

Monsanto

LEGAL COUNSEL & LITIGATION

Patent Department - General Offices

DATE

December 3, 1969

SUBJECT

Patent and Literature Survey

AROCLOR and Biphenyl

REFERENCE

HSB to JEM, 12-9-68

TO

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HBERG

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W. A. Kuhn - WKUHN
R. M. Kountz - RKOUN
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The Patent Department has completed the survey you requested on recent patents and literature relating to polyphenyls and chlorinated polyphenyls to determine current areas of commercial interest and to develop a picture of "who is doing what" in this area.

The scope of the survey included the manufacture and chlorination of polyphenyls and uses of the chlorinated material. Particular emphasis was placed in the pyrolysis of benzene, chlorination of biphenyl, and uses of AROCLOR, as being of particular business interest.

The patent art was searched back to 1950. This cut-off date was selected on the basis that the search would include all unexpired patents and that any patents issuing prior to 1950 and still of current interest would be well known in the business group.

The literature search covered a period from 1965 to 1968, the last three years reported in Chemical Abstracts. Earlier searching did not appear justified considering that important novel work published prior to 1965 would be expected to be disclosed in recent patent literature.

A patent survey reported in 1958 dealt at length with the history and development of the AROCLOR business, and discussed the possible areas in which Monsanto might improve its patent position. The information contained in that report is intended to supplement the present search results, and a copy of the report is appended hereto.

Patents and literature relating to the manufacture of biphenyls and chlorinated biphenyls are contained within a relatively narrow field of search and can be collected

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without great difficulty. Information on the use of these materials, however, is scattered throughout the literature and patent art, and it is impossible to conduct a search with a high level of confidence that all pertinent references have been found. This is particularly true for a versatile material like AROCLOR which is found in many widely divergent applications.

Because of the complexity of uncovering use patents, we resorted to computer searching by IFI (Information for Industry). A check of these search results against our collection of known references gave evidence that the machine searching technique is not sufficiently dependable to be used alone, but that it is a valuable contributor to the total search effort. Accordingly, the results contained herein are not represented as being an all-inclusive collection of the prior art with no reference omitted, but certainly a good segment of the pertinent art is reported and should provide a basis for examining the activities of others in this field. In the event that a critical study should be required in any particular area for legal or business reasons, this collection of art can be used as a basis from which a complete study can be developed.

The search was organized according to the Index which is appended hereto together with abstracts of all the pertinent patents and literature references collected in the search. The discussion which follows is organized according to the main headings of this index. Numbers in parenthesis following section headings designate the number of references included in that section.

DISCUSSION

I. Manufacture of Diphenyl

A. Pyrolysis of Benzene (13)

Recent patents have been issued to Dow Chemical and Progil. Dow 3,262,983 specifies the use of certain nickel chromium steels to inhibit carbon formation in the reactor. This is Dow's equivalent to Monsanto 3,228,994 which specifies reactor alloys such as Hastalloy X. Dow 3,359,340 teaches the pyrolysis of benzene containing small amounts of phenol in the presence of copper. Three older Dow patents are listed for general interest.

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Progil 3,112,349 and 3,227,525 disclose conditions and apparatus for the pyrolysis of benzene which have already been given considerable attention by Monsanto. Progil 3,207,799 concerns the deliberate preparation of terphenyls by recycling diphenyl through the pyrolysis zone. None of these patents are considered to threaten Monsanto's position.

In addition to the patent mentioned above, Monsanto 2,702,307 describes a basic process for pyrolysis in terms of temperature and vapor flow rate. These two patents are the only ones on pyrolysis issuing to Monsanto since 1950.

B. Other Routes (16)

Other routes to biphenyl include mainly liquid phase reactions and hydrodealkylation of petroleum fractions. Gulf 3,401,207 and Shell 3,145,237 concern the catalytic coupling of benzene. Universal Oil 3,274,277 describes an interesting process for the reaction of benzene and ethylene under pressure in the liquid phase.

Phillips 3,435,084 describes the preparation of biphenyl by hydrodealkylation of certain petroleum fractions. Ashland 3,055,956 and 2,951,886, and Atlantic 3,160,671 disclose processes for preparing benzene by a hydrodealkylation process which presumably could be controlled to produce biphenyl.

Monsanto holds four patents on the preparation of terphenyls by arylation of aromatics. One of these, 3,231,629, is reported to be a basic MCL patent.

C. Refining and Purification (4)

Dow 3,363,020 is a recent issue which refines and decolorizes biphenyl by the addition of sulfuric acid followed by distillation. Also of interest is unassigned Czech. patent 124,741 which treats diphenyl with a mixture of CaO and Perlite to improve the dielectric constant.

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II. Chlorination (13)

d'Ugine 3,029,295 (Fr. 1,387,233) describes a process for the vapor phase chlorination which is reported to provide high purity material in good yield. This patent could have an adverse affect on Monsanto's business interests and is presently the subject of separate validity study.

Liquid phase chlorination of polyphenyls is disclosed in two patents to Pennsalt; 2,859,252 describes chlorination by reaction with benzene hexachloride and 2,812,370 concerns recovery of the $AlCl_3$ catalyst used in the reaction.

Texaco 3,358,040 is directed to the preparation of chlorinated biphenyls and biphenyl ethers from substituted diphenyls and biphenyl ethers from substituted diphenyls. French 1,448,922 to Sandoz describes chlorination of biphenyl in a $TiCl_4$ solvent. The remaining references in this section are of general interest.

Monsanto patents in this area issuing since 1950 include two on the preparation of AROCLOR by decomposing an aromatic sulfonyl halide, and one on the chlorination of *m*-diphenylbenzene. Monsanto's basic patents to the chlorination of biphenyl were issued prior to 1950 and are expired.

III. Functional Fluids

A. Heat Transfer (23)

A number of references to the use of polyphenyls as coolants for nuclear reactors were found in the period of 1959 to 1964. From our own efforts in this area, we know that there is currently little interest in organic coolants in this application except for work being done in Canada. The diminished interest accounts for the fact that more recent references were not found.

Seven patent references issued to different companies are abstracted in the appendix, all dealing with stabilizers which increase the resistance of the polyphenyls to radiation damage.

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Five literature references also abstracted are concerned with general evaluation of different mixtures for radiation resistance and heat transfer coefficients.

An interesting publication by the U. of British Columbia discusses the use of AROCLOR as a direct-contact heat exchange agent for the condensation of steam in a packed column. The direct contact technique was claimed in Monsanto 3,249,152 where AROCLOR was sprayed into exhaust gas and then contacted with water to transfer the heat collected. There may be a possibility for commercial exploitation of this approach to heat transfer.

Also of general interest is a recent patent to General Electric (3,415,896) for preparing substituted biphenyls by a catalytic transfer hydrogenolysis. These compounds are reported to be useful as high temperature heat transfer fluids.

Monsanto has four patents to stabilized fluids for nuclear reactor use, and two to the process for reclaiming used fluids by removing or cracking the high boilers formed by exposure to radiation.

B. Dielectrics (24)

Emphasis in dielectric compositions is on finding new stabilizers and acid scavengers for the AROCLOR, with the favorite scavengers being epoxy compounds. General Electric and Westinghouse each have obtained patents to this type scavenger. Sprague Electric has two older patents (1957-1959) on compositions of AROCLOR plus butadiene polymer in tetra(2-ethylhexyl)orthosilicate. These patents are not seen to be of any immediate concern to Monsanto.

Of more recent interest, duPont 3,200,077 claims a mixture of fluoroalkyl benzoate and AROCLOR as a dielectric composition. Progil 3,194,766 is directed to a specific mixture of dichloro-, trichloro- and tetrachloro diphenyls.

Monsanto has had eleven patents issue since 1950 on scavengers for AROCLOR dielectrics. We also have one patent to combinations of tri- and tetrachloro biphenyls, and another to the isomerization of dichlorobiphenyl to improved dielectric compositions.

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It appears that the opportunity is still open to patent halogenated diphenyl compositions where advantageous properties can be shown for specific mixtures of isomers and/or different chlorine contents. The crowded art makes conclusive evidence of unusual properties essential to the case, but it appears certain that more patents like Progil above will be issued to whoever makes the showing of desirable properties.

C. Hydraulics (13)

References which are specifically intended for use as hydraulic fluids are included in this section. Three recent patents to McDonnell Douglas claim fluids comprising chlorinated diphenyl ether with phosphate esters and/or chlorinated biphenyl. These fluids are not incorporated in the Commercial Enterprise.

Bayer 3,282,847 claims a mixture of tetrachlorodiphenyl and TCP, a composition which is probably limited in its commercial utilization by present pollution considerations. Bayer 3,056,745 is to a combination of chlorinated diphenyl and polyoxyalkylene diol.

Monsanto has had three patents issue on this subject matter since 1955. Additional cases including the PYDRAUL 312 composition are on file, but the Patent Office has been unwilling to grant broad claims to mere mixtures of known hydraulic fluid components. New patent issues in this crowded art will likely be restricted to rather narrowly limited compositions having unusual or unexpected properties clearly demonstrated by extensive experimental data.

D. Lubricants (8)

Biphenyls and halogenated biphenyls specifically intended for use in lubricants are generally restricted to the function of minor additives or to compositions for specialty applications.

For example, Shell 3,297,574 employs chlorinated biphenyl as an EP additive in aliphatic ester lubes, and Standard 2,852,468 adds small amounts of AROCLOR to mineral oil.

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In specialty applications, chlorinated biphenyl is used in pressure forming fluoroethylene polymers (duPont) and as a molding lubricant for ceramic powders.

Monsanto has no patents issued since 1950 on this subject matter, and there does not seem to be much activity in this area of limited application.

E. Thermodynamic Fluids (1)

Monsanto 3,234,734 is the only patent found that suggests the use of biphenyl and AROCLOR as thermodynamic fluids. However, it has since been shown that these compounds are generally inferior to certain other compositions which are characterized by low entropy change as claimed in a pending application.

F. Quenchants (2)

Monsanto has two patents to the use of AROCLORS as quenchants in steel treating operations. No other references were found, and there does not seem to be any active interest in this area.

IV. Adhesive Compositions

A. Hot Melt (9)

Chlorinated biphenyls are used in a variety of adhesive compositions where their plasticizing effect causes the composition to become tacky when heated, and to reset in cooling. National Starch 3,220,966 combines the biphenyl with olefin polymers. Other patents disclose polyamides and vinyls as the polymeric component.

USP 3,282,811, purchased by Monsanto from National Starch, claims a copolymer of ethylene and vinyl acetate modified with a chlorinated terphenyl. This is Monsanto's only entry in this field.

McLaurin-Jones 2,633,432 describes a novel multilayer heat activated adhesive where the biphenyl is separated from the polymeric component until the application of heat causes the two to merge into a single tacky layer.

For a comprehensive report on literature and patents concerning hot melt adhesives in general, see Report No. 3609, Literature Search on Hot Melt Adhesives and Coatings, by Paula Raizman, Nov. 1969.

B. Other (9)

A variety of glues and adhesives utilizing chlorinated biphenyl are disclosed in the art and include both synthetic and natural base compositions. French 1,482,172 to Bericol broadly discloses the combination of pentachlorobiphenyl with polyamide, polyester, or natural rubber, but most of the U. S. patents are to specific compositions.

The art suggests most of the adhesive development work is being conducted by individual manufacturers to fill their own needs.

The opportunity for additional patent coverage in this area appears limited to narrow compositions having certain specific desirable properties well defined by experimental evaluation.

V. Coating Compositions (20)

Coating compositions are defined for purposes of this survey to include any combination of biphenyl or halogenated biphenyl with a polymer resin, or other material which is applied to a substrate material for purposes of coating, sealing, or impregnating the substrate. This broad definition necessarily includes combinations where the biphenyl serves as a plasticizer, solvent, or flame retardant, and these sections should be considered as closely related to the present one.

Most of the patent references found were prior to 1960 which indicates a recent decrease in activity in this area. The earlier references disclose the use of chlorinated biphenyl in compositions useful for insulating, rust preventing, concrete sealing, antistatic, and waterproofing.

Eastman 2,635,970 describes a translucent paper impregnated with an ester-AROCLOR composition. Kodak and 3M each have recent British patents to thermographic papers employing AROCLOR as a heat sensitive material.

Monsanto has three patents to the use of AROCLOR in a floor polish, a waterproofing coating, and an impregnant for cellulose. The nature of the business requires to a large extent that products be tailored to solve specific problems. The result is that the majority of patents are issued to the ultimate consumers who solved their own problem, and there is little possibility or potential for anyone to develop a strong patent position.

VI. Plasticizers (25)

A number of references in the Russian literature were found discussing biphenyls and chlorinated biphenyls as plasticizers for poly(vinyl chloride). Specific objectives were in dielectric films, radiation resistant paints, and adhesive coatings. One U. S. patent to Calresin disclosed the plasticization of PVC molding resins with AROCLOR.

Other references disclose the combination of AROCLOR and polyesters, polyethylene, and various resins and rubbers.

Eastman appears to be doing a considerable amount of work on the use of chlorinated biphenyls as antiplasticizers for polyesters and polycarbonates to increase film stiffness. USP 3,240,735 and 3,254,047 issued to Eastman in 1966 claim this subject matter. Related articles published as late as 1967 indicate a continuing effort in this area by Eastman.

Monsanto has one expired patent (2,506,014) describing the use of chlorinated biphenyl high boilers as plasticizers for polyvinylacetal compositions.

VII. Solvents (7)

Chlorinated biphenyl is widely used as a solvent in a variety of applications ranging from ink and dye carriers to epoxy cement strippers and organic reaction media. The patents have been obtained by the individual manufacturers for specific applications. The potential for obtaining additional patents in this area is limited to new specific applications, probably narrow in scope.

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VIII. Flame Retardants (9)

The chlorine content of AROCLOR makes it a natural additive to impart flame resistance to natural and synthetic polymeric materials. Patent protection for such use will depend on demonstrating benefits beyond those to be expected or calculated on the basis of the chlorine content. A natural approach is to claim combinations of AROCLOR with other materials which enhance the desired effect by a synergistic action.

DuPont 3,418,267 is to a flame-resistant polyamide containing chlorinated biphenyl and a metal oxide. Badische 3,321,416 uses AROCLOR to impart flame resistance to polystyrene, and G.E. 3,154,515 incorporates AROCLOR in silicone rubber. Other applications mentioned in the references include textiles, polyurethane, and thermoplastic molding polymers.

The trend toward ever greater use of plastics and synthetic fibers in consumer goods has created a large market for a variety of flame retardants, and it is conceivable that Monsanto could develop and patent flame retardants for selected end uses.

Any work planned in this area should include brominated compositions as well as the chlorinated ones. The current opposition to chlorinated hydrocarbons due to pollution considerations, and the greater effectiveness and stability of the brominated materials enhances the potential of brominated flame retardants for commercial success.

Monsanto presently has two patents issued in 1967 for the use of AROCLOR as a flame retardant for phenolic resins and for asphalt base coating compositions.

IX. Miscellaneous (22)

A variety of applications for biphenyls and chlorinated biphenyls which are not readily classified in any of the preceding sections are included herein. Uses include for example U.V. light stabilizers, antidusting agents, preservatives for citrus fruit, insecticides, U.V. light polarizers, and as a component in pigment pastes.

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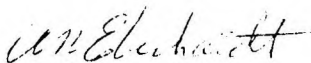
One unusual use of some interest described in Great Lakes Carbon 3,035,901 involves the purification of artificial graphite bodies containing metallic impurities by impregnating the graphite with a chlorinated hydrocarbon at a high temperature to form and volatilize chlorides of the impurities. The process is particularly applicable to the purification of graphite anodes used in electrolytic cells.

Monsanto patents included herein relate to binders for rocket propellants, a biphenyl-polyamide polymer, insecticide, and light stabilizers.

COMMENTS

It is apparent from the results of this search effort that the subject matter regarding uses and applications of biphenyls and chlorinated biphenyls is too broad to permit more than a thumbnail sketch of any particular area. There are no doubt pertinent references which have not been found because of limitations in the search effort imposed by the scope of the subject matter. This report will, however, provide an indication of the current state of the art in these several areas which can form a basis for a more concentrated effort if warranted by business or technical demands. Any further searching should be conducted within guidelines of well-defined objectives and limited subject matter.

The results on biphenyl manufacture and chlorination which were the primary objectives of this survey are considered to be reasonably complete, as is the listing of pertinent Monsanto patents. The Patent Department will undertake to keep these results current, and to supplement the sections on use as additional references are uncovered during the course of time.



W. R. Eberhardt

WRE:map
Enclosures

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A P P E N D I X

I N D E X

The survey covered both manufacture and use of chlorinated biphenyls and polyphenyls according to the following:

<u>Subject</u>	<u>Number of References</u>	
	<u>Others</u>	<u>Monsanto</u>
I. Manufacture of Biphenyl and Polyphenyls		
A. Pyrolysis of Benzene	11	2
B. Other Routes	12	4
C. Refining and Purification	4	0
II. Chlorination of Biphenyl & Polyphenyls	10	3
III. Functional Fluids		
A. Heat Transfer		
Reactors	13	7
Others	2	1
B. Dielectrics	8	16
C. Hydraulics	10	3
D. Lubes	8	0
E. Thermodynamic Fluids	0	1
F. Quenchant	0	2
IV. Adhesive Compositions		
A. Hot Melt	7	1
B. Others	9	0
V. Coatings	17	3
VI. Plasticizers - Antiplasticizers		
A. PVC	9	0
B. Resins	8	1
C. Antiplasticizers	7	0
VII. Solvents	7	0
VIII. Flame Retardants	7	2
IX. Miscellaneous	16	5
Insecticides		
Preservatives		
Stabilizers		

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ABSTRACTS OF REFERENCES

I. Manufacture of Biphenyl and Polyphenyls

A. Pyrolysis of Benzene

- 3,359,340
Dow Chem. A process for the production of polyphenyls by the pyrolysis of benzene containing 0.1-5% phenol in the presence of Cu. The pyrolysis temperature is about 680°C. and method yields 90% biphenyl and 9% terphenyl based on about 11% benzene conversion.
- 3,262,983
Dow Chem. A process for the production of diphenyls and terphenyls from the pyrolysis of benzene using certain nickel chromium steels to inhibit carbon formation. The steel specified contains 11-30% Cr, and a max. of 1.5% Ni.
- 2,099,350
Dow Chem. Benzene is pyrolyzed in apparatus of iron or carbon steel, the walls of which have been previously subjected to the action of ammonia at a temperature of between 450 and 550°C. for a time sufficient to form a nitrite coating thereon whereby the formation of carbon during the pyrolysis is substantially reduced.
- 1,978,069
Dow Chem. A process for producing diphenyl wherein benzene is pyrolyzed by heating at a temperature between 650° and 950°C. The improvement which consists in maintaining in the benzene a sulfur content in excess of about 0.10% by adding a substance from the class consisting of sulfur and volatile sulfur compounds to the benzene before it enters the pyrolyzing zone.
- 1,976,468
Dow Chem. Polyphenyls are prepared by pyrolyzing a benzene biphenyl mixture containing from 5 to 20% biphenyl, separating the polyphenyls and recycling the biphenyl and unreacted benzene. The reaction takes place in the presence of a small amount of sulfur compound to minimize coking. Other operating conditions are, temperature 650 to 950°C. with vapor velocity sufficiently high to minimize coking. Conversion is between 5 and 20% of the benzene biphenyl vapors.

- 1,322,983
Barrett Co. Diphenyl is produced in a process wherein benzene is vaporized and mixed with steam then reacted at a temperature of between 600 and 800°C. and at a pressure of about 60 pounds per square inch.
- 3,228,994
Monsanto A process for the pyrolysis of benzene to biphenyl and polyphenyl in a tubular reactor constructed of a particular metallic alloy which retards the formation of coke. (Hastalloy X)
- 2,702,307
Monsanto A method for the pyrolysis of benzene in a tubular reactor wherein the flow rate corresponds to a Reynolds number of 600 to 100,000 and the temperature is maintained at 773°K. to 1073°K.
- 3,227,525
Progil This patent covers an apparatus designed to be used in the process of U. S. Patent 3,122,349 and claims a heat exchange tube having an internal diameter in the range of 55mm to 200mm and a length in the range of from about 30 meters to 100 meters and shaped of U bends joined by straight portions.
- 3,207,799
Progil A process for the production of terphenyls by the pyrolysis of benzene in the gaseous phase comprising the steps of heating a mixture of benzene containing 20 to 30% by weight of diphenyl at a temperature in the range of 680°C. to 820°C. for a period of from 10 to 500 seconds. The process being characterized in that the proportion of diphenyl in the gaseous mixture admitted to the pyrolysis zone is equal to proportion in the mixture leaving the zone so that there is no net consumption or production of diphenyl in the process.
- 3,112,349
Progil This patent covers a method of producing diphenyl by the pyrolysis of benzene vapor in a tube having the diameter in the range of 55mm to 205mm and causing the vapor to flow with a turbulence having a Reynolds number in the range of 120,000 to 500,000.
- 1,968,154
Swann Research Carbon formation during the pyrolysis of benzene to diphenyls is retarded by coating the walls of the reactor with a metal sulfide.
- 1,957,988
I.G.Farben Diphenyl is produced by passing vapors of benzene at about 750°C. through a reaction space having a copper surface and containing a neutral reacting silicate selected from the group consisting of magnesium and aluminum silicates free from alkyl metal compounds.

B. Other Routes

- 3,435,084 Biphenyls and other aromatic hydrocarbons are prepared from mixtures of C_{6-9} hydrocarbons by a process involving a series of fractionating, concentrating and hydrodealkylating steps.
Phillips
Petroleum
- 3,401,207 Biphenyls are prepared from a liquid phase reaction of benzene with a palladium salt and acid catalyst.
Gulf Research
- 3,274,277 A process for the preparation of biphenyl by liquid phase reaction of benzene and ethylene at 125-200°C. and 800-1200 psi, in the presence of a strongly alkaline catalyst on activated Al_2O_3 .
Universal Oil
- 3,160,671 A process for the production of high purity benzene by thermal dehydrodealkylation of toluene, wherein the formation of diphenyl in the benzene stream is prevented by recycling diphenyls to the furnace. The amount of diphenyl recycled is described as that necessary to establish an equilibrium to prevent further formation. A furnace is operated at 12,050 to 13,000 degrees F. and at 600 PSIG.
Atlantic
- 3,145,237 A process for the production of diphenyls by the catalytic coupling of benzene using a palladium or platinum salt catalyst under substantially anhydrous conditions and at a temperature of from about 40-200°C.
Shell Oil
- 3,055,956 A process for recovering naphthalene from petroleum hydrocarbon fractions which comprises removing the alkyl naphthalenes by fractionation and hydrodealkylating the remainder to convert the alkylbenzenes into benzene and lower boiling alkylbenzenes.
Ashland Oil
- 2,951,886 Benzene is obtained by subjecting coke oven or coal tar light oil to catalytic cracking in the presence of hydrogen at temperatures above 1200°F. The catalyst is chromium oxide on a high purity, low sodium, gamma type alumina support.
Ashland Oil
- 2,918,503 A process for preparing a p-terphenyl which comprises subjecting an alpha-methylstyrene to reaction in the liquid phase at a temperature from between about 150 and 700°C. in the presence of an iodine compound catalyst.
American Oil
- British
1,164,561 Biphenyl is obtained in 18% yield by reacting CO with a mixture of $PhHgCl$, $CuCl_2$, and $LiPdCl_3$ in acetonitrile at atmospheric pressure.
Hercules

British 1,159,653 Unassigned	Benzene is converted to diphenyl in the presence of an iridium catalyst.
Japan 6464 Yawata Chem.	Dimers of methylstyrene are heated in the nitrogen atmosphere at 500°C. in the presence of chromia-alumina catalyst to give p-terphenyl.
French 1,522,859 VEB Synthese- werk	Chlorinated biphenyls and trichlorobenzenes are prepared by treating the γ -hexachlorocyclohexane residue from the preparation of lindane with $AlCl_3$.
3,244,721 Monsanto	A process for arylation of aromatics by reacting a compound like biphenyl or naphthalene with benzene sulfonyl chloride in the presence of a catalyst such as a copper or silver salt.
3,231,629 Monsanto	A process for arylation by reacting an aromatic like biphenyl or naphthalene with benzene sulfonyl chloride at 275°C. This is a basic MCL patent.
3,328,473 Monsanto	Aromatic compounds are arylated with an acylanilide and a nitrosating agent. Mixed terphenyls are made by reacting diphenyl with acetanilide and amyl nitrite at 85°C.
3,197,520 Monsanto	A process for the arylation of aromatic compounds such as the preparation of terphenyl by introducing a phenyl group onto diphenyl.

C. Refining and Purification

3,363,020 Dow Chem.	Biphenyl is refined and the yellow color removed by adding H_2SO_4 and distilling.
Czech. 124,741 Unassigned	The dielectric constant of chlorinated diphenyls improved by heating the diphenyl with a mixture of CaO and perlite.
Czech. 123,386 Unassigned	Crude diphenyl is heated to isomerize the o-terphenyl the m- and p- isomers which are then separated from the diphenyl.
French 1,489,353 Euratom	Terphenyl is contacted with Zr metal at 300-400° to remove chlorinated impurities.

II. Chlorination of Biphenyl & Polyphenyls

- 3,358,040
Texaco
Chlorinated biphenyls and biphenyl ethers are prepared by treating substituted diphenyls with a cupric halide in the presence of an aluminum halide catalyst and an inert solvent. Products are 4,4'-bis(p-chlorophenoxy)biphenyl and 4,4'-bis(p-chlorophenyl)biphenyl.
- 3,029,295
d'Uguine Wyan-
dotte
A process for the vapor phase chlorination of diphenyl in a fluid bed catalyst at a temperature of 470-530°C. (French 1,387,233)
- 2,859,252
Pennsalt
A process for producing chlorinated polyphenyls comprising reacting benzene hexachloride with a nuclear halogenated aromatic hydrocarbon at a temperature of 130-225°C.
- 2,854,491
Columbia-
Southern Chem.
A method for producing chlorinated aliphatic hydrocarbons by chlorinolysis of a cyclic compound having at least 5 ring members with chlorine under pressure
- 2,812,370
Pennsalt
A process for recovering the $AlCl_3$ catalyst used in the production of chlorinated polyphenyls by reaction of benzene hexachloride with a reactive aromatic.
- 2,608,591
Niagara Al-
kali
A process of nuclear substitution chlorination which comprises dissolving an aromatic hydrocarbon in liquid chlorine in the presence of a chloride chlorination catalyst at about 80°C. and under pressure.
- French
1,448,922
Sandoz Ltd.
A process for the halogenation of aromatic hydrocarbons (biphenyl) using $TiCl_4$ as a solvent.
- Polish
51,533
Glowny Inst.
Diphenyl is chlorinated over spiral steel shavings to yield a non-flammable oil.
- E. Germany
62,553
Unassigned
Addition to East German 58,739. The chlorination reaction is conducted in perchloroethylene which is a solvent for the reactants but not the catalyst.
- E. Germany
58,739
Unassigned
A process for the chlorination of hydrocarbons in the presence of $AlCl_3$ to produce chlorinated biphenyls, trichlorobenzene, and chloroarene polymers.

- 2,551,562
Monsanto A new composition of matter of 50 to 80% of chlorinated meta-diphenylbenzene and 20 to 50% of chlorinated para-diphenylbenzene, the mixture containing 50 to 70% chlorine. The process of producing the composition by chlorinating meta-diphenylbenzene obtained as the high boiling fraction from the distillation of crude diphenyl material.
- 3,256,350
Monsanto Halogenated aromatics are produced by decomposing an aromatic sulfonyl halide in the presence of a high boiling solvent (AROCLOR).
- 3,256,343
Monsanto Halogenated aromatic compounds (AROCLOR) are produced by the vapor phase thermodecomposition of an aromatic sulfonyl halide.

III. Functional Fluids

A. Heat Transfer - Reactors

- 3,064,061
U.S. AEC Polymerized polyphenyl heat transfer fluids are reclaimed by catalytic cracking to yield mixtures of biphenyl and terphenyl.
- 2,925,448
N.A.Aviation A nuclear reactor coolant comprising an aromatic hydrocarbon and 0.1 to 5% of an aluminum or tin halide.
- 2,915,567
U.S. AEC The resistance of polyphenyls to neutron radiation at elevated temperatures is improved by the incorporation of certain metal free aromatic inhibitors capable of forming stable free radicals and selected from the group consisting of naphthacene, phthalocyanine, and triphenyl-methane.
- 2,909,488
U.S. AEC A nuclear reactor coolant consisting essentially of a liquid aromatic hydrocarbon and having dispersed therein beryllium or magnesium metal.
- 2,909,487
U.S. AEC A nuclear reactor coolant consisting essentially of a liquid aromatic hydrocarbon having dispersed therein an alkali metal.
- 2,909,486
U.S. AEC A nuclear reactor coolant consisting essentially of a liquid aromatic hydrocarbon and from 0.1 to 5% of a group IIA or IVA metal hydride.

2,883,331 U.S. AEC	The resistance of polyphenyls to neutron radiation at elevated temperatures is improved by the incorporation of certain arylselenium and sulfur compounds at a level from about 1 to 10% by weight.
Belgium 649,520 AEC-France	A fluid comprised of a mixture of non-substituted terphenyls and short chain alkylaromatics.
England(1964) Chem.Eng.Progr. 60(51)128-36	Heat transfer in organic cooled reactors and the convective heat-transfer coefficients for unirradiated and irradiated polyphenyl coolants are described.
England(1964) Kieller Rept. KR 83, 12 pp. No.Amer.Avia.	The irradiation facility which uses a eutectic mixture of biphenyl, o-terphenyl, and p-terphenyl as a coolant is described.
(1964) Euratom Bull. 7-13	A critical discussion of the advantages and disadvantages of biphenyls and terphenyls as organic coolants for atomic reactors.
(1964) At.Energy,Can. Ltd. AECL-1915 At.Energy,Can. Ltd.	Low melting organic coolants for reactors are terphenyl-biphenyl mixtures or partially hydrogenated terphenyl mixtures.
Germany(1961) Kernenergie 4(9),669-84 Inst. Phys., Dresden,Ger.	Diphenyls, terphenyls, and mixtures thereof are evaluated as moderators and coolers in nuclear reactors.
3,280,206 Monsanto	A process for reclaiming used polyphenyl nuclear reactor fluids by removing the undesirable high boilers with a two component solvent such as benzene plus n-dodecane.
3,209,042 Monsanto	A process for reclaiming used polyphenyl nuclear reactor fluids by hydrocracking the high boilers using hydrogen with a platinum or chromium catalyst.
3,184,390 Monsanto	Biphenyl and nuclear reactor coolants are stabilized against radiolytic degradation by adding up to 50% of a mixture of bitumens selected from asphalt, coal, tar and petroleum residue.

- 3,183,165
Monsanto Biphenyl and nuclear reactor coolants are stabilized against radiolytic degradation by adding about 30% of a partially hydrogenated terphenyl (HB-40).
- 3,152,961
Monsanto Rosin acids are added to terphenyls to provide a radiation-resistant reactor moderator or coolant.
- 3,113,090
Monsanto Biphenyl and nuclear reactor coolants are stabilized against radiolytic degradation by adding 5% anthracene.
- 3,064,061
Monsanto A process for cracking polyphenyls, such as terphenyl, to biphenyl and benzene at 500-600°C. using hydrogen and a platinum or nickel catalyst.

Heat Transfer - Others

- 3,415,896
General Elec. Biphenyls having an -OR or a -NH₂ group is reacted with a benzene or biphenyl having at least one cyclohexyl substituent at a temperature of 300-500°C. and in the presence of a nickel, platinum or palladium catalyst. The reaction permits the preparation of novel substituted biphenyls useful as high temperature heat transfer fluids.
- England(1967)
Can.J.Chem.Eng. AROCLOR is used as a direct-contact heat exchange agent with the condensation of steam in a packed column.
45(3),170-4
Univ. of Brit.
Columbia
- 3,249,152
Monsanto Heat is recovered from exhaust gases by spraying a chlorinated diphenyl into the gas, then transferring the heat from the diphenyl to water.

B. Dielectrics

- 3,419,498
Westinghouse A cellulosic insulation material for use in transformers in the presence of air and a liquid dielectric.
- 3,362,908
General Elec. A chlorinated diphenyl dielectric plus an epoxide compound as a scavenger material.
- 3,200,077
DePont A dielectric composition consisting of a mixture of a fluoroalkyl benzoate and a chlorinated aromatic hydrocarbon.

3,194,766 Progil	A dielectric comprising at least 20% of 2,4'-dichlorodiphenyl and 40-70% of poly chlorodiphenyls having 3-4 chlorines.
3,170,986 General Elec.	AROCLOR plus an epoxide scavenger and a zeolite dehydrating compound.
2,902,451 Sprague Elec.	AROCLOR plus a low molecular weight liquid polymer of butadiene or an alkyl or aryl derivative thereof as a thermo stabilizer.
2,840,627 Westinghouse	A dielectric comprising AROCLOR with an epoxy compound and a basic nitrogenous compound as scavengers.
2,788,327 Sprague Elec.	A dielectric consisting of a liquid chlorinated aromatic admixed with 10% tetra-2-ethyl-hexyl ortho-silicate.
3,089,987 Monsanto	A dielectric composition consisting of a mixture of chlorinated biphenyls and an alkyl chlorobiphenyl ether.
3,072,728 Monsanto	A process for the preparation of bis(2-chlorophenyl) ether dielectrics by chlorinating 2-chloro-2'-Nitro diphenyl ether.
3,068,297 Monsanto	A process for the isomerization of 2,2'-dichlorobiphenyl to a dielectric mixture rich in the 2,4'- and 2,3'-isomers (Weingarten).
3,038,107 Monsanto	A dielectric fluid prepared by halogenating 2,4'-dichlorobiphenyl (Weingarten).
2,977,516 Monsanto	Dielectric combinations of tri- and tetra-chlorobiphenyl isomers having unusually high dielectric constants (Weingarten).
2,646,403 Monsanto	Dielectric comprising AROCLOR plus diphenyl tri-diethylate as a scavenger.
2,627,504 Monsanto	Dielectric comprising AROCLOR plus mono-ortho-tolyl biguanide as a scavenger.
2,617,770 Monsanto	Dielectric comprising AROCLOR plus a scavenger such as diaminodiphenylamine, o-anisidine, and nitro aniline.

2,582,200 Monsanto	Dielectric comprising AROCLOR plus ethyl silicate as a scavenger.
2,578,359 Monsanto	Dielectric comprising AROCLOR plus dibutyl diphenyl tin as scavenger.
2,573,894 Monsanto	Dielectric comprising AROCLOR plus certain organotin compounds as scavengers. (triphenyl-thienyl tin and di-thienyl tin mentioned)
2,572,808 Monsanto	AROCLOR as a dielectric and heat transfer fluid containing N,N'-1-3-dimorpholino-isopropanol as a scavenger.
2,566,208 Monsanto	Dielectric comprising AROCLOR plus organic antimony compounds as scavengers.
2,566,196 Monsanto	Dielectric comprising AROCLOR plus aminated-N-phosphoryl-o-aminobiphenyl as a scavenger.
2,566,195 Monsanto	Dielectric comprising AROCLOR plus aluminum isopropylate as a scavenger.
2,532,616 Monsanto	A dielectric comprising an AROCLOR with a scavenger such as zinc dithiocarbamate and the alkyl, cyclic and aryl substituted derivatives thereof.

C. Hydraulics

3,432,437 McDonnell- Douglas	A fire resistant hydraulic fluid comprising a mixture of phosphate ester, chlorinated diphenyl ether, and a chlorinated biphenyl.
3,432,436 McDonnell- Douglas	A fire resistant hydraulic fluid comprising a mixture of chlorinated diphenyl ethers and chlorinated biphenyl.
3,352,784 McDonnell- Douglas	A fire resistant hydraulic fluid comprising a mixture of phosphate esters with chlorinated diphenyl ether.
3,136,726 Douglas	A fire-resistant hydraulic fluid and lubricant comprising 20-80% triaryl phosphate, 80-20% chlorinated biphenyl of 40-55% Cl, plus V.I. improver. A Commercial Enterprise Fluid.
3,282,847 Farben-Bayer	A hydraulic fluid comprised of tricresyl phosphate and tetrachlorodiphenyl.

3,251,773 Dow Chem.	m-dibromo-phenyl ether is added to silicone and mineral oils to impart flame resistance.
3,056,745 Farben-Bayer	A hydraulic fluid consisting of a chlorinated diphenyl and a polyoxyalkylene diol in the ratio of from 10:1 to 100:1.
2,502,392 Hooker	A hydraulic fluid comprised of hexachlorobutadiene and isopropyl trichlorobenzene containing a small amount of pentachlorodiphenyl and other halogenated materials to lower the freezing point.
U.S.S.R. (1966) 178,439 Unassigned	A hydraulic fluid comprising a petroleum base, an ethylpolysiloxane, and an additive package of chlorinated biphenyls, biphenylamine, and ionol.
France (1966) 1,458,437 Progil, S.A.	A hydraulic and lubricating fluid comprising a mixture of diphenoxydiphenyls, diphenoxybenzene and terphenyl.
3,149,077 Monsanto	Composition of Pydraul 200 comprising chlorinated biphenyl and a small amount of a metal salt of an organic thiophosphate, EP agent and a polyamine/oleic acid reaction product as rust inhibitor.
2,741,598 Monsanto	A heat transfer, hydraulic and thermoregulator medium consisting of 62% chlorinated biphenyl, 25% o-terphenyl and 13% biphenyl.
2,707,176 Monsanto	A functional fluid comprised of 40-55 parts tri-cresyl phosphate, 45-60 parts chlorinated biphenyl of 40-60 parts chlorinated biphenyl of 40-60% Cl and a V.I. improver.

D. Lubes

3,352,780 Labofina, Belg.	An E.P. and hydrolysis resistant lubricant comprising a polychlorinated diphenyl containing 0.5-5% of a phosphoric ester. Also useful as hydraulic and heat transfer fluid. (Belg. 668,430)
3,297,574 Shell Oil	Chlorinated biphenyl and a triaryl ester of phosphorothionic acid are added as EP agents to an aliphatic acid ester lubricating oil.
3,123,560 Richfield Oil	A grease composition comprising chlorinated diphenyl synthetic oil of lubricating viscosity and 2 to 10% of a pyrogenic silica thickener.

2,863,833 Unassigned	A lubricant comprising sulfur, soapstone, graphite and about 5% chlorinated diphenyl.
2,852,468 Standard Oil	A lubricating composition consisting of sulfurized mineral oil, a fatty acid ester, and AROCLOR 1254 as an EP agent.
2,630,417 DuPont	A pressure coalescing composition comprising tetrafluoroethylene colloidal polymer admixed with a chlorinated aromatic of 15-65% chlorine.
2,593,507 Thompson Prod.	Low molecular weight chlorinated diphenyls are used as lubricants in molding non-plastic, ceramic like powders.
England(1965) Wear 8(5)358-73 Inst.Petrochem Russia	Solid biphenyl is used as a lubricant in metal to plastic friction.

E. Thermodynamic Fluids

3,234,734 Monsanto	Biphenyl and AROCLOR are disclosed as thermodynamic fluids for Rankin cycle engines.
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F. Quenchant

3,271,207 Monsanto	AROCLOR is used as a quenchant for heat-treating glass or metal.
3,224,910 Monsanto	The duplex steel quenching process using an upper water phase and a lower AROCLOR phase.

IV. Adhesive Compositions

A. Hot Melt

3,378,509 Chemical Decor- ation Co.	A thermosetting hot melt composition comprising a vinyl polymer binder and biphenyl solvent with stabilizers and crosslinking agents.
3,220,966 Natl.Starch	Chlorinated biphenyl resins are blended with ethylene-propylene copolymers and polyolefins to provide a tacky, hot-melt adhesive.

2,685,572 B.B.Chemical	A heat activatable cement for attaching shoe soles comprising 100 parts AN-butadiene copolymer, 10-30 parts zinc carbonate, 70-125 parts VA VCl polymer and 10-50 parts of a chlorinated biphenyl resin having 65-67% chlorine.
2,643,238 Shawinigan	Chlorinated diphenyl is used as plasticizer for a hot melt vinyl ester base adhesive resin.
2,633,432 McLaurin-Jones	A heat-sealable label stock having a multilayer adhesive coating including one layer of a thermoplastic material and an adjoining layer of a plasticizer for the material which are merged by heating into a single tacky layer.
2,622,056 Union Carbide	An adhesive consisting of polyethylene resin and a halogenated benzene, diphenyl, or naphthalene.
2,612,463 DuPont	A hot melt adhesive comprising a polyamide and a chlorinated diphenyl useful in bookbinding.
3,282,881 Monsanto	Copolymers of ethylene/vinyl acetate are modified by the addition of a chlorinated terphenyl resin to produce a hot-melt adhesive composition.

B. Others

2,988,461 National Cash Register	An adhesive suitable for micro-encapsulation comprising a chlorinated rubber, polymerized rosin, hydroabietyl phthalate, chlorinated diphenyl and diethylbenzene.
2,954,353 St.Regis Paper	A remoistenable adhesive mixture comprising polyvinyl alcohol and lignosulfonic acid containing 5% of a migration inhibitor such as chlorinated diphenyl.
2,947,710 Johnson & Johnson	Chlorinated biphenyl is incorporated as a tackifying agent in an elastomeric rubber base pressure sensitive adhesive.
2,678,586 Eastman	A thermosetting optical cement comprising a mixture of diallyl phenyl phosphonate and a chlorinated diphenyl.

2,677,672 Swift & Co.	An adhesive for wood comprising a mixture of PVA and a vinyl methyl ether-maleic anhydride copolymer.
2,633,593 Detro Mfg.	A tackifier for a tack rag consisting of a solution of chlorinated triphenyl and polystyrene.
French (1967) 1,482,172 Bericol S.A.	A glue composition comprising polyamide, polyester, or natural rubber and pentachlorobiphenyl.
E.Germany(1965) 40,927 Unassigned	Chlorinated biphenyl is added to the adhesive used for poly(vinyl chloride) films.
E.Germany(1965) 37,967 Unassigned	Chlorinated biphenyl is used as an ingredient in an adhesive consisting of chlorinated polybutadiene and rosin.

V. Coatings

3,279,945 I.B.M.	Chlorinated biphenyls are combined with resins to coat the ferrite core in a magnetic memory computer and thereby reduce magnetic vibrations.
2,938,937 Ideal Chem. Prod.	A flame-resistant, high-heat insulating composition comprising a filler of asbestos fiber and vermiculite, and a vehicle comprising a chlorinated rubber and a chlorinated hydrocarbon.
2,879,827 Taylor Fiber Company	An insulating material comprising a paper coated with cresol, phenol, formaldehyde-resin, tricresyl phosphate, and chlorinated diphenyl.
2,840,486 Unassigned	A composition of matter comprising pigment, a wetting agent, a solvent, and a chlorinated polyphenyl. A putty composition which can be used under water.
2,828,213 Union Oil	A rust preventing coating for ferrous metals comprising 85-97% chlorinated polyphenyl containing 50-70% chlorine, 0.5-7.5% petroleum sulfonate and 1.5-7.5% partial ester of a polyhydric alcohol.

2,672,793 Bonafide Mills	A sealer for concrete floors comprising a priming layer of a slow-drying penetrating solvent and a resinous material such as chlorinated rubber or chlorinated polyphenyl.
2,640,817 Nash-Kelvina- tor	An anti-static coating material comprising polychloro biphenyls and an acrylate polymer.
2,635,970 Eastman Kodak	A translucent paper impregnated with 25 parts cellulose acetate butyrate, 75 parts chlorinated diphenyl, and overcoated with a mixture of cellulose acetate butyrate, dibutyl sebacate, and butyl stearate.
2,635,085 Soc. des Usines Chimique, France	An electrical insulating and moisture-proofing comprising 40-50% PVC, 25-35% soft pitch and 15-35% plasticizer as chlorinated diphenyl.
2,556,451 Insl-X	A moisture resistant and fungus resistant hot melt coating composition comprising lanolin, a butyl methacrylate polymer, a high melting waxy acylamide, chlorinated diphenyl, a resin and a mercury compound.
2,549,127 Stopall	A waterproofing composition for wood comprising a chlorinated polyphenyl, a hydrogenated methyl abietate, polysiloxane and solvent.
2,536,657 Di-Noc	Drawing material comprising a sheet of thermoplastic resinous material with a coating comprised of an acrylic resin, AROCLOR, and a fine abrasive.
British(1966) 1,047,512 3M	Halogenated polyphenyls are used as heat sensitive coating materials for thermographic papers.
British(1966) 1,020,108 Formica Corp.	Chlorinated biphenyl is used in a phenolic resin to impregnate and laminate paper into printed circuit boards.
British (1965) 986,053 Kodak Ltd.	Thermographic papers are impregnated with AROCLOR as a heat volatilizable oil which is readily transferred from one sheet to another.

Netherlands 109,025 (1964) Unassigned	A heat resistant coating for ironing boards comprising a mixture of cellulose acetobutyrate, chlorinated biphenyl, and aluminum metal particles.
French (1964) 1,358,684 Kommanditbolaget	Chlorinated biphenyl is used as one ingredient of a white camouflage coating having U.V. radiation properties similar to snow.
2,926,096 Monsanto	A composition consisting of chlorinated phenol and a phosphoric acid ester, for impregnating cellulose to make them flame retardant and resistant to fungus and insects.
2,606,165 Monsanto	A polishing composition comprising an aqueous emulsion of a vinyl copolymer, a wax and chlorinated biphenyl.
2,500,426 Monsanto	Meta-terphenyl with paraffin and yellow ceresin as a moistureproof coating for artificial flowers, fruit and the like.

VI. Plasticizers - Antiplasticizers

A. PVC

2,525,177 Calresin	PVC or PVC-acetate molding resins are plasticized with chlorinated terphenyls.
Russia (1967) Lakokrasoch, Mater. Ikh Primen. (1),10-14	A study of the effect of plasticizers such as chlorinated biphenyl on the degradation of coatings based on chlorinated poly(vinyl chloride) in the process of radiation aging and on drop in adhesion in this process. Tricresyl phosphate was found to be a more effective stabilizer.
Russia (1967) Vysokomol. Soedin., Ser. A 9(11), 2370-5	Poly(vinyl chloride) containing 3% Ca stearate was plasticized with 36% of biphenyl or p-terphenyl.

Russia (1967) Biphenyl is used as a plasticizer in poly(vinyl chloride) dielectric film.

Vysokomol.
Soedin.,
Ser. A 9(9),
1967-72

Russia (1967) The dielectric and mechanical properties of poly-
Izv. Vyssh. (vinyl chloride) films containing biphenyl as a
Ucheb.Zaved., stabilizer are discussed.

Khim. Khim.
Tekhnol.
10(2), 245-8

Russia (1966) Biphenyl and p-terphenyl are evaluated as plasti-
Izv. Vysshikh cizers for poly(vinyl chloride).

Uchebn. Zave-
denii, Khim. i
Khim. Tekhnol.
9(2), 303-5
Eng. Construct.
Institute

Russia (1966) Chlorinated poly(vinyl chloride) coating material
Lakokrasochnye is plasticized with chlorinated biphenyl to decrease
Materialy glass transition temperature and increase adhesion
i ikh Pri- properties.
menenie

(4), 46-9

Russia (1965) Chlorinated biphenyl is shown to be an interbundle
Vysokomolekul. plasticizer for chlorinated poly(vinyl chloride)
Soedin polymer. The biphenyl does not enter into the
7(4), 751-5 structural elements.

Russia (1965) Biphenyl and pentachlorobiphenyl are evaluated as
Kolloidn. Zh. plasticizers for poly(vinyl chloride).
27(1), 19-23
Inst.Bldg.&Eng.

B. Resins

3,269,308 Chlorinated biphenyls are used as plasticizers for
Unassigned various resins used in flexographic printing plates.

3,200,056 An electrically non-conductive stabilized polyethylene
3M containing as stabilizers an organic chlorinated ma-
terial, antimony trioxide, an amine-antioxidant, and
carbon black.

3,182,036 W.R.Grace Co.	AROCLORS are added to poly(b-hydroxybutric acid) as a plasticizer.
2,968,639 Eastman	AROCLORS are used as plasticizers for high molecular weight, high melting linear polyesters in the molding operation.
2,580,023 Goodcliff, Ltd.	Chlorinated diphenyls are used as softeners in a coating composition for steel comprised of chlorinated rubber and a heavy metal powder.
2,529,260 Armstrong	Several varieties of resins and rubber compositions suitable for use as floor tiles are plasticized with diphenyl or chlorinated diphenyl.
England (1965) J. Oil Colour Chemists' Assoc. 48(1), 28-37 At. Energy Res. Estab.	Vinyl polymer based paints plasticized with chlorinated biphenyls are used in atomic energy installations and are tolerant to high energy radiation.
French (1965) 1,402,991 S. Civile Fiorillo	Chlorinated biphenyls or polyphenyls are used as plasticizers in a putty consisting of a vegetable drying oil and a copolymer of ethylene with vinyl acetate or styrene.
2,506,014 Monsanto	Still residues from the preparation of chlorinated diphenyls and diphenyl benzenes are incorporated in polyvinyl acetal compositions for recording disks.

C. Antiplasticizers

3,254,047 Eastman Kodak	Chlorinated biphenyls are added to polycarbonate film to increase the film stiffness.
3,240,735 Eastman Kodak	Chlorinated biphenyls are added to polyester thermoplastic films to improve the stiffness of the film.
England (1967) J.Appl.Polym. Sci. 11(2), 227-44 Tenn. Eastman	AROCLOR is used as an antiplasticization additive for polyester polymers. The additives appreciably increase the modulus and tensile strength and decrease the elongation and heat distortion temperatures of the polymers.

England (1967) AROCLORS are used as antiplasticizers for bis-J. Appl. Polym. phenol polycarbonates.

Sci.

11(2), 211-26

Tenn. Eastman

England (1966) Bisphenol polycarbonate is antiplasticized with Amer. Chem. Soc. 20% AROCLOR 5460 to yield a clear, hard, stiff, Div. Org. Coat- tough, self-extinguishing molding plastic.

ings Plastics

Chem. Preprints

26(2), 170-9

Eastman Kodak

England (1965) Chlorinated biphenyls and terphenyls are used as Advan. Chem. Ser. antiplasticizers for bisphenol polycarbonates, to No. 48, 185-95 increase tensile modulus and tensile strength of Tenn. Eastman films and decrease the elongation.

England (1965) High molecular weight 2,2-bis(4-hydroxyphenyl) J. Polymer Sci. propane polycarbonate is plasticized with chloro- Pt. A biphenyl (AROCLOR 1254) as control for PEG plas- 3(6) 2189-203 ticizer evaluation.

Eastman Kodak

VII. Solvents

2,934,575

DuPont

A process of polymerizing acetylene to monovinyl-acetylene by introducing acetylene into an anhydrous mixture composed of two immiscible liquid phases, one of which is an inert liquid hydrocarbon or chlorinated hydrocarbon phase and the other is a solution of cuprous chloride and an aliphatic amine hydrochloride in a carboxylic acid amine solvent.

2,593,428

Standard Oil

A process for the preparation of an organic ester from an organic carboxylic acid and a branched saturated aliphatic monohydric unsubstituted alcohol wherein the esterification is conducted in the presence of a minor proportion of diphenyl propane.

2,550,473

Natl. Cash
Register

Chlorinated diphenyl is used as a carrier for dye in a pressure sensitive record material.

2,548,366 Chlorinated diphenyl is used as inert liquid
 Natl. Cash carrier for the color reactant in a sensitized
 Register record material sheet.

Russia Polyarylates are prepared by the condensation of
 170,661 dicarboxylic acid chlorides with dihydric phenols
 Unassigned in solutions of chlorinated biphenyl.

England (1965) Chlorinated biphenyl is used as an epoxy cement
 Plastics Design stripper for removing cured epoxy adhesives from
 Process anodized aluminum parts.
 18-21

England (1966) Biphenyl is used as a dye carrier in the dyeing of
 J.Soc.Dyers polyester fiber with disperse dyes.
 Colour.
 82(11),405-9
 Monsanto Co.

VIII. Flame Retardants

3,418,267 A flame-resistant polyamide resin comprising 5-20%
 DuPont of a chlorinated biphenyl and 3-15% of a metallic
 oxide.

3,321,416 AROCLOR is added to polystyrene plastics to provide
 Badische 2-7% chlorine for flame retardancy.
 Anilin

3,154,515 Chlorinated polyphenyls are added to organopoly-
 General Elec. siloxanes to provide a flame-retardant silicone
 rubber formulation.

3,014,000 A flame-retardant finish for textiles comprising
 Assoc. Lead antimony trioxide, a halogenated vinyl polymer, and
 Mfg. Ltd. a plasticizer containing chlorinated diphenyl or
 chlorinated paraffin.

2,881,097 Chlorinated diphenyl is incorporated as a flame-
 Harshaw Chem. retardant in mildewcide compositions containing
 copper antimonate.

2,590,211 Chlorinated diphenyls are incorporated with thermo-
 Diamond Alkali plastic polymers to impart flame resistance.

French 1,388,667 Stauffer Chem.	Mixtures of chlorinated hydrocarbons and a phosphonic acid ester are used as fireproofing agents for polyurethanes.
3,352,744 Monsanto	A flame-resistant phenolic resin composition comprising 5-60% of a chlorinated polyphenyl and 3-40% of a phosphate compound.
3,342,614 Monsanto	AROCOLOR is used as a flame-retardant for asphalt based roofing and wire coating compositions.

IX. Miscellaneous

3,467,536 Farben-Bayer	Chlorinated terphenyls are added to lacquers as light stabilizers.
3,394,095 M.Arguesco Co.	A resin composition comprising a natural wax, a high molecular weight ethylene vinyl acetate copolymer, a hydrogenated glyceride, and a chlorinated diphenyl. The resin is hard and has a high coefficient of friction.
3,378,509 Chemical Decor-ator Co.	A pigment paste suitable for coloring a vinyl base hot melt adhesive comprising epoxidized soybean oil, AROCLOR 1254, TiO_2 , and pigment.
3,282,902 Thiokol Chem.	AROCOLOR is mixed with liquid polysulfide polymer and other additives to produce a cureable polysulfide.
3,277,046 Johnson & Johnson	Chlorinated biphenyls and terphenyls are added to poly-a-olefins containing U.V. stabilizers to further increase the stability.
3,254,562 Polaroid	Hydroxypolyphenyls are U.V. polarizers and are used to treat a film of poly(vinyl alcohol).
3,035,901 Great Lakes Carbon	Artificial graphite bodies containing metallic carbide impurities are purified by heating the graphite in a chlorinated hydrocarbon at a temperature sufficiently high to impregnate the graphite with the hydrocarbon and form and volatilize chlorides of the impurities.
2,966,440 Shell Oil	An insecticidal composition comprising an insecticide and a resin such as chlorinated polyphenyl resin

2,921,911 Pennsalt	Finely divided strong oxidizing agents such as calcium hypochlorite are made substantially dustless by treating with chlorinated biphenyls having a flash point in excess of 180°C.
2,809,147 (Public) U.S.Govt.	An insecticidal composition comprising a chlorinated hydrocarbon insecticide and a film-forming chlorinated terphenyl.
2,746,872 Crown Zellerbach	Citrus fruits are packaged in a paper treated with diphenyl present in an amount sufficient to control decay, said paper being also treated with a citrus oil of the group consisting of lemon oil and bergamot oil and mixtures thereof.
2,713,006 Hunter Metal-lics	A paste pigment composition of finely divided ferrous metal particles wetted and coalesced with a liquid chlorinated polyphenyl.
England(1967) J.Chem.Phys. 47(11), 4329-34 Bell Telephone Labs	Measurements of dynamic shear impedance of chlorinated biphenyls and polystyrene-chlorinated biphenyls solutions were made by an ultrasonic reflectance technique. The results are analyzed in terms of viscoelastic behavior.
England(1967) Plant Dis.Rep. 51(1), 58-61 Volcani Inst. Agr. Res.	Paper impregnated with biphenyl is placed between layers of fruit to control citrus fruit rot.
England(1966) Citrus Ind. 47(10), 9-11 Univ. of Florida	Diphenyl is added to citrus fruits stored in polyethylene bags to prevent citrus rot.
England(1966) J.Phys.Chem. 70(7), 2271-6 Univ. Kyoto, Japan	Normal and shear stresses of solutions of polystyrene and chlorinated biphenyl solvent were measured.
3,209,046 Monsanto	A process for the alkylation of an aromatic compound by heating the aromatic (diphenyl) with an aliphatic sulfonyl halide or an aliphatic sulfonyl acid.

3,014,796 Monsanto	A solid rocket propellant containing a binder of ethyl cellulose plasticized with a chlorinated polyphenyl.
2,894,923 Monsanto	Terphenyl is added as a light stabilizer to halogen containing epoxy resin compositions.
2,857,258 Monsanto	A rocket propellant comprising a particular non-plastic gas generating composition and a binder comprising a resinous chlorinated diphenyl or terphenyl.
2,588,318 Monsanto	A water emulsifiable soil poison concentrate comprising 25-45% chlorinated biphenyl, 25-45% trichlorobenzene, 7-13% pentachlorophenol plus an alcohol, oil and wetting agent.

WRE:rk