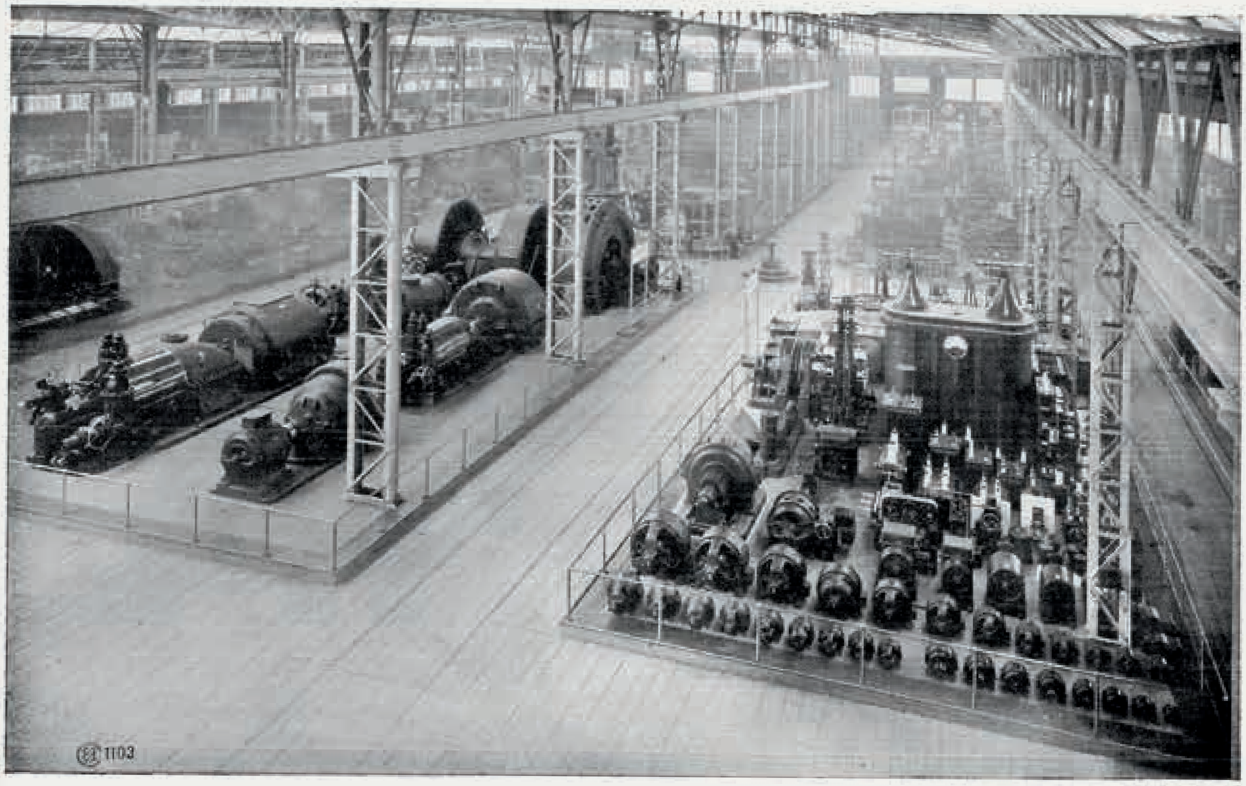
1ère ANNÉE.

No. 1, JUILLET 1914.

REVUE BBC

Publiée par la Société Anonyme BROWN, BOVERI & Cie., à BADEN (Suisse)



Les stands BBC dans la galerie des machines de l'Exposition Nationale Suisse, à Berne.

SOMMAIRE:

100 years of *ABB Review*

Looking back on a century in print

ANDREAS MOGLESTUE – History is more than the recording of chronology. Although the great milestones of political change, of wars and of landmark achievements may form the skeletal backbone of history, what breathes life and context into our understanding of the past are the smaller events that are handed down to us: the memories, photographs, facts about everyday life and objects that each tell a story. Much of the great fascination in looking back over *ABB Review*'s 100 years lies in the latter.


REVUE BBC

1914

ABB Review's predecessor journal, *BBC Review*[1], was first published in July 1914. Its initial purpose was to inform sales agents and business partners of the company's products, developments and activities. In later years, distribution grew to encompass a broader readership including customers and suppliers, consultants and journalists as well as universities, educators, students and lay people with an interest in technology. Many engineers who later came to work for ABB began to read *ABB Review* in their student days and were inspired in their career choice by the company's technological prowess. Similarly, many trade journals regularly publish articles that were first seen on the pages of *ABB Review,* and illustrations and diagrams from its pages have been republished in university text books. Part of the journal's appeal lies in its aim to be as objective as possible: Although it clearly speaks from an ABB perspective, *ABB Review* strives to remain factual and unbiased in the claims it makes.

Over the last 100 years, the pages of *ABB Review* have featured a staggering number of contributions on a broad range of subjects. Some articles covered the predecessors of products still manufactured by ABB. Many of the statements made in these articles are still surprisingly valid today. Other contributions reflect developments that were not pursued further by the company or that developed in a different way than expected.

Besides documenting this progress, the archives also present other insights. The style of publication has clearly developed over time – not just in terms of the development of typography, the gradual intro-

Title picture
This was the cover of the first-ever edition of *BBC Review*. The photograph depicts the Swiss National Exhibition held between May and October 1914 in Bern (Switzerland).

Footnote
1 Although BBC's full name was "Brown, Boveri & Company," the journal was spelled wihout the comma – *The Brown Boveri Review*.

1914
BBC Review published for the first time
Panama Canal is officially opened

1918
Reader's Digest is launched

1921
Women achieve equal voting rights in Sweden

1922
Insulin hormone is isolated by Sir Frederick Grant Banting

1923
First publication of TIME magazine

duction of color photographs or questions of style or presentation, but also in the manner in which articles are presented. Early issues make more liberal use of mathematical proofs, detailed circuit diagrams and construction drawings than is the case today. This may on the one hand be driven by concerns over the need to protect intellectual property, but also by changed reader expectations and subtle changes in the positioning of the journal.

BBC's sister company, ASEA (with which it merged in 1988 to form ABB) had its own publication, *ASEA Journal*. The latter was some years older than *BBC Review,* having first appeared in 1909. The company merger also led to a merging of the two editorial offices and *ABB Review* builds on the traditions of both predecessor journals.

Today, *ABB Review* is distributed to more than countries and published in five languages. Almost 60,000 copies of every edition are printed. There is furthermore a growing electronic distribution, both using a "classical" pdf format and more advanced tablet versions for iOS and Android.

Space constraints mean that the historical clippings presented in the following pages must appear in a much abridged form in the print and pdf versions. The tablet version contains more extensive versions of some of the items.

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Remembering the founders

Charles Eugene Lancelot Brown and Walter Boveri jointly founded BBC on October 2, 1891. Although both men came from an engineering background, Boveri grew increasingly active in the stewardship and growth of the company whereas Brown continued to focus on engineering challenges. Their names are remembered today in the two Bs of ABB. Both men passed away in 1924. As far as the editorial team can ascertain, theirs were the only obituaries ever to have been published on the pages of this journal.

The founders of ASEA, Ludwig Fredholm and Jonas Wenström passed away in 1891 and 1893 respectively, before the birth of the *ASEA Journal*.

The death of C. E. L. Brown, which took place at Montagnola near Lugano on the morning of May 2nd after a brief illness, marks the passing of a figure which had already become almost legendary in the world of electrical engineering. This is partly accounted for by the fact that Brown retired from active participation in electrical affairs thirteen years ago, but is, perhaps, to a great extent due to the attitude of a younger generation, which takes for granted the achievements of the past and, striving onwards, finds but little leisure for considering pioneer work carried out before its time. Thus, there is a tendency to forget to whose genius we owe so much of the progress which has been made in the design and construction of electrical machinery.

Charles Eugene Lancelot Brown was born at Winterthur in Switzerland on June 17th, 1863, the son of Charles Brown, an engineer well known as the originator of the bayonet-type frame and the Sulzer drop-valve steam engine. After one year's apprenticeship with M. Burgin in Basle, he was engaged in the spring of 1885, when hardly 22 years old, by the Oerlikon Engineering Works, and two years later was put in control of the electrical department. This marks the commencement of an exceptionally fruitful career.

During his first years with the Oerlikon Company, Brown devoted his energies to the development of the direct-current system, and particularly to the production of practical direct-current machines.

But a few months have elapsed since we recorded the death of the genial inventor and designer C. E. L. Brown, and now his nearest colleague and the co-founder of our firm, Walter Boveri, has followed him on the last journey. His passing away has deprived the Swiss electrical industry of its most outstanding personality, and no deeper loss could have been sustained.

W. Boveri was born in Bamberg in the year 1865, and after a course of engineering training at Nuremberg, he came to Switzerland when 20 years of age. Here he entered the Oerlikon Engineering Works, where, under the direction of C. E. L. Brown, the manufacture of electrical machinery was just being undertaken. Boveri, who subsequently took charge of their erection department, assisted throughout the development of the direct-current machine there, and in the year 1888 carried out the erection and setting into operation of the first electric power transmission scheme from Kriegstetten to Solothurn. In 1891, after a period of six years with the Oerlikon Company, he and C. E. L. Brown, with whom he was closely associated, founded the firm of Brown, Boveri & Co. at Baden.

In the early years following the foundation of the firm, Boveri devoted himself, as at Oerlikon, to the planning, installation, and putting into operation of both small and large plants. The unusually good results obtained with Brown's designs, however, soon resulted in a very rapid increase in the activity of the Baden works, and it was not long before Boveri was faced with work of a very different nature. The pro-

1924

1924

Death of Charles E.L. Brown, cofounder of BBC

Death of Walter Boveri, cofounder of BBC

First winter Olympics

1925

John Logie Baird demonstrates television

1928

Flying Doctor service starts in Australia

1931

Opening of the Empire State Building in New York

1935

First night game in Major League Baseball made possible by electric lighting

The Hollerith machine

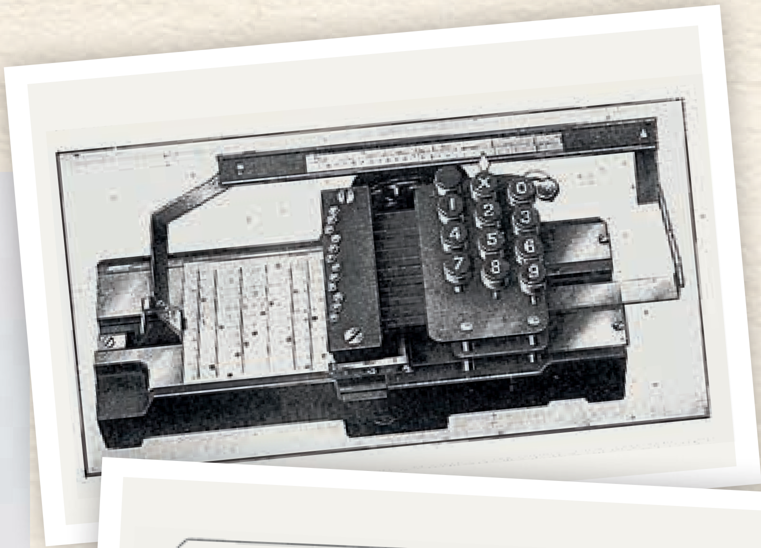
The Hollerith classification system permitted the automatic compilation of statistics. Data were stored by punching holes in cards. Counters were triggered by electrical connections. Herman Hollerith's machines were used in the 1890 US census, permitting the counting to be completed in a year (the previous 1880 census had taken eight years). The Hollerith machine can be considered an early computer.

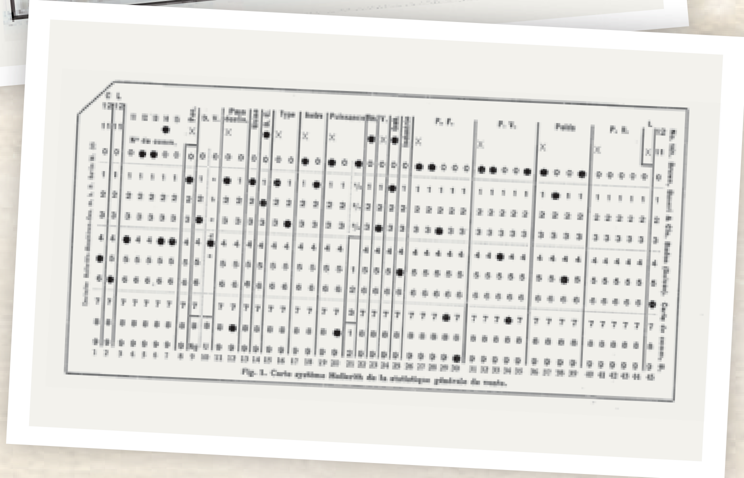
Hollerith's invention was initially patented, but because of its universal significance in improving the handling of data, the US government removed this restriction in 1910. BBC was one of the companies to benefit from this.

Punched cards were first introduced in the 18th century and used to "program" textile looms and musical machines. Later they were used for data storage and the programming of computers.

It is interesting to observe that today's DVDs still rely on microscopic holes to store data.

The Brown Boveri Review, November–December 1914





Throughout its long history, ABB has equipped countless power plants, many of which are still generating electricity today. This one is in Peru's Santa Eulalia Valley.

The Brown Boveri Review, October 1939

THE BROWN BOVERI REVIEW

THE HOUSE JOURNAL OF BROWN, BOVERI & COMPANY, LIMITED, BADEN (SWITZERLAND)

VOL. XXVI OCTOBER, 1939 No. 10

The Brown Boveri Review is issued monthly. — Reproduction of articles or illustrations is permitted subject to full acknowledgment.

JUAN CAROSIO, A BIG MODERN HYDRO-ELECTRIC POWER STATION IN PERU.

Decimal index 621.311.21 (85).

A description is given, here, of the design of the generators and transformers and of the layout of the switchgear of the new Juan Carosio hydro-electric power station in Peru. Further, details are given of the protective and regulating devices for the machines and the network and a description of the auxiliary devices of the power station.

A new hydro-electric high-head plant of 3 × 17,150 H.P. output (Fig. 1) has been built by the Empresas Eléctricas Asociadas, Lima, in the Santa Eulalia valley, at 1400 m above sea level and at about 60 km from the town of Lima. This is one of the biggest hydro-electric power stations built, so far, in South America. Thanks to their wide experience in hydro-electric station work, Brown Boveri were given the order for the entire electric equipment. The power station conforms to the very latest conceptions in power plant design, oil being eliminated as far as possible as an insulating agent in apparatus; air-blast circuit breakers and bushing current transformers being put in, to this end. Further, special measures have been taken to facilitate service and supervision by making use of a light diagram and by using electro-pneumatic remote control of circuit breakers and disconnecting switches as well as effective protective and regulating devices and extensive automaticity of the auxiliary services. Since the spring of 1938, this plant has been running to the entire satisfaction of the clients, allowing the Empresas Eléctricas Asociadas to stop the Lima steam power station, entirely, and keep it as a stand-by and peak-load plant.

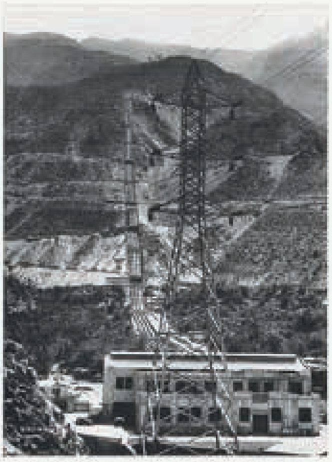


Fig. 1.—External view of the Juan Carosio hydro-electric power station, in Peru.

I. LAYOUT OF THE PLANT.

Fig. 2 gives the fundamental diagram of connections of the electrical part. There are three generator-transformer sets each of 17,500 kVA, working directly on a double set of 64-kV bus-bars. From these, 5 high-voltage transmission lines take off, of which 4 to Lima. At the moment, there are only three of them built. Two 250-kVA station transformers, a Diesel-electric stand-by set and a storage battery cover the requirements of the station itself. Fig. 3 shows the layout of the power station composed of an engine room with built-on switchgear house. The arrangement of the equipment will be explained in describing the various parts of the plant.

II. GENERATORS.

As is seen in Fig. 4, there are three horizontal-shaft hydro-electric sets in the engine room. The generators are direct coupled to Pelton wheels each of 17,150 H.P. and are built for the following conditions:

Terminal output at an altitude of 1400 m	17,500 kVA
Active load at p.f. = 0·7	12,250 kW
Terminal voltage	6 to 6·5 kV
Frequency	60 cycles
Rated speed	514 r. p. m.
Flywheel effect	82 tm².

A century of hum

A trio of BBC transformers are the same age as *ABB Review*

SALLY DURRANT – They started service before the invention of the toaster, the TV and the Internet. Qantas and Canberra weren't even born yet. And two world wars, the Beatles, Britney Spears, Monty Python, spaceflight, penicillin and Velcro also impacted our world for better or worse over those years.

So what has withstood the test of time?

Three ABB power transformers have been stalwarts in the rural Victorian landscape of Australia for the last 100 years, actively doing their business for local utility SP AusNet. The transformers were part of a zone substation supplying the local area which also included two hydrogeneration companies.

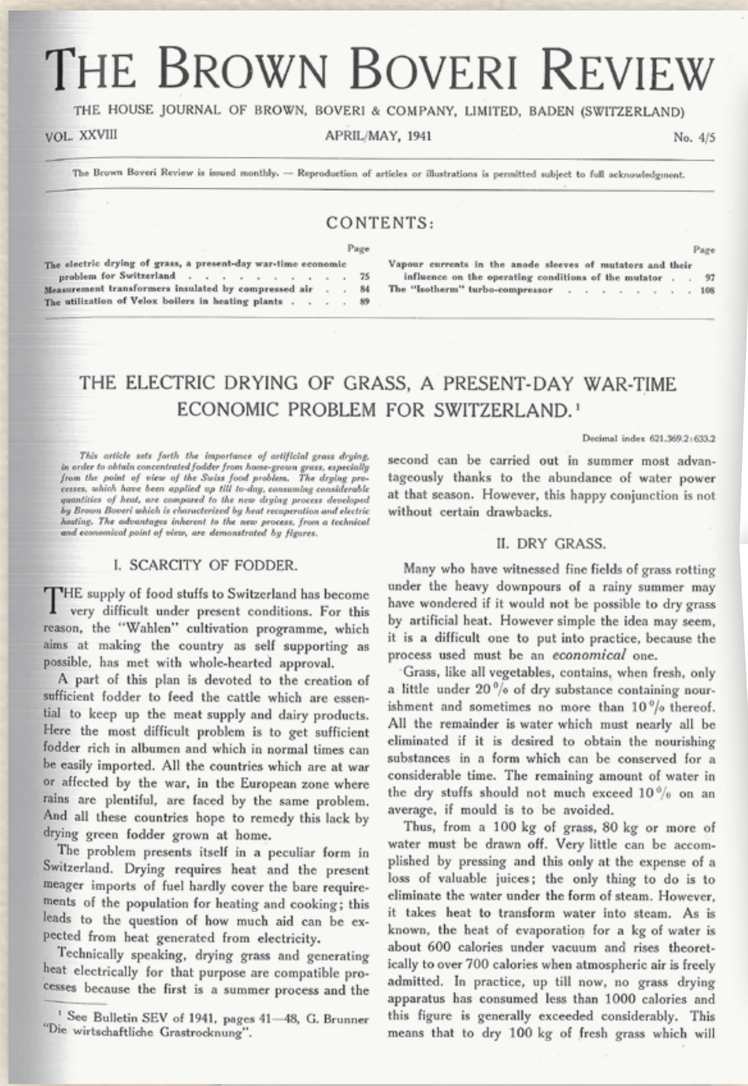
SP AusNet's Project Manager for Capital Delivery and Engineering, Neil Sequeira agreed. "These ABB transformers were way over engineered and built to last," he said. The only loving care they seemed to require was to feed their thirst for oil. Well you wouldn't deny a 100-year-old a drink every now and then!

The three grand old dames (or gents, depending on your point of view) are being retired not because they aren't pulling their weight, but because the SP AusNet substation is being rebuilt. One of the transformers will be shipped to ABB's Moorebank, Sydney facility where it will live out its twilight years under the shade of a gum tree as part of a display of old and new – a testament to the great technology ABB continues to invent and reinvent.

Happy 100th birthday transformer 1, 2 and 3. May you enjoy your well-deserved retirement!

Sally Durrant
Moorebank, Australia
ABB Corporate Communications
sally.durrant@au.abb.com

The three 9 MVA 22/66 kV GSU transformers are just as old as *ABB Review*. They were supplied by BBC in 1914.



THE BROWN BOVERI REVIEW

THE HOUSE JOURNAL OF BROWN, BOVERI & COMPANY, LIMITED, BADEN (SWITZERLAND)

VOL. XXVIII APRIL/MAY, 1941 No. 4/5

CONTENTS:

THE ELECTRIC DRYING OF GRASS, A PRESENT-DAY WAR-TIME ECONOMIC PROBLEM FOR SWITZERLAND.[1]

Decimal index 621.369.2:633.2

This article sets forth the importance of artificial grass drying, in order to obtain concentrated fodder from home-grown grass, especially from the point of view of the Swiss food problem. The drying processes, which have been applied up till to-day, consuming considerable quantities of heat, are compared to the new drying process developed by Brown Boveri which is characterized by heat recuperation and electric heating. The advantages inherent to the new process, from a technical and economical point of view, are demonstrated by figures.

I. SCARCITY OF FODDER.

THE supply of food stuffs to Switzerland has become very difficult under present conditions. For this reason, the "Wahlen" cultivation programme, which aims at making the country as self supporting as possible, has met with whole-hearted approval.

A part of this plan is devoted to the creation of sufficient fodder to feed the cattle which are essential to keep up the meat supply and dairy products. Here the most difficult problem is to get sufficient fodder rich in albumen and which in normal times can be easily imported. All the countries which are at war or affected by the war, in the European zone where rains are plentiful, are faced by the same problem. And all these countries hope to remedy this lack by drying green fodder grown at home.

The problem presents itself in a peculiar form in Switzerland. Drying requires heat and the present meager imports of fuel hardly cover the bare requirements of the population for heating and cooking; this leads to the question of how much aid can be expected from heat generated from electricity.

Technically speaking, drying grass and generating heat electrically for that purpose are compatible processes because the first is a summer process and the second can be carried out in summer most advantageously thanks to the abundance of water power at that season. However, this happy conjunction is not without certain drawbacks.

II. DRY GRASS.

Many who have witnessed fine fields of grass rotting under the heavy downpours of a rainy summer may have wondered if it would not be possible to dry grass by artificial heat. However simple the idea may seem, it is a difficult one to put into practice, because the process used must be an *economical* one.

Grass, like all vegetables, contains, when fresh, only a little under 20% of dry substance containing nourishment and sometimes no more than 10% thereof. All the remainder is water which must nearly all be eliminated if it is desired to obtain the nourishing substances in a form which can be conserved for a considerable time. The remaining amount of water in the dry stuffs should not much exceed 10% on an average, if mould is to be avoided.

Thus, from a 100 kg of grass, 80 kg or more of water must be drawn off. Very little can be accomplished by pressing and this only at the expense of a loss of valuable juices; the only thing to do is to eliminate the water under the form of steam. However, it takes heat to transform water into steam. As is known, the heat of evaporation for a kg of water is about 600 calories under vacuum and rises theoretically to over 700 calories when atmospheric air is freely admitted. In practice, up till now, no grass drying apparatus has consumed less than 1000 calories and this figure is generally exceeded considerably. This means that to dry 100 kg of fresh grass which will

[1] See Bulletin SEV of 1941, pages 41—48, G. Brunner "Die wirtschaftliche Grastrocknung".

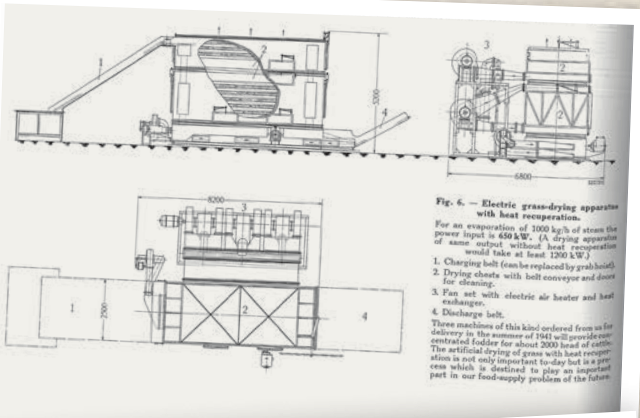
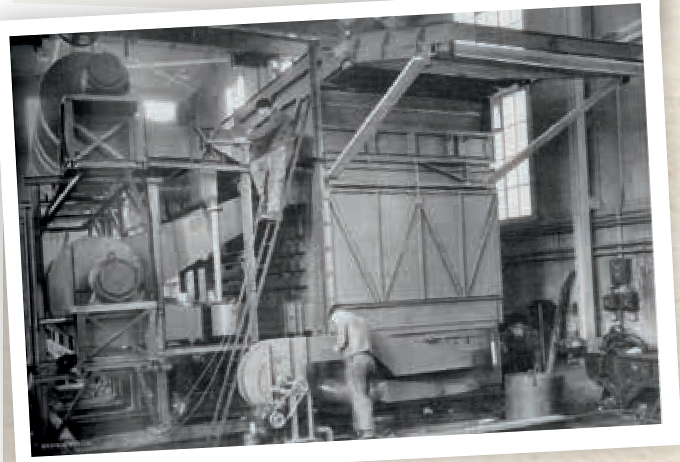


Fig. 6. — Electric grass-drying apparatus with heat recuperation.

For an evaporation of 1000 kg/h of steam the power input is **650 kW.** (A drying apparatus of same output without heat recuperation would take at least 1200 kW.)

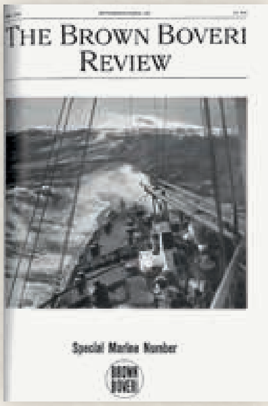
1. Charging belt (can be replaced by grab hoist).
2. Drying chests with belt conveyor and doors for cleaning.
3. Fan set with electric air heater and heat exchanger.
4. Discharge belt.

Three machines of this kind ordered from us for delivery in the summer of 1941 will provide concentrated fodder for about 2000 head of cattle. The artificial drying of grass with heat recuperation is not only important to-day but is a process which is destined to play an important part in our food-supply problem of the future.



Drying grass to make winter fodder for cattle? And that using electricity? ABB Review has no shortage of articles on unusual applications.

The Brown Boveri Review Review, April/May 1941



1942

1937

Nylon, invented by Wallace Carothers, is patented

1938

Chester Carlson invents a dry printing process called electrophotography, commonly called a Xerox

1939

BBC demonstrates the first transmission of HVDC (Wettingen to Zürich)

BBC builds the first combustion gas turbine for generating electricity

1942

Gagnan and Cousteau devise the scuba aqualung

1943

BBC builds the first 110 kV high-speed air-blast circuit breaker

The wristwatch connection

BBC’s contribution to the LCD

ANDREAS MOGLESTUE – ABB and its forerunner companies have never been shy to break new ground and pioneer new technologies. Some of these escapades have taken the company well outside its usual market segment. At times, BBC was in the market for such devices as domestic ovens, fridges and floor-polishing machines. It was also once at the heart of a fashionable wristwatch.

Prototype of a patented passive-matrix super-twisted nematic LCD with 540 × 270 pixels

Today, the concept of a digital watch is mostly associated with the 1980s era. It is easily overlooked that the concept of the liquid crystal display (LCD) is much older. The Austrian botanist, Friedrich Reinitzer, is generally credited with having first observed (in 1888) a material displaying a curious intermediate state between solid and liquid. He shared his observation with the German physicist, Otto Lehmann, who investigated it further. Lehmann noticed that the substance (cholesteryl benzoate) had the refractive qualities of a crystal during its intermediate phase. He hence dubbed it a “liquid crystal.”

In 1962, Richard Williams of the Radio Corporation of America (RCA) showed that the alignment of liquid crystals of p-azoxyanisole could be influenced by electric fields. His RCA colleague, George Heilmeier, made this realignment visible through the use of dyes, paving the way for LCDs. In circa 1968, Sharp commenced research in the area, recognizing the technology’s potential for calculator displays. The first such calculator was launched in 1973.

In 1969, BBC began a joint research effort with Hoffmann La Roche. Initially this was based in BBC’s research center in Dättwil (Switzerland), which had been inaugurated two years previously. The research effort soon bore first fruits, with Wolfgang Helfrich and Martin Schadt patenting the twisted nematic field effect in the following year. Cells using this effect displayed a greater sharpness and lower power consumption than previous LCDs. Hoffmann La Roche withdrew from the collaboration in 1972, but BBC continued developing the technology. A first production line was set up in BBC’s tube factory at Birrfeld (Switzerland) in 1973. The following year, an entirely new factory was opened in Lenzburg (Switzerland). It was expanded to 4,370 m^2 in 1978.

The compact size and low power consumption of the displays made them ideal for wristwatches. In the early years, BBC collaborated with several small-volume Swiss watchmakers, but the real breakthrough came when CASIO was brought onboard. The innovative Casiotron wristwatch that was launched in 1974 used a BBC LCD. The Casiotron was not only the first LCD watch to be produced in large numbers, but also the first with a built-in calendar (even taking into account leap years).

In later years, BBC added the backlighting concept that is still used for LCDs today. In 1983, the company invented the super-twisted nematic LCD, representing another great leap forward in terms of the crispness of the display and resolution. This technology was used in the Nintendo Game Boy and early mobile phones. BBC benefitted from this mostly through patent income as the company’s own production was already being ramped down. The facility in Lenzburg is today a center of power semiconductor manufacturing.

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Further reading

H. Kawamoto, “The History of Liquid-Crystal Displays,” Proceedings of the IEEE, vol. 90, no. 4, pp. 460–500, Apr. 2002.
P. J. Wild, *First-Hand: Liquid Crystal Display Evolution – Swiss Contributions*, http://www.ieeeghn.org/wiki/index.php/First-Hand:Liquid_Crystal_Display_Evolution_-_Swiss_Contributions

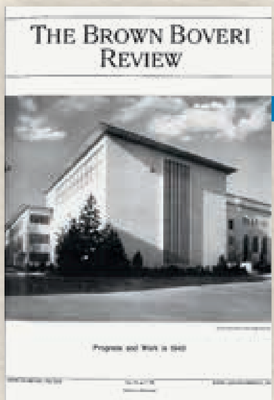
Fig. 146. — Passenger motor car converted to electric drive "Fiat 500 Topolino". Output 4·2 H.P., lead battery 90 Ah (for ten-hour discharge), 84 V, showing how the battery is built in.
For short trips in towns with moderate inclines.
Maximum speed attained on the flat 60 km/h.

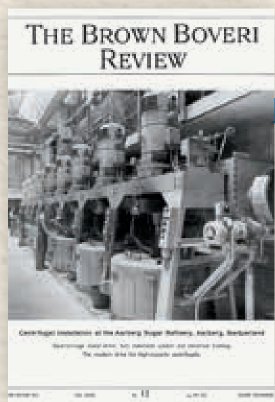
What we today call electromobility is no new field for ABB.

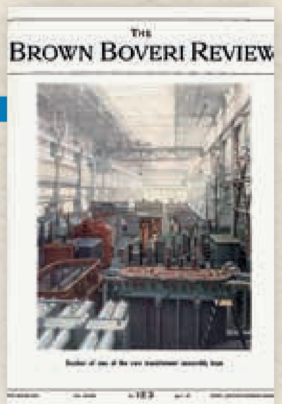
The Brown Boveri Review, January/February/March 1942

Moving transformers in 1908 (above) and 1937 (left)

The Brown Boveri Review, November/December 1942







1944

BBC develops the first high-speed locomotive with a direct drive system

1945

George Orwell publishes *Animal Farm*

1946

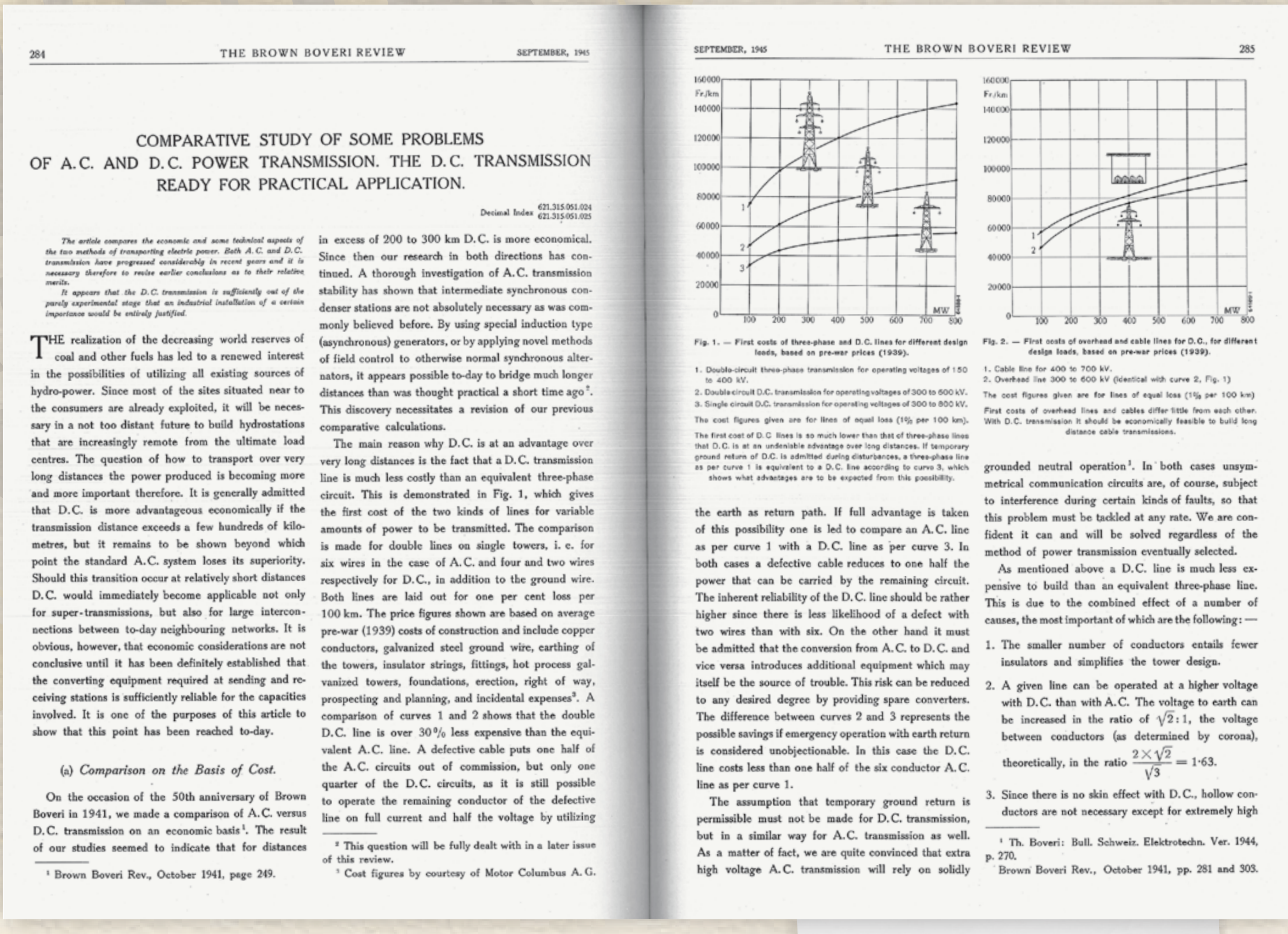
Disposable diapers are invented by Marion Donovan

1947

The transistor is invented by Bardeen, Brattain, and Shockley

1951

First BBC *Review* cover in color



COMPARATIVE STUDY OF SOME PROBLEMS OF A.C. AND D.C. POWER TRANSMISSION. THE D.C. TRANSMISSION READY FOR PRACTICAL APPLICATION.

Decimal Index 621.315.051.024
621.315.051.025

The article compares the economic and some technical aspects of the two methods of transporting electric power. Both A.C. and D.C. transmission have progressed considerably in recent years and it is necessary therefore to revise earlier conclusions as to their relative merits.

It appears that the D.C. transmission is sufficiently out of the purely experimental stage that an industrial installation of a certain importance would be entirely justified.

THE realization of the decreasing world reserves of coal and other fuels has led to a renewed interest in the possibilities of utilizing all existing sources of hydro-power. Since most of the sites situated near to the consumers are already exploited, it will be necessary in a not too distant future to build hydrostations that are increasingly remote from the ultimate load centres. The question of how to transport over very long distances the power produced is becoming more and more important therefore. It is generally admitted that D.C. is more advantageous economically if the transmission distance exceeds a few hundreds of kilometres, but it remains to be shown beyond which point the standard A.C. system loses its superiority. Should this transition occur at relatively short distances D.C. would immediately become applicable not only for super-transmissions, but also for large interconnections between to-day neighbouring networks. It is obvious, however, that economic considerations are not conclusive until it has been definitely established that the converting equipment required at sending and receiving stations is sufficiently reliable for the capacities involved. It is one of the purposes of this article to show that this point has been reached to-day.

(a) *Comparison on the Basis of Cost.*

On the occasion of the 50th anniversary of Brown Boveri in 1941, we made a comparison of A.C. versus D.C. transmission on an economic basis[1]. The result of our studies seemed to indicate that for distances in excess of 200 to 300 km D.C. is more economical. Since then our research in both directions has continued. A thorough investigation of A.C. transmission stability has shown that intermediate synchronous condenser stations are not absolutely necessary as was commonly believed before. By using special induction type (asynchronous) generators, or by applying novel methods of field control to otherwise normal synchronous alternators, it appears possible to-day to bridge much longer distances than was thought practical a short time ago[2]. This discovery necessitates a revision of our previous comparative calculations.

The main reason why D.C. is at an advantage over very long distances is the fact that a D.C. transmission line is much less costly than an equivalent three-phase circuit. This is demonstrated in Fig. 1, which gives the first cost of the two kinds of lines for variable amounts of power to be transmitted. The comparison is made for double lines on single towers, i. e. for six wires in the case of A.C. and four and two wires respectively for D.C., in addition to the ground wire. Both lines are laid out for one per cent loss per 100 km. The price figures shown are based on average pre-war (1939) costs of construction and include copper conductors, galvanized steel ground wire, earthing of the towers, insulator strings, fittings, hot process galvanized towers, foundations, erection, right of way, prospecting and planning, and incidental expenses[3]. A comparison of curves 1 and 2 shows that the double D.C. line is over 30 % less expensive than the equivalent A.C. line. A defective cable puts one half of the A.C. circuits out of commission, but only one quarter of the D.C. circuits, as it is still possible to operate the remaining conductor of the defective line on full current and half the voltage by utilizing

[1] Brown Boveri Rev., October 1941, page 249.

[2] This question will be fully dealt with in a later issue of this review.

[3] Cost figures by courtesy of Motor Columbus A. G.

Fr./km; 0, 20000, 40000, 60000, 80000, 100000, 120000, 140000, 160000; 1, 2, 3; 100, 200, 300, 400, 500, 600, 700, 800 MW

Fig. 1. — First costs of three-phase and D.C. lines for different design loads, based on pre-war prices (1939).

1. Double-circuit three-phase transmission for operating voltages of 150 to 400 kV.
2. Double circuit D.C. transmission for operating voltages of 300 to 600 kV.
3. Single circuit D.C. transmission for operating voltages of 300 to 600 kV.

The cost figures given are for lines of equal loss (1% per 100 km).

The first cost of D.C lines is so much lower than that of three-phase lines that D.C. is at an undeniable advantage over long distances. If temporary ground return of D.C. is admitted during disturbances, a three-phase line as per curve 1 is equivalent to a D.C. line according to curve 3, which shows what advantages are to be expected from this possibility.

Fr./km; 0, 20000, 40000, 60000, 80000, 100000, 120000, 140000, 160000; 1, 2; 100, 200, 300, 400, 500, 600, 700, 800 MW

Fig. 2. — First costs of overhead and cable lines for D.C., for different design loads, based on pre-war prices (1939).

1. Cable line for 400 to 700 kV.
2. Overhead line 300 to 600 kV (identical with curve 2, Fig. 1)

The cost figures given are for lines of equal loss (1% per 100 km)

First costs of overhead lines and cables differ little from each other. With D.C. transmission it should be economically feasible to build long distance cable transmissions.

the earth as return path. If full advantage is taken of this possibility one is led to compare an A.C. line as per curve 1 with a D.C. line as per curve 3. In both cases a defective cable reduces to one half the power that can be carried by the remaining circuit. The inherent reliability of the D.C. line should be rather higher since there is less likelihood of a defect with two wires than with six. On the other hand it must be admitted that the conversion from A.C. to D.C. and vice versa introduces additional equipment which may itself be the source of trouble. This risk can be reduced to any desired degree by providing spare converters. The difference between curves 2 and 3 represents the possible savings if emergency operation with earth return is considered unobjectionable. In this case the D.C. line costs less than one half of the six conductor A.C. line as per curve 1.

The assumption that temporary ground return is permissible must not be made for D.C. transmission, but in a similar way for A.C. transmission as well. As a matter of fact, we are quite convinced that extra high voltage A.C. transmission will rely on solidly grounded neutral operation[1]. In both cases unsymmetrical communication circuits are, of course, subject to interference during certain kinds of faults, so that this problem must be tackled at any rate. We are confident it can and will be solved regardless of the method of power transmission eventually selected.

As mentioned above a D.C. line is much less expensive to build than an equivalent three-phase line. This is due to the combined effect of a number of causes, the most important of which are the following: —

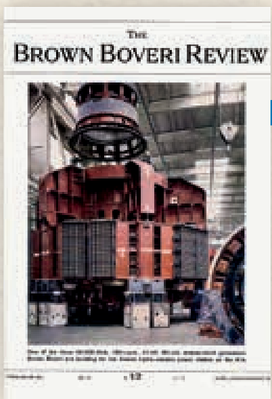
1. The smaller number of conductors entails fewer insulators and simplifies the tower design.
2. A given line can be operated at a higher voltage with D.C. than with A.C. The voltage to earth can be increased in the ratio of $\sqrt{2}:1$, the voltage between conductors (as determined by corona), theoretically, in the ratio $\frac{2\times\sqrt{2}}{\sqrt{3}} = 1{\cdot}63$.
3. Since there is no skin effect with D.C., hollow conductors are not necessary except for extremely high

[1] Th. Boveri: Bull. Schweiz. Elektrotechn. Ver. 1944, p. 270.
Brown Boveri Rev., October 1941, pp. 281 and 303.

The arguments for using DC transmission to integrate renewable generation are far from new, as this 1945 contribution shows.

Despite BBC's early activities, it was the ASEA side of the company that established early leadership in the field of HVDC (see also page 33 of this edition of *ABB Review*).

The Brown Boveri Review, September 1945



1954

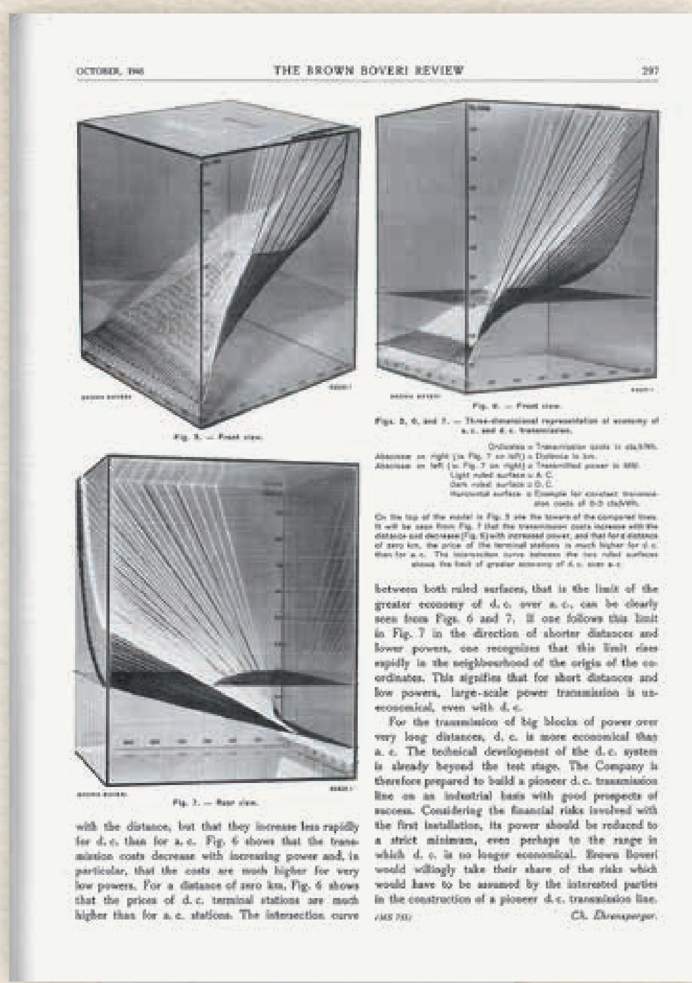
1952
Jonas Salk develops a vaccine against poliomyelitis (polio)

1953
ASEA is the first company in the world to manufacture synthetic diamonds

1954
ASEA lays the first-ever commercial HVDC transmission line

1960
Theodore Maiman invents the laser

1961
Bob Dylan makes his debut performance in Greenwich Village, New York



OCTOBER, 1946 THE BROWN BOVERI REVIEW 297

Fig. 5. — Front view.

Fig. 6. — Front view.

Figs. 5, 6, and 7. — Three-dimensional representation of economy of a.c. and d.c. transmission.

Ordinates = Transmission costs in cts/kWh.
Abscissae on right (in Fig. 7 on left) = Distance in km.
Abscissae on left (in Fig. 7 on right) = Transmitted power in MW.
Light ruled surface = A.C.
Dark ruled surface = D.C.
Horizontal surface = Example for constant transmission costs of 0·3 cts/kWh.

On the top of the model in Fig. 5 are the towers of the compared lines. It will be seen from Fig. 7 that the transmission costs increase with the distance and decrease (Fig. 6) with increased power, and that for a distance of zero km, the price of the terminal stations is much higher for d.c. than for a.c. The intersection curve between the two ruled surfaces shows the limit of greater economy of d.c. over a.c.

Fig. 7. — Rear view.

with the distance, but that they increase less rapidly for d.c. than for a.c. Fig. 6 shows that the transmission costs decrease with increasing power and, in particular, that the costs are much higher for very low powers. For a distance of zero km, Fig. 6 shows that the prices of d.c. terminal stations are much higher than for a.c. stations. The intersection curve between both ruled surfaces, that is the limit of the greater economy of d.c. over a.c., can be clearly seen from Figs. 6 and 7. If one follows this limit in Fig. 7 in the direction of shorter distances and lower powers, one recognizes that this limit rises rapidly in the neighbourhood of the origin of the co-ordinates. This signifies that for short distances and low powers, large-scale power transmission is uneconomical, even with d.c.

For the transmission of big blocks of power over very long distances, d.c. is more economical than a.c. The technical development of the d.c. system is already beyond the test stage. The Company is therefore prepared to build a pioneer d.c. transmission line on an industrial basis with good prospects of success. Considering the financial risks involved with the first installation, its power should be reduced to a strict minimum, even perhaps to the range in which d.c. is no longer economical. Brown Boveri would willingly take their share of the risks which would have to be assumed by the interested parties in the construction of a pioneer d.c. transmission line.

(MS 751) *Ch. Ehrensperger.*

Long before MATLAB™ was invented, *ABB Review* was already using 3-D depictions to present results.

The Brown Boveri Review, October 1946

There's nothing new about using refuse as a fuel.

Brown Boveri Review, July 1969

Steam and Power from Refuse

628.492:621.182
628.492:621.311

The question of refuse incineration combined with steam and power generation is discussed.

This method of refuse disposal, its requirements and consequences, are still not widely known.

It is known that, beyond a certain annual volume of refuse, the running costs (including capital charges) of an incineration plant can be lowered appreciably by using the heat to produce steam and electricity, which is then sold. When the electricity undertakings negotiate tariffs for purchasing electricity from power-generating incineration plant, however, the agreed rates should be such that sales of electricity lower the specific cost of incineration per ton of refuse. Purchase prices between SFr. 0·03 and 0·05/kWh are generally sufficient.

An example of a project, based on practical data, illustrates the advantages of this method of incineration.[1]

Introduction

As industrialization and population density increase, so too do the problems and necessity of efficient refuse disposal. The specific quantity of refuse per head of population rises every year by several per cent, though there are certain differences between rural, urban and industrial areas. It requires a specialist to appreciate the problem in all its aspects and, despite its complexity, to find a simple but economical solution.

Refuse Incineration

It has been clearly demonstrated that the most hygienic way to dispose of refuse is to burn it, where-upon the combustion process gives rise to slag and flue gases. Because of the high temperatures in the boiler furnace, the slag can be considered as sterile, with no risk of decomposing. It can be safely dumped or used for some other purpose.

Refuse burns at temperatures between 900 and 1000 °C. Odourless flue gases can be guaranteed only if the combustion gases pass through a zone of temperatures high enough to eliminate smells, i.e. about 800 °C. The hot gases must also be cooled and cleaned before they are discharged from the chimney into the atmosphere. To be filtered, they must first be cooled to about 300 °C. This is usually done by injecting water or adding cold air. The heat remaining in the flue gases is thus removed without being utilized.

It is here that economic considerations enter into the picture. The heat in the flue gases is energy, and this energy can be used to generate steam and electricity.

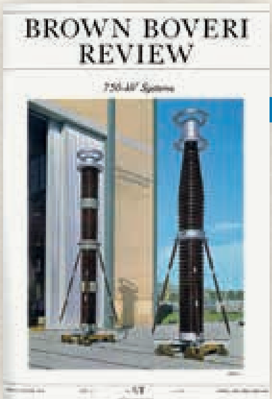
Steam and Power Generation

The calorific value of refuse increases year by year. The annual mean value for urban conditions, for example, has now passed 2200 kcal/kg. This refuse thus has almost the same calorific value as young brown coal which, despite its low heat content, is used in some countries for generating electricity.

Assuming this calorific value of 2200 kcal/kg and a boiler efficiency of 65 %, one ton of refuse produces roughly 2·3 tons of steam. Generated in a well designed boiler, this quantity of steam can be passed through a condensing turboset and produce up to 500 kWh.

[1] A film produced by the Swiss Association for the Protection of Water and Air against Pollution entitled "Waste— the Penalty of Affluence" and presented to the 4th International Congress of the International Research Group on Refuse Disposal (IRGR) on 2nd June 1969 in Basle came to the same conclusion as described in this article.

BBR 7-69 329



1964

1962

Rachel Carson publishes *Silent Spring*, frequently cited as being one of the key catalysts that inspired the environmental movement

The audio cassette is invented

1964

BASIC is invented by John George Kemeny and Tom Kurtz

1965

Compact disc is invented by James Russell

1967

First calculator is invented

1968

Douglas Engelbart demonstrates the world's first computer mouse

Fig. 116. — Brown Boveri radiotelephony equipment for Paris City Police
This equipment permits excellent telephone communication between patrol cars and police headquarters within a 50 km radius.

Radio equipment for the Parisian police.

The Brown Boveri Review, January/February 1949

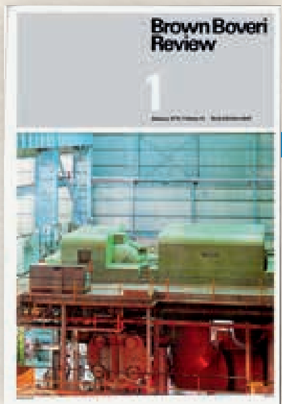
Installing power equipment in northern Canada sometimes called for unconventional methods.

The Brown Boveri Review, July/August 1955

JULY/AUGUST 1955 THE BROWN BOVERI REVIEW 245

Fig. 25. — The rough and ready transport facilities in Northern Canada necessitated the PLC equipment being taken by air to Snare River power station near the Great Slave Lake

Fig. 26. — Snare River power plant supplies the goldmining town of Yellow Knife over a 115-kV line 100 km long
This line also serves the carrier-frequency telephone link, which is the only means of communicating with the outside world.



1974

1975

1969

BBC develops the first gearless cement drive

1971

Women achieve equal voting rights in Switzerland

1974

Erno Rubik gives the world the Rubik's cube

ASEA launches one of the world's first electrical in-dustrial robots

1975

Digital camera invented by Steve Sasson of Kodak

1976

Inkjet printer is invented

THE BROWN BOVERI REVIEW

ISSUED BY BROWN, BOVERI & COMPANY, LIMITED, BADEN (SWITZERLAND)

VOL. 42 SEPTEMBER 1955 No. 9

CONTENTS

THE FIRST 150-MW TURBO-GENERATOR SET IN EUROPE

The largest turbo-generator set in Europe, having an output of 150 MW, was supplied by Brown Boveri to the lignite-fired power station of Weisweiler, near Aachen, Germany, where it has been in operation for several months. In the following article the authors describe in detail the turbine, the alternator and the exciter.

At the beginning of 1955 in the Weisweiler power station near Aachen, belonging to the Rheinisch-Westfälisches Elektrizitätswerk AG. (RWE), Europe's first 150-MW turbo-generator set was taken into service. Since then the plant has operated without disturbance, delivering its full output to the supply system.

The Weisweiler Power Station

The newly-built 350-MW steam-driven power station,[1] which was planned by the RWE, employs as fuel low-grade lignite having a high ash and moisture content. In power stations such as this, burning so little high-grade coal, capital is burdened to a considerable degree with the cost of producing current: operational expenditure is high. When planning the Weisweiler power station greatest stress was placed on: low building costs, short building time (i.e. reduced interest on building capital), maximum reliability (i.e. high utilization factor), and low operating costs.

[1] W. Kretschmann: Neuzeitliche Braunkohle-Grosskraftwerke Braunkohle, Wärme und Energie 1953, No. 19/20, p. 393-418.
W. Kretschmann: Das Braunkohle-Kraftwerk Weisweiler. Elektrizitätswirtschaft 1955, Vol. 54, No. 11, p. 343-50.

The ever-increasing demand for power made on the supply system of the RWE (about 8% per annum) and the desire to produce with a minimum of delay as much additional electrical energy as possible for the outlay of capital led inevitably to the employment of large units, as the specific cost of plant reduces in relation to the increase in unit size. The power station (see title page of this issue) is planned for an immediate output of 350 MW, but full consideration has been taken of the need for future expansion. In view of the fact that the output of large turbo-sets is always interrelated with the power being supplied to the system and bearing in mind that the power available to the entire German grid amounts to approximately 6000 MW, it will be recognized that the choice of one 150-MW and two 100-MW turbo-sets—corresponding to 2·5% (or 1·77%) of the total power in the grid—was in line with the obvious trend to employ large units.

The thermal circuits of the individual units are quite independent of each other and interconnections are eliminated; and on the current-producing side, also, the unit system is employed for the three sets; in fact, each system is fully independent as far as the h.v. transmission lines, beyond the transformers. In order to achieve optimum reserve and low partial-load conditions each of the two 100-MW turbines are supplied with steam by two 200-t/h high-pressure, drum-type boilers, and the 150-MW turbine, by two 300-t/h forced-circulation boilers.

THE MAGNETOSTRICTIVE RESONATOR AND ITS USE IN OSCILLATORS AND FILTERS

538.652
621.373.1:538.652
621.372.54:538.652

Magnetostrictive resonators are electro-mechanical oscillatory systems, in which the electrical and mechanical quantities are related according to magnetostrictive laws. In this article, the author examines practical and theoretical aspects of such elements and describes their construction and application.

As with all electro-mechanical principles, attempts were also made to apply the magnetostrictive effect in resonant oscillatory systems and electro-mechanical transducers. The first investigations into magnetostrictive resonators as frequency-determining elements in tube oscillators provided most encouraging results.[1] Consequent on the high mechanical quality of such resonators, it was possible to attain a degree of stability quite equal to that obtainable from quartz crystals. But the temperature coefficient of the frequency for the particular alloy used was much too large ($\alpha_f = 10^{-4}/°C$) to permit replacement of quartz by magnetostriction oscillators. The frequency range was practically limited to 10–50 kc/s. At lower frequencies the range was restricted by the length of the rod, at higher frequencies pure electrical resonances blanketed the magnetostrictive effect.

By systematic investigation it has become possible to develop magnetostrictive elements for the frequency range 20–350 kc/s, in which all earlier shortcomings have been made good. By employing a suitable alloy, subjected to special thermal treatment, for the vibrating rod the temperature coefficient of frequency was reduced to $\alpha_f \approx 5.10^{-5}/°C$. Moreover, the layout of the vibrator and the selection of the magnetic working point made it possible to avoid pure electrical resonances and to ensure that the magnetostrictive effect was large enough throughout the entire frequency range to determine the frequency definitively in oscillator circuits. As a result of the qualities attained—high degree of stability and small temperature coefficient—it is now possible to use magnetostriction vibrators for the same purposes as quartz crystals without needing a thermostat, due to the low temperature coefficient. For instance, all Brown Boveri single-sideband PLC (power line carrier) sets are equipped with magnetostriction oscillators without thermostats.

[1] G. W. Pierce: Magnetostriction Oscillators. Proc. Inst. Radio Engrs, 1929, Vol. 17, No. 1, p. 42–88.

Theory of Magnetostrictive Resonators

Due to the interaction of the magnetostrictive effect and the mechanical behaviour of a (longitudinally) vibrating rod, the electrical quantities in the coil surrounding the rod are related to the mechanical quantities. Depending on whether the rod is surrounded by one or two magnetically decoupled coils, it is usual to refer to a two- or four-terminal network. The latter is also known as a magnetostriction element.

Before we commence to deduce the characteristic equations, let us first explain what is meant by magnetostrictive effects.

1. If a sample of ferromagnetic material is exposed to a magnetic field, its geometrical dimensions change.

2. If a sample of ferromagnetic material is in a magnetic field and mechanical strains are set up in it by external forces, its state of magnetization changes.

A quantitive formulation of the magnetostrictive phenomena is, for present purposes, expressed by Joule's and Villari's laws:

Joule's law: If a rod of ferromagnetic material is magnetized axially, the change in axial length is proportional to the change in field strength and to the length of the rod.

$$dl = \lambda l_0 \, dH \quad (\sigma \text{ constant}) \qquad (1)$$

Villari's law: If a rod of ferromagnetic material, premagnetized axially, is subjected to an axial mechanical strain, the magnetic induction varies in proportion to this strain.

$$dB = \lambda \, d\sigma \quad (H \text{ constant}) \qquad (2)$$

Observe that the magnetostriction is independent of the direction of the field:

$$\Delta l = F(H) = F(-H) \qquad (3)$$

If, in the event of a sinusoidal field, it is desired that the change of length shall also be sinusoidal, premagnetization is essential. The proportionality factor λ for both equations (1) and (2) is called the magnetostriction constant, although λ is dependent on the premagnetization H_0. Depending on the material, λ can be positive or negative.

Deduction of the Equation for a Magnetostrictive Four-Terminal Network

For an element of rod of constant cross-section and length dx, the following equations of motion are valid in the x-axis (ignoring internal friction):

$$d^2\xi = -s \, d\sigma \, dx \quad (H \text{ constant}) \qquad (4)$$

$$d\sigma = -\rho \frac{d^2\xi}{dt^2} \cdot dx \qquad (5)$$

where $d\xi$ = change of length of element dx
s = stiffness = $1/E$ (E = Young's modulus)
σ = mechanical strain
ρ = specific gravity.

Further, for ferromagnetic material, the appropriate version of the magnetostrictive equation (1) must be added

$$d^2\xi = \lambda \, dh \, dx \quad (\sigma \text{ constant}) \qquad (6)$$

The latter is true, provided the rod is premagnetized by a d.c. field and the alternating field $h \ll H_0$. By combining (4) and (6) and substituting v for $d\xi/dt$, we obtain the following equation for simultaneous variation of mechanical strain and field strength:

$$\frac{dv}{dx} = -s \frac{d\sigma}{dt} + \lambda \frac{dh}{dt} \qquad (7)$$

and from (5), substituting dv/dt for $d^2\xi/dt^2$:

$$\frac{d\sigma}{dx} = -\rho \frac{dv}{dt} \qquad (8)$$

Referring to the magnetostrictive law (2), we find the equation of the magnetic circuit consisting of the magnetostrictive rod, surrounded by a coil of N turns and the magnetic return circuit, as follows:

$$\theta = 4\pi i N - \frac{\lambda}{\mu_0 \mu} \int \sigma \cdot dx = \Phi \sum_\nu \frac{l_\nu}{\mu_\nu q_\nu} = \Phi R_{m\,tot} \qquad (9)$$

from which, introducing

$$u = N \frac{d\Phi}{dt} = \frac{4\pi N}{R_{m\,tot}} \left[N \frac{di}{dt} - \frac{\lambda}{\mu} \int_0^l \frac{d\sigma}{dt} dx \right] \qquad (10)$$

we obtain, for the internal field strength of the element of rod dx:

$$\frac{dh}{dt} = u \frac{R_m}{Nl} + \frac{\lambda}{\mu_0 \mu} \cdot \frac{d\sigma}{dt} \qquad (11)$$

where l = length of the rod
R_m = reluctance of the rod.

Thus, by substituting in (7), we obtain the relation between the electrical and mechanical quantities

$$\frac{dv}{dx} = -s' \frac{d\sigma}{dt} + \lambda \frac{R_m}{Nl} u \qquad (12)$$

where $s' = s\,(1 - 4\pi\lambda^2/\mu s)$. For a sinusoidal impressed voltage $u = Ue^{j\omega t}$, the simultaneous equations (8) and (12) give the following solution:

$$\sigma = \sigma_0 \cos\gamma x - jz v_0 \sin\gamma x - jz k u (1 - \cos\gamma x) \qquad (13)$$

$$v = \frac{\sigma_0}{jz} \sin\gamma x + v_0 \cos\gamma x + k u \sin\gamma x \qquad (14)$$

where $z = \sqrt{\frac{\rho}{s'}}$ $\qquad \gamma = \omega\sqrt{\rho s'}$ $\qquad k = \frac{\lambda R_m}{N\gamma l}$

σ_0, v_0 = are mechanical strain and velocity at the end of the rod $x = 0$. If we substitute (10) in the equations (13) and (14) with the boundary condition $\sigma_0 = 0$ (i.e. the rod has a free end), we obtain the electromechanical transducer equations:

$$u = \frac{N\gamma l}{jz\lambda R_m}\left[\sigma_l \frac{\cos\gamma l}{1 - \cos\gamma l} + jz v_l \frac{\sin\gamma l}{1 - \cos\gamma l}\right] \qquad (15)$$

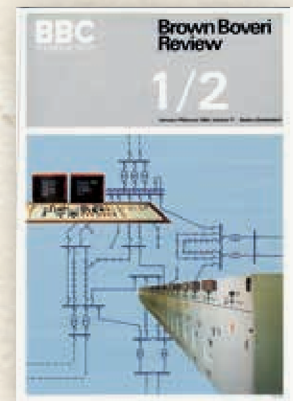
$$i = u \frac{R_{m\,tot}}{j\omega 4\pi N^2} + \frac{\lambda z}{j\gamma N\mu} \cdot \left[\frac{\sigma_l}{jz} \frac{\gamma l \cos\gamma l - \sin\gamma l}{1 - \cos\gamma l} + v_l \frac{\gamma l \sin\gamma l - 2(1 - \cos\gamma l)}{1 - \cos\gamma l}\right] \qquad (16)$$

Control room of a hydroelectric power plant in Italy. ABB still equips control rooms today – although today's equivalent looks very different.

The Brown Boveri Review, January 1955

Manhauling equipment on sleds for the La Dôle television transmitter, Switzerland.

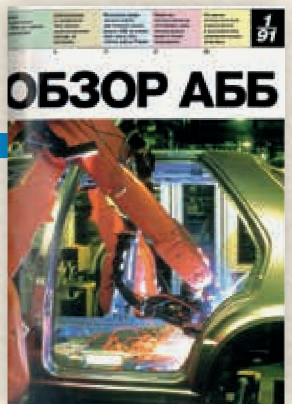
The Brown Boveri Review, March 1955



1984

1987

1991



1978

First IVF baby is born

1987

First *BBC Review* in Spanish

1988

ASEA and BBC merge to create ABB

Stephen Hawking publishes *A Brief History of Time*

1990

ABB launches the Azipod® electric propulsion system for ships

1991

First *ABB Review* in Russian

NEWS IN BRIEF

German-Swedish-Swiss working group develops HVDC circuit-breaker

High-voltage direct-current (HVDC) transmission will have an increasingly more important role to play in the future in meeting the needs for electrical energy. All existing HVDC transmissions have so far been two-terminal systems, but in the future multi-terminal systems will also be required. However, up to now there has not existed on the market any suitable d.c. circuit-breaker capable of interrupting the service current, disconnecting unloaded transmission lines and, together with the convertor control system, clearing any faults.

"Arbeitsgruppe HGÜ-Schalter," the working group established, in 1970, by AEG-Telefunken, ASEA, Brown Boveri (BBC) and Siemens, has now developed and tested, in co-operation with Institut für Hochspannungstechnik der TU Braunschweig (the Institute for High-Voltage Technology at Brunswick), West Germany, a model assembly of an HVDC circuit-breaker.

Each breaking unit consists of an oil-minimum a.c. breaker serving as a commutating switch, connected in parallel with a commutating circuit comprising a spark gap and capacitor as well as with an energy absorption circuit incorporating a surge arrester. The latter serves at the same time as a breaker for the residual current.

Development work on the new HVDC breaker has proceeded in three stages. The first stage involved the testing of the serviceability of the individual breaker components, where series-manufactured parts were used as far as possible. During the second stage, the interaction of the individual components with one another was investigated. The development work during these first two stages took place at Brunswick. Finally, a complete breaking unit underwent tests at FGH (Forschungsgemeinschaft für Hochspannungs- und Hochstromtechnik e.V.), Mannheim-Rheinau, West Germany. This testing involved breaking tests at full voltage on a complete breaking unit and at reduced voltage per unit on an arrangement consisting of two breaking units connected in series. All these tests were successful in every respect.

Breaking tests were performed on one breaking unit involving the interruption of 300 to 2300 A at inductances in the d.c. circuit varying between 0.5 and 1.9 H. At 1.9 H and 2350 A, 7.1 MWs was then developed in the surge arrester. In addition, a test series involving a O – 3 min – O – 3 min – O cycle was performed at 1800 A and 0.5 H. The stresses resulting from this duty do not in any way limit the interruption capability of the breaker.

In the model assembly, one breaking unit with commutating and energy-absorbing circuits is designed for a system voltage of up to 300 kV. HVDC breakers for higher system voltages can be obtained by connecting two or more breaking units in series. Thus, the model assembly with an additional surge arrester could already be used for a 400 kV HVDC system. A special high-speed disconnector assures full isolation of the breaker in the open position. The breaker is designed so that the overvoltage factor 1.6 (p.u.) will not be exceeded for any interruption duty. Thus, the breaker voltage for a 400 kV HVDC breaker will not exceed 2 × 320 kV.

ASEA Rep. 54

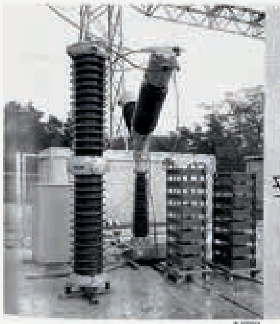


Fig. 1. Model assembly of an HVDC breaker developed by "Arbeitsgruppe HGÜ-Schalter," in co-operation with Institut für Hochspannungstechnik der TU Braunschweig (the Institute for High-voltage Technology at Brunswick), undergoing tests at FGH, Mannheim-Rheinau, West Germany. From left to right: d.c. surge arrester, oil-minimum circuit-breaker and commutating capacitor.

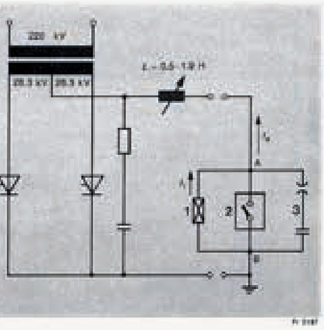


Fig. 2. Design of the breaking unit for HVDC circuit-breaker.

1 Energy absorption circuit with d.c. surge arrester
2 Oil-minimum circuit-breaker
3 Commutating circuit with spark gap and capacitor

In 1988, ASEA and ABB merged to form ABB. But this was far from the first cooperation between the two companies. As this article documents, The companies collaborated in a project to create an HVDC breaker during the 1970s.

ASEA Journal, vol. 48, no. 3, 1975

ABB drives can take your car for a test drive.

Brown Boveri Review, March 1986

Four-Roller Test Rig for Four-Wheel Drive Vehicles

Production of four-wheel drive vehicles is increasing year by year. To speed up development work, the vehicle industry requires suitable test rigs. Brown Boveri have responded to this need by developing and building a dynamic four-roller test rig specially for this type of vehicle. The rig has four drives rated 110 kW and can be used to test vehicles with axles spaced 2 to 3.5 m at speeds up to 240 km/h.

***R. Gas** works on test rig projects in our Industrial Plants Division.*
Mannheim, Federal Republic of Germany

Four-wheel drive vehicles are appearing on the market in ever-increasing numbers. As a great many vehicle trials are performed today on test rigs, suitable roller performance rigs had to be developed and built for this type of vehicle. Features in favour of testing on rigs are:

- The conditions encountered during road tests can be simulated reliably on modern test rigs.
- Test cycles are far easier to reproduce on test rigs than on the open road.
- Trials carried out on test rigs are more cost-effective and less time-consuming than road tests.

A multi-purpose vehicle test rig must satisfy the following requirements:

- An individually driven roller must be provided for each wheel of the vehicle.
- Shafts connecting the rollers should be avoided to ensure access to all parts of the vehicle from below.

Two stipulations result from these requirements: the rollers must be synchronized and they must be capable of displacement. Brown Boveri consequently designed and built a test rig for the more traditional front-wheel and rear-wheel drives as well as for the four-wheel drive. This test rig is described in the following.

The rig is intended for putting vehicles, their functional assemblies and individual components through their paces under realistic road conditions.

Brown Boveri provided the following services and equipment for the test rig:

- Mechanical and electrical design of the test rig, plus delivery of the control hardware and running resistance simulator
- All calculations connected with vibrations and the layout design of the test rig foundations
- Structural design

The customer consulted Brown Boveri in all matters concerning the civil engineering. This covered items such as the facilities for supplying cooling air and water and for emission removal, all of which were provided by the customer.

Operators and suppliers of this type of test facility often refer to them as roller bed or performance test rigs.

Fig. 1 – Rear-wheel drive vehicle on the four-roller performance test rig

Four-Roller Test Rig for Four-Wheel Drive Vehicles   Brown Boveri Review 3-86   151

1994

1997

Deep Blue computer defeats world chess champion Gary Kasparov

1998

World's longest (1,990 m) suspension bridge, the Akashi Kaikyo, opens in Japan

2001

First full Web presence of *ABB Review*

Apple launches the iPod

2002

ABB links the AC networks of South Australia and Victoria with the world's longest underground transmission

2003

2003

First *ABB Review* in Chinese

Brown Boveri Systems Control One of the Most Modern Baggage Sorting Facilities in the World

Swissair entrusted Brown Boveri with the design and delivery of control systems for the new baggage sorting facility in finger dock A at Zurich airport in Switzerland. By installing the BBC-PARTNERBUS® and the INDACTIC® 15 control system, Brown Boveri contributed to the reliability and transparency of this facility, in which decentralized sorting computers are a main feature.

M. Heuer is in charge of special projects in the Airport Planning Department of Swissair and has overall responsibility for the new sorting facility.
Kloten, Switzerland

K. Kimmig is Project Manager in charge of the equipment and systems delivered by our company.
Turgi, Switzerland

Introduction

Flight passengers rightly expect the baggage they checked in before departure to arrive with them at their destination. This presumes, however, that the baggage travels on the same flight as the passengers. To ensure that this is always so, Zurich airport placed in operation, on November 1, 1985, one of the most modern baggage sorting facilities in the world.

Design Concept

The design concept used for the new sorting system in terminal A is similar to that used for the system in terminal B, which has given reliable service for more than ten years. With the new system, Zurich airport now offers passengers the following services:

- Check-in at any time on the day of travel up until shortly before the flight departure
- A free choice of the shortest queue at the check-in counters to any destination
- Flight connections with short transfer times can be used in the knowledge that the baggage will also arrive on time at the final destination

If these services to the customer are to be guaranteed, however, it must be possible to sort large quantities of baggage and direct the suitcases, etc. to their correct destinations. High-speed conveyor belts, such as those linking terminal A to terminal B, are one means by which this can be accomplished. Another is to ensure a high level of operational reliability.

Transport and Sorting of the Baggage

The check-in counters in the newly designed departure hall of terminal A are divided into two groups. Each counter is linked by a conveyor belt to the baggage sorting room, which is in the basement of the finger dock. To enable passengers to check-in shortly

Fig. 1 – Suitcases entering the sorting bay

Brown Boveri Systems Control One of the Most Modern Baggage Sorting Facilities in the World — Brown Boveri Review 5-86 265

Maybe BBC technology helped sort your airline luggage!

Brown Boveri Review, May 1986

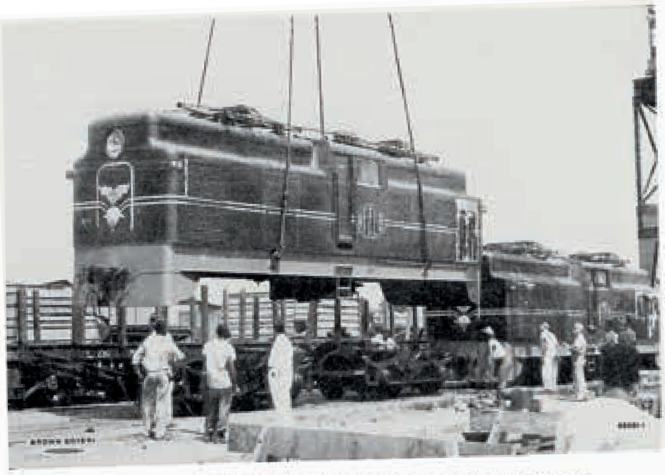


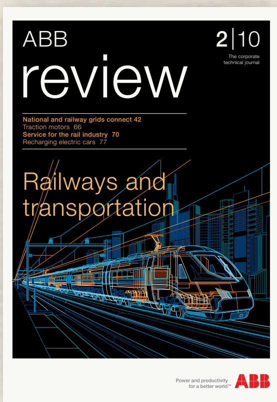
Fig. 91. — 1500 h.p. d.c. locomotive of the Viação Férrea Federal Leste Brasileiro em Salvador

Ten locomotives of this type were equipped by Brown Boveri with driving motors, circuit breakers and voltage converters with quick-acting regulators.

BBC supplied the motors, circuit breakers and regulators for this 3 kV DC, 1,00 hp locomotive headed for Brazil in 1955. BBC has since its early days been a supplier to the railway industry, and still is today.

The Brown Boveri Review, January 1955

2008



2010

2013

2008

World's tallest Ferris wheel, Singapore Flyer, opens in Singapore

2009

Usain Bolt sets a new men's 100 m sprint record of 9.58 s

2010

ABB opens the world's highest substation in the world's tallest building, the *Burj Khalifa*, in the UAE

2012

ABB successfully designs and develops a hybrid DC breaker suitable for the creation of large inter-regional DC grids

2013

ABB Review made available in e-reader format