Philips Research
100 years of patents and publications
Foreword

100 years of patents and publications from Philips Research

- Phase 1: Start and diversification (1914 - 1945)
- Phase 2: Autonomous research (1945 - 1970)
- Phase 3: Connecting to the Product Divisions (1970 - 1990)
- Phase 4: Becoming a front-end innovation organization (1990 - 2013)

- Publishing
- Research and IP

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Historical timeline

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Innovation is absolutely core to what Philips is – it is part of our strategy. It is how we improve people’s lives, how we make the world healthier and more sustainable. Innovation is how we create superior value for our customers and for our shareholders. We put people at the center of everything we do, responding to their aspirations, needs and desires.

Philips Research is a front-end of innovation organization that is a preferred co-creation partner for the Philips businesses and selected strategic relations. We work in multidisciplinary teams, and we are at the leading edge of core technologies that extend throughout the entire product portfolio of Philips, which allows the company to generate new businesses and real competitive advantage in the marketplace. We also have an extensive set of partnerships, because we don’t have all necessary know-how in house.

Our approach has led to more than a century of breakthrough innovations. To be able to protect our ideas, we have been working closely together with Philips Intellectual Property & Standards (IP&S) to create intellectual property (IP). Over many years, IP&S has created a large IP portfolio with world-class IP solutions to support the growth, competitiveness, and profitability of the Philips businesses.

Moreover, since our foundation by Gilles Holst in 1914, publishing papers about new developments in Research has been a means to position ourselves as an important player in the world of science and technology, and strengthen our reputation in innovation. By doing so, we are able to provide scientific underpinning for our commercial offerings, and at the same time attract talent and potential partners for innovation co-creation.

With this publication, we would like to give some insights in the most important and impactful patents and publications that have been created by Philips Research over the past 100 years. For each decade, we show the ten most-cited publications, as well as a few examples of patents that have contributed to value generation for Philips in the 100-years’ existence of Philips Research. My special thanks go to Frank Toolenaar from Philips Research and Maaike van Velzen from Philips Intellectual Property & Standards who compiled and edited the material brought together in this booklet.

This collection presents a fascinating insight in our rich history – I hope you will enjoy reading it.

Henk van Houten
General Manager Philips Research
January 2014
As a corporate Research organization, Philips Research has always been flexible in adapting to the demands of the time and to the strategy of Philips as can be seen in the several overviews that have been published on previous occasions. In 1994, Marc de Vries distinguished three distinct phases in the way Philips Research handled the challenges of the then 80 years of its existence. We want to summarize his assessments and expand to 2013 with a fourth phase, with special attention to publications.

Phase 1: Start and diversification (1914 – 1945)
In the early 20th century, technological developments became more and more dependent on scientific knowledge, especially in the fields of chemical technology and electricity, which led to the foundation of corporate scientific laboratories at companies such as General Electric (1900), Dupont (1902), Siemens (1905), AT&T (1910), Marconi (1912), and Philips (1914). Such laboratories typically were responsible for three types of tasks: (1) quality control for existing production processes, (2) knowledge acquisition for innovation and improvement of products or processes, based on existing science, and (3) acquisition of new knowledge that may result in new products.

Gerard Philips viewed research as a means of reducing costs in the production of incandescent lamps. On the other hand, Gilles Holst, the founder of the Research organization, aimed at understanding as well as controlling materials and processes. The main tasks at the Natuurkundig Laboratorium in its early years were twofold: understanding the physics of the half-watt lamp, and experimenting with new light sources. Until 1923 there were really only two scientists (Holst and Oosterhuis), but that number grew fast when the lab began contributing to the diversification of Philips from light bulbs to other types of vacuum tubes.

Gas discharge lamps were the first products beyond incandescent light bulbs, followed closely by X-ray tubes such as the Metalix, a compact X-ray tube developed by Blouwers. This research can be considered as the basis of the later Medical Devices / Healthcare division. The development of radio tubes both for receiving and transmission purposes led to the fabrication of radios, which formed the basis of Consumer Electronics and various Professional Electronics divisions.

Research into magnetic ceramic ferrite materials started in 1920s, as an essential material in loudspeakers for radios. This led to applications in dynamics and in the first rotary shaver. Two basic material inventions were developed around WWII, (ferro-)magnetic Ferroxcube and (soft-magnetic) Ferroxdure, which after 1950 was to be applied widely in coil cores for various products. Other companies became very interested in using these materials and Philips was thus able to obtain Bell’s transistor knowledge via a patent cross license.

Holst wanted to have researchers with excellent scientific reputations. To achieve this, he created a culture in which researchers felt free to do high-level scientific and technological research – with management ensuring appropriate alignment with business priorities. He organized colloquia in which famous physicists (such as Ehrenfest, Einstein, and Pauli) shared their latest insights with the scientists of the lab. Holst also stimulated publications in academic journals as an independent and open forum for judging the lab’s scientific output. Holst also hoped that a strong reputation as a serious scientific research institute would attract good scientific university graduates.

At the same time, Holst also stimulated that the outcomes of research were profitable for the company. Scientists were expected to submit ideas for patents (white cards), which were judged by Holst himself before submission to the Patent department. In 1936, Holst also created a special journal, the Philips Technisch Tijdschrift (with translations in English, French and German), to answer the increasing number of enquiries for data and particulars of Philips products and also to make contacts with the engineering world.

Phase 2: Autonomous research (1945 – 1970)
After the Second World War, Philips created separate product divisions with their own development laboratories, next to the corporate Research organization. Under Hendrik Casimir, one of the most visible successors of Holst, a trend developed to incorporate some of the forefronts of science into the research program of Philips Research, instead of just relying on contacts with academic institutions.

Casimir saw science and technology develop in a spiral in which science uses technology without such a time lag, while science uses technology without such a time lag. He advocated that a research environment should exist within an industry to foster both science and technology. Researchers in such an environment should be given considerable freedom and be encouraged to communicate and share their findings in journals and at professional meetings. Fundamental research became a particular task as a cradle for creating future options for the company. Conversion into devices and systems was seen as the responsibility of the development labs at the Product Divisions (PDs). In such an environment, publishing was seen as important output and source of pride.

However, also during this period the Natuurkundig Laboratorium did make some very important contributions which created very profitable products for Philips. One example is the Plumbicon, a pickup tube for television cameras, which was an innovation that every company in the television broadcasting business had to use to remain compatible. Another success was LOCOS (LOCal Oxidation of Silicon), a silicon process technology to create local silicon-dioxide areas on silicon to insulate the individual MOS transistors from each other. In the IC world of the 1980s, no company could ignore LOCOS. Both innovations generated significant value for Philips through use in products and licensing.

Around 1970 the post-war economic boom ended and the world began to face successive crises. This affected...
companies by recurrent stagnation periods that forced them to reorganize to maintain efficiency, which for Philips coincided with strongly increasing competition from Japan. From the early 70s the notion grew that insights from the marketplace might be more important for industrial breakthroughs than basic research. Casimir’s successor Pannenborg stated already in 1972 that attention should shift from technology push to market pull – Research should be oriented towards converting scientific developments into Philips products rather than in exploring new scientific fields. This resulted into a rapid termination of whole areas of research (Stirling motor, biology, futurology, solar cells, pollution) – and an increased focus on programs that were aligned with the business units’ scope and strategies. The development of digital optical storage on disc during this period can be considered as one of the major breakthroughs in the consumer electronics area. On the basis of its broad research capabilities Philips – together with Sony – launched the compact disc in 1979. Due to the close co-operation with a partner like Sony and with the music industry, this success was extended to other formats.

Phase 4: Becoming a front-end innovation organization (1990 - 2013)

In the mid-1990s Philips decided to concentrate on high-volume electronics, including semiconductors, displays, audio and TV, mobile phones, and data storage. However, towards 2000 it became clear that the company’s position in many of these fields was not tenable, due to rapid price erosion, and the emerging fierce competition from Korean and Chinese industry. As a result, components and semiconductor divisions as well as the display, audio and television activities were divested. From that point onwards, there was increasing focus on healthcare, lighting and consumer products in the area of health and well-being – catering to unmet needs related to significant macro-economic and societal trends. In the Healthcare sector, a position was built in home healthcare next to the hospital franchise. In Lighting, focus was on the disruptive replacement of lamps by LEDs, and on the digitization of the industry, with LED lamps becoming part of the Internet of Things. In Consumer Lifestyle the focus shifted to domestic appliances, personal care, and well-being products.

For Research, this meant a massive reorientation on new fields of expertise – re-using as much as possible world-class competencies like signal and image processing, optics, and miniaturization. But new competencies needed to be added, from psychology to bio-molecular engineering and clinical sciences, data analytics, and service engineering.

In terms of ways of working, it was realized that it was not enough to have close contacts with the technical community in Philips’ business sectors. The whole process from idea generation to production should be a close cooperation between R&D, strategy, business management, and marketing. Research needed to become a ‘co-creation partner’ of the businesses, with a focus on the front end of innovation, but extending into product development for the more disruptive types of innovation. This required a change in culture and competency profiles in the Research organization.

Open Innovation received much more attention as well. However, although this might seem paradoxical, it was realized that this does not necessarily mean becoming more open – a clear strategy was needed on what type of widely available knowledge should be sourced from outside, what could be shared in joint research, and what should be kept fully controlled. Confidentiality therefore became much more explicit, which led to a decrease in focus on external publications.

Publishing

The policy on publishing has long been characterized by the 4-square rule of Hofst (as recorded by Casimir in 1969): let them publish and take part in scientific activities. In the regulations of Research it was stated explicitly that it was in the first place the responsibility of the researcher what, where, and how to publish. Over the years, authors were encouraged to submit manuscripts for external publication, after approval via an internal review round.

In this internal approval process, two (‘peer’) colleagues and the patent department evaluate the quality of and the absence or presence of patentable material in the manuscript. With this input the department head then makes the final decision about submission to a journal or conference. Recently, the policy has been reformulated from a more focused strategic perspective.

Publishing is a means to position ourselves as an important player in the world of science and technology, strengthen our reputation in innovation, attract talent, provide scientific underpinning for our commercial offerings, and support external cooperation and the innovative image of Philips.

Publishing is still seen as a quality benchmark when papers from Philips Research are accepted by top-rate journals and conferences, but...

External publishing is not a right of the employee, but it should be supporting the overall objectives of Philips Research in co-creating meaningful innovation.

In the end, industrial researchers simply must focus on helping bring new products onto the market, leading to profitable growth of the company.

Statistics on publications from Philips Research

Since the first paper by Lely and Hamburger in 1914, publications have been meticulously recorded and collected in printed registers, which contain the data of the publications, clustered on author’s names and on subject. See Table 1 for the publication volume over the first 54 years.

Table 1: Registers with data of publications from Philips Research. Eindhoven between 1914 and 1968. The R-numbers refer to publications in Philips journals.

<table>
<thead>
<tr>
<th>Register</th>
<th>Years</th>
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<td>1 1914-1935</td>
<td>1001-1000</td>
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<td>2 1935-1951</td>
<td>1001-2000; R1-R171</td>
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<td>3 1951-1961</td>
<td>2001-3000; R175-R182</td>
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<td>4 1961-1968</td>
<td>3001-4000; R426-R455</td>
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After 1968, the publications of the ‘sister laboratories’ in other countries were included, each with their own report types and numbering system. Between 1973 and 2012 around 18,000 publications are found – see Fig 1 for the numbers per year.

If we compare the outputs of different corporate organizations (see Figure 2) – Philips is not that different from others – most show a gradual increase with a decline in recent years. The exception is Samsung that seems to be investing heavily in publishing.

It is difficult to determine the impact that publications from Philips (Research) have had on the business of...
Philips. Unlike patents that impact is rarely if ever direct – although this may change in the future as publications underpinning professional (medical) claims will become more important. Of course, enhancing the image of Philips in the scientific community, and using that also as a means to attract top talent, is priceless.

We would like to give some insights in the most important and impactful publications in the 100-years existence of Philips Research. We have chosen citation data as objective criterion, but we are well aware that the citation behavior has rapidly changed over time. Therefore we have chosen to search for the top 10 most-cited publications per decade. From two of these papers we show the abstract or opening part and one or two characteristic figures.

This collection presents a fascinating insight in our rich history.

Research and IP

Over many years, Philips Intellectual Property & Standards (IP&S) has worked closely with Research to create intellectual property (IP). IP&S has created a large IP portfolio with world-class IP solutions to support the growth, competitiveness, and profitability of the Philips businesses.

Philips’ IP portfolio currently comprises approximately 59,000 patent rights of which a significant part derives from activities in Research. In 2012, Philips registered approximately 1,500 patents, the majority of which relate to the growth sectors of healthcare and well-being. Through IP, the Philips businesses are enabled to grow, enter new markets, and increase competitive strength and profitability.

The IP portfolio has increased profitability of the Philips businesses in many of its activities ranging from television to healthcare. In addition to value created in the Philips businesses, the IP portfolio has been used to generate licensing income. In the early years of the 21st century, Philips started large licensing programs, e.g., on the audio cassette, LOCOS technology for semi-conductor industry, and optical recording/DVD and Blu-ray. These programs have made a significant contribution to Philips’ profit over the years.

This collection gives examples of patents that are part of the portfolio that generated value for Philips. The patents in this collection originate from Philips Research. The full IP portfolio is composed of inventions generated in Research, the Philips businesses, and obtained by acquisition of IP or entire companies.

The list includes IP that covers products sold by the Philips businesses and IP that is part of larger licensing programs. Although a fully quantitative value determination for IP is difficult, we defined several components that contribute to value generation through IP. These components include direct revenue from licensing agreements and the contribution made by IP to the profit generated by the other Philips businesses.

Real value generation with IP usually starts several years after the filing of the patent applications and their publication 18 months later. Therefore, we also included a few patents of the most recent decade to show their potential for value generation.

The publications in this book are derived from the “Web of Science core collection” by Thomson Reuters and this book only includes a selection of reviewed articles from 12,000 most renowned scientific journals and 150,000 conference proceedings. A publication was considered for inclusion if at least one of the authors has a Philips affiliation. Other publications created by Philips Research (such as scientific books and publications in newspapers, etc.) were left out of the selection criteria. Nevertheless, it is important to stress that these publications were also crucial to the reputation of Philips Research as a thought leader. Here, we would like to give special mention to “Simulated Annealing and Boltzmann Machines,” by E. Aarts and J. Korst (4,400 citations according to Google Scholar) and “The new everyday” by E. Aarts and S. Marzano (353 citations according to Google Scholar).

1 Veelvrij jaren research: natuurkundig laboratorium der N.V. Philips’ gloeilampfabrieken, Philips Eindhoven 1955
3 H.B.G. Casimir – An anthology of Philips research. (1891-1966), Philips 1966
5 Marc J. de Vries – 80 Years of research at the Philips Natuurkundig Laboratorium 1914-1994
6 A. Sarleijn and P. Kroes – Between science and technology. North Holland, 1990
8 D. Lely, L. Hamburger – Z. Anorg. Allgemeine Chemie 87, 209-228 (1914)
9 Searching for addresses containing “philips res*” or “philips forschung*” or “philips nat*” or limel-breivannes or briaciff
10 As the publication data have never been converted into a practical database, it is unfortunately not possible to give yearly figures on output volumes before 1973. From Web of Science this is possible after 1973 when they began to add address data to their records. For the first 60 years between 1914 and 1973 we had to identify the most important authors from the Registers and then check these names for citations.
Historical timeline
1914 – 2013
Patents and IP have always been important in Philips. The first Philips Research patent dates back from June 11, 1914, when Gilles Holst filed a patent on a new incandescent projection lamp. It was granted in 1918.

In 1921, Philips started its own IP department. In the next chapters you’ll see examples of valuable patents and publications per decade.
**Publications**

1. Über die Anregungs- und Ionisierungsspannungen von Neon und Argon und ihren Zusammenhang mit den Spektren dieser Gase
   - GL Hertz
   - ZEITSCHRIFT FÜR PHYSIK 18, 307-316 (1923)
   - Times Cited: 48

2. Über die elektrische Leitung in Gassen
   - G Holst, E Oosterhuis
   - PHYSICA 1, 78-87 (1921)
   - Times Cited: 47

3. Experimentelle Untersuchungen über die Wärmeleitfähigkeit der Gase. I
   - S Weber
   - ANNENALER DER PHYSIK 54, 325-356 (1917)
   - Times Cited: 34

4. Experimentelle Untersuchungen über die Wärmeleitfähigkeit der Gase. II
   - S Weber
   - ANNENALER DER PHYSIK 54, 437-462 (1917)
   - Times Cited: 32

5. Untersuchungen über das Gleichgewicht von Flüssigkeit und Dampf des Systems Argon-Stickstoff
   - G Holst, L Hamburger
   - ZEITSCHRIFT FÜR PHYSikalische CHEMIE 91, 533-547 (1916)
   - Times Cited: 31

6. Unkristallin Wolfram
   - AE van Arkel
   - PHYSICA 3, 76-87 (1923)
   - Times Cited: 26

7. Herstellung der Elemente Thorium, Uran, Zirkon und Titan
   - D Lely, L Hamburger
   - ZEITSCHRIFT FÜR ANorganische UND Allgemeine CHEMIE 87, 209-228 (1914)
   - Times Cited: 22
1924 – 1933

Patents

1. **Pentode**
   - G Holst; BDH Tellegen
   - US Patent 1,945,040 (1926)

2. **X-ray tube**
   - A Bouwers
   - US Patent 1,893,759 (1927)

3. **Amplifier**
   - K Posthumus
   - US Patent 1,996,830 (1928)

4. **Strapper Magnetron**
   - K Posthumus
   - US Patent 2,103,638 (1933)

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**A Bouwers**

**K Posthumus**

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**G Holst, BDH Tellegen – Pentode**

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**A Bouwers – X-ray tube**

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This invention has reference to the amplification of electric oscillations by means of thermionic devices. It is known that when these devices were used in a vacuum tube, the negative grid and anode contained a substance which was resistive to the flow of current. This resistance was due to the fact that the grid and anode were made of materials which were not perfectly vacuum-tight. The resistance of the grid was such that a certain amount of current flowed through it, even when no oscillations were present in the vacuum tube. This current was called the grid leak current. In order to overcome this disadvantage, the grid leak current could be reduced by using a grid with a high resistance. Another solution was to use a grid with a low resistance, but this would result in a decrease in the amplification of the vacuum tube. The invention described in this patent solves this problem by using a grid with a low resistance and a device for controlling the grid leak current. This device consists of a control grid which is connected to the anode through a resistor. The value of the resistor can be adjusted, so that the grid leak current can be controlled. When the resistor is adjusted to a high value, the grid leak current is reduced, resulting in an increase in the amplification of the vacuum tube. When the resistor is adjusted to a low value, the grid leak current is increased, resulting in a decrease in the amplification of the vacuum tube. The invention is therefore useful for obtaining a desired amplification of the vacuum tube by adjusting the grid leak current.
### Publications

1. **Der Niedervoltbogen**
   - **Author:** MJ Druyvesteyn
   - **Journal:** Zeitschrift für Physik 64, 781-798 (1930)
   - **Citations:** 597

2. **Über die Stromung sehr verdünnter Gase durch Rohren von beliebiger Länge**
   - **Author:** P Clausing
   - **Journal:** Annalen der Physik 12, 961-989 (1932)
   - **Citations:** 407

3. **On relaxation-oscillations. I**
   - **Author:** B van der Pol
   - **Journal:** Philosophical Magazine 2, 978-992 (1926)
   - **Citations:** 369

4. **The heartbeat considered as a relaxation-oscillation and an electrical model of the heart**
   - **Author:** B van der Pol; J van der Mark
   - **Journal:** Philosophical Magazine 3, 673-775 (1928)
   - **Citations:** 318

5. **Über die Strahlf ormung bei der Molekularstromung**
   - **Author:** P Clausing
   - **Journal:** Zeitschrift für Physik 66, 471-476 (1930)
   - **Citations:** 190

6. **Frequency demultiplication**
   - **Author:** B van der Pol; J van der Mark
   - **Journal:** Nature 120, 363-364 (1927)
   - **Citations:** 186

7. **Über den Zusammenhang zwischen Deformationsvorgang und Rekristallisationstextur bei Aluminium**
   - **Authors:** WG Burgers; exper. PC Louwerse
   - **Journal:** Zeitschrift für Physik 67, 605-678 (1931)
   - **Citations:** 160

8. **Über Ionisation durch metastabile Atome**
   - **Author:** FM Penning
   - **Journal:** Naturwissenschaften 15, 818 (1927)
   - **Citations:** 147

9. **Darstellung von reinem Titanium-, Zirkonium-, Hafnium- und Thoriummetall**
   - **Authors:** AE van Arkel; JH de Boer
   - **Journal:** Zeitschrift für Anorganische und Allgemeine Chemie 148, 345-350 (1925)
   - **Citations:** 146
1934 – 1943

Patents

1. High pressure mercury vapour lamp
   C Bol; W Ellenbaas; HJ Lemmens
   US patent 2,094,694 (1934)

2. Rectifying device
   FM Penning
   US Patent 2,182,736 (1936)

3. Permanent Magnet
   GB Jonas
   US Patent 2,295,082 (1938)

4. Philishave rotary electric shaver
   A Horowitz; A van Dam
   US Patent 2,308,920 (1939)

5. Electron Discharge Device
   JH de Boer
   US Patent 2,159,946 (1939)

6. Ferroxcube
   JL Snoek
   US Patent 2,452,529 (1941)
1934 – 1943

Publications

1. The London – van der Waals attraction between spherical particles
   HC Hamaker
   PHYSICA 4, 1058-1072 (1937)
   Times Cited: 1884

2. Electronic conductivity and transition point of magnetite (Fe3O4) and its transition point at low temperatures
   EJW Verwey
   NATURE 144, 327-328 (1939)
   Times Cited: 671

3. Electronic conductivity and transition point of magnetite (Fe3O4)
   EJW Verwey
   Physica 8, 979–987 (1941)
   Times Cited: 616

4. Mechanism of electrical discharges in gases of low pressure
   MJ Druyvesteyn, FM Penning
   REVIEWS OF MODERN PHYSICS 12, 87-174 (1940)
   Times Cited: 427

5. Effect of small quantities of carbon and nitrogen on the elastic and plastic properties of iron
   JL Snoek
   PHYSICA 8, 711-733 (1941)
   Times Cited: 425

6. Cation arrangement in a few oxides with crystal structures of the spinel type
   EJW Verwey; JH de Boer
   RECUEIL DES TRAVAUX CHIMIQUES DES PHYS-BAS 55, 979-987 (1941)
   Times Cited: 268

7. The non-linear theory of electric oscillations
   B van der Pol
   PROCEEDINGS OF THE INSTITUTE OF RADIO ENGINEERS 22, 1051-1086 (1940)
   Times Cited: 264

8. The non-linear theory of electric oscillations
   B van der Pol
   PROCEEDINGS OF THE INSTITUTE OF RADIO ENGINEERS 22, 1051-1086 (1940)
   Times Cited: 264

9. The non-linear theory of electric oscillations
   B van der Pol
   PROCEEDINGS OF THE INSTITUTE OF RADIO ENGINEERS 22, 1051-1086 (1940)
   Times Cited: 264

10. Die Glimmentladung bei niedrigem Druck zwischen koaxialen Zylindern in einem axialen Magnetfeld
    FM Penning
    PHYSICA 3, 873-894 (1936)
    Times Cited: 240

11. Semi-conductors with partially and with completely filled 3d-lattice bands
    JH de Boer; EJW Verwey
    PROCEEDINGS OF THE PHYSICAL SOCIETY 49, 59-71 (1937)
    Times Cited: 230

12. Heat dissipation of parallel plates by free convection
    W Elenbaas
    PHYSICA 9, 1-28 (1942)
    Times Cited: 220

13. The propagation of radio waves over a finitely conducting spherical earth
    B van der Pol, H Bremmer
    PHILOSOPHICAL MAGAZINE 171, 817-834, (1938)
    Times Cited: 27

14. The London – van der Waals attraction between spherical particles
   by H.C. Hamaker
   "Introduction. Frequently we experience the existence of adhesive forces between small particles, which result in adhesion phenomena, e.g., in the London–van der Waals attraction between spherical particles. In this paper, we will discuss this phenomenon in detail. The London–van der Waals attraction is caused by the interaction of the electric dipoles in the particles with the electric field of the surrounding medium. This interaction gives rise to a dipole-dipole attraction force between the particles."

With respect to a second sphere of radius R, the centre being a distance r apart, the same method may be applied and we obtain the total energy of interaction \( E \) (compare eq. 2):

\[
E = \frac{\pi}{6} \varepsilon_0 \varepsilon_r R^3 \left( C - \frac{3}{2} \right) \frac{1}{r} - \frac{\pi}{12} \varepsilon_0 \varepsilon_r R^3 \left( C - \frac{3}{2} \right) \frac{1}{r^2}.
\]
1944 – 1953

Patents

1. Vorrichtung zur Verstärkung kleiner Spannungen mit einer elektrischen Entladungsrohre
   AJW Overbeek
   DE 809220c1 (1944)

2. Gyrorator
   BDH Tellegen
   US Patent 2,647,238 (1947)

3. L-Cathode
   HJ Lemmens; MJ Jansen; R Loosjes
   US Patent 2,543,726 (1947)

4. Deltamodulation
   JF Schouten; F de Jager; JH Greefkes
   US Patent 2,662,118 (1948)

5. Ferroxdure
   JJ Went; GW van Oosterhout; EW Gorter
   US Patent 2,762,777 (1950)

6. X-ray image intensifier tube
   MC Teves; T Tol
   US Patent 2,757,293 (1951)

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**United States Patent Office**

**Passive Four Terminal Network for Gyrorating a Current into a Voltage**

For the impedance elements connected between the terminals of a passive electrical quadrupole or quadro terminal network we have hitherto been limited to inducences (L), resistances (R), capacitances (C) and ideal transformers as the basic circuit elements. The first three elements are defined as the ratioanous values of the current i passing through and the voltage V set-up across the elements being given by:

\[ V = L \frac{di}{dt} = RI + \frac{q}{C} \]

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**BDH Tellegen – Gyrorator**

**MC Teves, T Tol – X-ray image intensifier tube**
1944 – 1953

Publications

1. On the attraction between two perfectly conducting plates
   HBG Casimir
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   HBG Casimir
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   EJW Verwey
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   GH Jonker; JH van Santen
   PHYSICA 19, 120-130 (1953)
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   GW van Oosterhout
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    D Polder; JH van Santen
    PHYSICA 12, 257-271 (1946)
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11. On the attraction between two perfectly conducting plates
    HBG Casimir
    (Communicated at the meeting of May 29, 1948.)

    In a recent paper by Polder and Casimir it is shown that the interaction between a perfectly conducting plate and an atom or molecule with a static polarizability \( \alpha \) is in the limit of large distances \( R \) given by

    \[
    \delta E = \frac{3}{8} \frac{\hbar c}{\pi} \frac{\alpha^2}{R^3}
    \]

    and that the interaction between two particles with static polarizabilities \( \alpha_1 \) and \( \alpha_2 \) is given in that limit by

    \[
    \delta E/L^2 = -\frac{\hbar c}{24 \times 30} \cdot \frac{1}{a^3}
    \]

    PGy 1

    March 1950

    PHILIPS RESEARCH REPORTS

    1. Introduction. During our investigation into the occurrence of the perovskite structure we prepared i.e. compounds of the general formula \( \text{La}_x \text{M}^{4+} \text{O}_{3-x} \). One of these, \( \text{La}_2 \text{O}_3 \), showed ferromagnetic properties at liquid-air temperatures, whereas \( \text{La}_2 \text{O}_3 \) and \( \text{La}_2 \text{O}_3 \) did not. It appeared, however, that \( \text{La}_2 \text{O}_3 \) was ferromagnetic at this temperature only when it contained some manganese of a valency higher than three. By a suitable thermal treatment in an oxygen atmosphere, the substance took on pure oxygen and Curie temperatures up to 270K were found. A similar increase of valency of Mn was marked by preparing mixed crystals \( \text{La}_2 \text{Mn}^{4+} \text{O}_3 \) to \( \text{La}_2 \text{Mn}^{3+} \text{O}_3 \) (Mn = large divalent ion). An

    \[
    \text{La}_2 \text{Mn}^{3+} \text{O}_3
    \]

    \[
    \text{La}_2 \text{Mn}^{4+} \text{O}_3
    \]

    \[
    \text{La}_2 \text{O}_3
    \]

    \[
    \text{La}_2 \text{O}_3
    \]

    \[
    \text{La}_2 \text{O}_3
    \]
1954 – 1963

Patents

1. Gallium emitter
   LJ Tummers; PW Haayman

2. Cathode-Ray Tube
   J Haantjes; GJ Lubben
   US Patent 2,866,125 (1954)

3. Deplistor
   OW Memelink
   US Patent 3,081,404 (1958)

4. Spiral groove bearing
   JA Haringx; EA Muijderman; H Rinia

5. Colour beam splitter
   H de Lang; G Bouwhuis

6. Plumbicon
   EF de Haan; PPM Schampers; JHN van Vucht

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Abstraction of the Disclosure

A method of making a photoresponsive device, in particular a television camera tube, employing a layer of PbO in which the PbO is vapor-deposited and subjected to the action of oxygen in combination with water vapor, hydrogen sulfide, tellurated or seleniated hydrogen to render the layer of PbO photo-sensitive.
1954 – 1963

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   SOLID STATE PHYSICS 3, 307-435 (1956)
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2. Ferrites
   J Smit; HPJ Wijn
   PHILIPS TECHNICAL LIBRARY, 373 pages (1959)
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3. Topotactical reactions with ferrimagnetic oxides
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   FK Lotgering
   JOURNAL OF INORGANIC AND NUCLEAR CHEMISTRY 9, 113-123 (1959)
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4. Experimental and theoretical study of the domain configuration in thin layers of BaFe12O19
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   PHILIPS RESEARCH REPORTS 15 (1), 7-29 (1960)
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   EW Gorter
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   GH Jonker
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   J Smit., HG Beljers
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   A van Wieringen, N Warmoltz
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FA Kröger et al. – Relations between the concentrations of imperfections in crystalline solids

EW Gorter – Saturation magnetization and crystal chemistry of ferrimagnetic oxides

K Compaan
1964 – 1973

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   E Kooi  
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2. **Charge transfer device**  
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4. **Optical Recording**  
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   G Blasse; A Bril
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11. G Frens – Controlled nucleation for regulation of particle-size in mono-disperse gold suspensions

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G Frens

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G Blasse

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JH van Vucht et al. – Reversible room-temperature absorption of large quantities of hydrogen by intermetallic compounds
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<thead>
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<th>Patent Title</th>
<th>Inventors</th>
<th>Patent Number</th>
<th>Year</th>
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<td>1978</td>
<td>Compact HG discharge lamp</td>
<td>GA Wesselink; H Roelofs; HM van Bommel</td>
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<td>Natural Motion</td>
<td>SL Tan; L van de Polder; G de Haan; F Vreeswijk</td>
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1974 – 1983

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1914, Philips NatLab on 4th floor at Emmasingel, Eindhoven.

2012, Philips hue, interactive lighting concept, controllable via smart device.

1964, Philips launches its first color TV.
1984 – 1993

**Patents**

1. **NMR with permanent magnet**
   - H Zijlstra

2. **Solid State circuit**
   - RJ van de Plassche

3. **IC, Audio transmission**
   - RJ Slayter et al.

4. **HD-MAC**
   - F Vreeswijk; J van der Meer; H Begas; TI Trew

5. **MR**
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   - G Lokhoff; R Roth; W Raaymakers

7. **UHP Lamp**
   - HE Fischer; H Hörster

8. **Method of determining spectral distribution of nuclear magnetization in a limited volume, and device for performing the method**
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9. **Electrochemical cell**
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    - P Vogel

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1984 – 1993

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   PHYSICAL REVIEW 40 (15), 10481- (1989)
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1994 – 2003

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   C van Berkel; JA Clarke

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   MS Abdel-Mottaleb; N Dimitrova

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   R Florent; L Nosjean; P Lelong

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9. **Transmission, UMTS, LTE**
   TJ Mouldsley

10. **IC, Audio transmission**
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13. **IC, Audio transmission**
    R Florent

14. **IC, Audio transmission**
    R Florent; L Mourier; P van de Weijer; C Liedenbaum; M van Delden

15. **IC, Audio transmission**
    R Florent; L Mourier; P van de Weijer; C Liedenbaum; M van Delden

16. **IC, Audio transmission**
    R Florent; L Mourier; P van de Weijer; C Liedenbaum; M van Delden

17. **IC, Audio transmission**
    R Florent; L Mourier; P van de Weijer; C Liedenbaum; M van Delden

18. **IC, Audio transmission**
    R Florent; L Mourier; P van de Weijer; C Liedenbaum; M van Delden

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1994 – 2003

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6. Measurement of absolute photoluminescence quantum efficiencies in conjugated polymers
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7. Stability of n-type doped conducting polymers and consequences for polymeric microelectronic devices
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   SYNTHETIC METALS 87 (1), 53–59 (1997)
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8. Solution-processed ambipolar organic fi eld-effect transistors and inverters
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DM de Leeuw
2004 – 2013

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**2004 – 2013**

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**GH Gelinck et al.** - Flexible active-matrix displays and shift registers based on solution-processed organic transistors
For more information about this publication, please send an email to research.communication@philips.com