6-dimethyl-1,4-phenylene ether resin                                | 50  | 70  |
| Isopropylated triphenyl phosphate                                          | 10  | 10  |
| 1,2-bis(2,4,6-tribromophenoxy)ethane                                       | 5   | 5   |
| Antimony oxide                                                             | 2   | 2   |

<table>
<thead>
<tr>
<th>Vertical Burn Test (1/8&quot; or 3/10 cm.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drip Characteristics</td>
</tr>
<tr>
<td>Seconds to quench</td>
</tr>
<tr>
<td>1st ignition</td>
</tr>
<tr>
<td>2nd ignition</td>
</tr>
</tbody>
</table>

ND = No Drip
EXAMPLES 10-12

The compositions were prepared by milling the ingredients at 380-390°F. (193-199°C.) and molding for ten minutes at 450-460°F. (232-238°C.). The results are shown in the Table.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylonitrile-butadiene-styrene resin</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Poly(2,6-dimethyl-1,4-phenylene ether) resin</td>
<td>40</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>Isopropylated triphenyl phosphate</td>
<td>10</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Styrene-ethylene-butylene-styrene block copolymer</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Tetrabromobisphenol-A oligomeric polycarbonate</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Bis diphenyl phosphate of resorcinol</td>
<td>--</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Antimony oxide</td>
<td>--</td>
<td>5</td>
<td>--</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Properties</th>
<th>10 seconds</th>
<th>25 seconds</th>
<th>30 seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal-propagation test, 1/8 in. after 30 seconds</td>
<td>3,1</td>
<td>0,1</td>
<td>1,1</td>
</tr>
<tr>
<td>Horizontal Burn Test, 1/8 inch(3/10 cm) specimen</td>
<td>ND,ND</td>
<td>ND,ND</td>
<td>ND,ND</td>
</tr>
<tr>
<td>Vertical Burn Test, 1/8 inch(3/10 cm) specimen</td>
<td>ND,ND</td>
<td>ND,ND</td>
<td>ND,ND</td>
</tr>
<tr>
<td>Seconds to quench, 1st ignition</td>
<td>4,4</td>
<td>3,3</td>
<td>2,2</td>
</tr>
<tr>
<td>2nd ignition</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* pre-extruded together at 500-600°F. (260-316°C.)
ND = No Drip
EXAMPLE 13

The ingredients were milled at 440 to 450°F.
(227 to 232°C.), and molded for ten minutes at 460°F.
(238°C.).

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Table 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS resin</td>
<td>50</td>
</tr>
<tr>
<td>Poly(2,6-dimethyl-1,4-phenylene ether) resin</td>
<td>50</td>
</tr>
<tr>
<td>Bis diphenyl phosphate of resorcinol</td>
<td>10</td>
</tr>
<tr>
<td>Styrene-ethylene/butylene-styrene block copolymer</td>
<td>20</td>
</tr>
</tbody>
</table>

Properties
- Horizontal propagation, after 30 seconds: ¼ in. (6/10 cm.)
- Horizontal Burn Test, 1/8 inch (6/10 cm.) specimen: ND

* pre-extruded at 490-570°F. (254-299°C.)
ND = No Drip
EXAM PLES 14-15

The following compositions were prepared by milling the ingredients at 400-410°F. (204-210°C.), and molding for ten minutes at 460°F. (238°C.).

Table 6

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS resin</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Poly(2,6-dimethyl-1,4-phenylene ether) resin</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Bis diphenyl phosphate of resorcinol</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Styrene-ethylene/butylene-styrene block copolymer</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Tetrabromobisphenol-A oligomeric polycarbonate</td>
<td>--</td>
<td>30</td>
</tr>
<tr>
<td>Antimony oxide</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Horizontal propagation test, (\frac{1}{4}) in. (6/10 cm.) after 30 seconds</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Horizontal Burn Test, 1/8 inch (3/10 cm.) specimen</td>
<td>ND</td>
<td>ND</td>
</tr>
</tbody>
</table>

* pre-extruded at 490-570°F. (254-299°C.)
ND = No Drip

All of the above-mentioned patents and/or publications are incorporated herein by reference. Obviously, other modifications and variations are possible in the light of the above disclosure. For instance, instead of poly(2,6-dimethyl-1,4-phenylene)ether resin, co-polymers such as poly(2,6-dimethyl-co-2,3,6-trimethyl-1,4-phenylene)ether can be substituted. Clay filled or glass fiber reinforced counterparts of the compositions shown are also possible.

Optionally, the compositions of this invention can and often do also contain an additional compound
selected from among those known to synergistically enhance the flame retardancy effect of brominated compounds. These are usually synergistic agents based on antimony or molybdenum. Preferably, the synergist is antimony oxide, as shown. Small amounts, e.g., less than 10% by weight, of this component are sufficient to enhance the flame retardancy effect.

It is to be understood, therefore, that changes may be made in the particular embodiments shown which are within the full intended scope of the invention. In non-limiting summary, the invention provides novel thermoplastic compositions and novel flame retardant agents thereof. The compositions contain a major amount of an ABS resin and an effective amount of the flame retardant agent. The agent is made up of a polyphenylene ether resin, an organic phosphate and a brominated bisphenoxyalkane or tetrabromo-bisphenol-A oligomeric polycarbonate or both.
stantly en-
trated compounds.  

ond anti-
mony or 
antimony 
oxide 
by 
weight, 
that changes 
shown which 
ndant agents 
the flame 
trant 
ylene ether 
ated bispheno-
ol polycarbonate
The Claims defining the invention are as follows:

**CLAIMS**

1. A thermoplastic composition comprising an admixture of:
   (a) a resin comprised of an alkenyl cyanide polymer, a conjugated diolefin polymer and a vinyl aromatic polymer; and
   (b) an effective amount of a flame retardant agent, comprising (i) a polyphenylene ether resin, (ii) an organic phosphate, and (iii) a brominated bisphenol-A polycarbonate or a mixture of both.

2. A composition according to Claim 1, in which component (a) is an acrylonitrile-butadiene-styrene resin.

3. A composition according to Claim 1, in which the polyphenylene ether resin, (b)(i), is a homopolymer or copolymer having units of the formula

   \[
   \begin{array}{c}
   \text{Q''} \\
   \text{Q'} \\
   \text{Q} \\
   \text{Q''} \\
   \end{array}
   \]

   \[n \]

   wherein Q, Q', Q'' and Q'' are independently selected from the group consisting of hydrogen, halogen, hydrocarbon radicals, halohydrocarbon radicals, hydrocarbonyl radicals and halohydrocarbonyl radicals; and n represents the total number of monomer units and is an integer of at least about 20.

4. A composition according to Claim 1, in which component (b)(i) is poly(2,6-dimethyl-1,4-phenylene) ether.
about 1 and about 20 parts by weight of the latter, based

as follows:

on comprising

alkenyl-cyanide

and a vinyl

flame retardant

ether resin,

brominated bis-

bisphenol-A

Claim 1, in

-butadiene-

Claim 1, in

((i), is a homo-

ently selected from

en, hydrocarbon

carbonoxy radi-

and n represents

an integer of

Claim 1, in

(1,4-phenylene)

5. A composition according to Claim 1, in

which the organic phosphate is an aromatic phosphate

compound of the formula

\[
\begin{align*}
&\text{R} \\
&\text{O} \\
&\text{P} \\
&\text{OR}
\end{align*}
\]

wherein R is the same or different and is alkyl, cyclo-

alkyl, aryl, alkyl substituted aryl, halogen substituted

alkyl, halogen, or a combination of any of the foregoing,

provided at least one R is aryl.

6. A composition according to Claim 1, in

which (b) (ii) is triphenyl phosphate.

7. A composition according to Claim 6, in

which the triphenyl phosphate is isopropylated.
8. A composition according to Claim 1, in which component (b)(ii) is a di- or polyfunctional compound or polymer having the formula

\[
\begin{align*}
R_1'O'P & \quad (X')_m \\
R_0'O'P & \quad (X')_m \\
R_0'O'P & \quad (X')_m \\
R_0'O'P & \quad (X')_m
\end{align*}
\]

and mixtures thereof, wherein \( R_1, R_3 \) and \( R_5 \) are, independently, hydrocarbon, \( R_2, R_4, R_6 \) and \( R_7 \) are, independently, hydrocarbon or hydrocarbonoxy, \( X' \), \( x' \) and \( x'' \) are halogen, \( m \) and \( r \) are 0 or integers from 1 to 4, and \( n \) and \( p \) are from 1 to 30.

9. A composition according to Claim 8, in which component (b)(ii) is a bis diphenyl phosphate of resorcinol.

10. A composition according to Claim 8, in which component (b)(ii) is a bis diphenyl phosphate of hydroquinine.
11. A composition according to Claim 8, in which component (b)(ii) is a bis diphenyl phosphate of bisphenol-A.

12. A composition according to Claim 1, in which (b)(iii) has the formula

\[
\begin{array}{c}
\text{(Br)}^q \quad \text{O} \quad \text{R'} \quad \text{O} \quad \text{(Br)}^s \\
\end{array}
\]

wherein R' is alkylene, straight or branched, having from 1 to 10 carbon atoms, and q and s represent the total number of bromine atoms on each ring and are independently integers from 1 to 5.

13. A composition according to Claim 1, in which (b)(iii) is 1,2-bis(2,4,6-tribromophenoxy) ethane.

14. A composition according to Claim 1, in which (b)(iii) is 1,2-bis(2,3,4,5,6-pentabromophenoxy) ethane.

15. A composition according to Claim 1, in which (b)(iii) is tetrabromobisphenol-A oligomeric polycarbonate.

16. A composition according to Claim 1, in which the weight ratio of (b)(i) to (b)(ii) is between 1:1 and 20:1.

17. A composition according to Claim 1, in which component (a) is present in a major amount, (b)(i) is present in an amount between about 5 and about 70 parts by weight, (b)(ii) is present in an amount between about 1 and about 20 parts by weight, and (b)(iii) is present in an amount between about 1 and about 20 parts by weight, based on 100 parts of (a) and (b)(i) combined.

18. A composition according to Claim 1, which also includes a synergistic agent for (b)(iii).

19. A composition according to Claim 18, in which the synergistic agent is an antimony compound.
20. A composition according to Claim 19, in which the antimony compound is antimony oxide.

21. A composition according to Claim 1, which includes a modifying elastomeric polymer.

22. A composition according to Claim 21, in which the modifying elastomeric polymer is a styrene-butadiene-styrene block copolymer.

23. A composition according to Claim 21, in which the modifying elastomeric polymer is a styrene-ethylene/butylene-styrene block copolymer.

24. A composition according to Claim 21, in which the modifying elastomeric polymer is a styrene-isoprene-styrene block copolymer.

25. A composition according to Claim 1, which also includes a filler.

26. A thermoplastic composition substantially as herein described.

27. A flame retardant agent substantially as herein described.

DATED this 21st day of June 1984

GENERAL ELECTRIC COMPANY
By Its Patent Attorneys

ARTHUR S. CAVE & CO.
According to Claim 19, in tony oxide.
According to Claim 1, which styrene.
According to Claim 21, in styrene.
According to Claim 21, in styrene-
According to Claim 21, in styrene-
According to Claim 1, which styrene-
According to Claim 1, which styrene-
According to Claim 1, which styrene-
According to Claim 1, which styrene-

June 1984.

ELECTRIC COMPANY
Patent Attorneys
S. CAVE & CO.