ELECTRIC HEATERS.

THEIR DESIGN AND DEVELOPMENT.

THE NATIONAL COLLEGE OF ART AND DESIGN

THESIS

THE DEVELOPMENT OF ELECTRIC HEATERS

Faculty of Design

Department of Industrial Design

Name : Seamus Sharkey

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CONTENTS

ELECTRICITY - ITS INTRODUCTION

Michael Faraday's experiments on electricity led to the invention of the electric motor in 1821. Ten years later, he demonstrated that electricity could be induced into a conductor by a changing magnetic field.

However, it was to take a further 50 years before Faraday's discoveries had been sufficiently developed to enable dynamo - electric generators to be built that were capable of supplying electricity to the public on a commercial basis. It was to take a further thirty years before electricity was available at a price that could be afforded by the public. Since its introduction in the 1880's very few people could avail of the comforts associated with electricty although most people enjoyed electric street lighting. Even in 1910 only two percent of households were wired for electricity. Up to this time, most of the publicity campaigns and advertisments launched by the various companies were specifically directed at the upper classes.

By 1914 there was enough power stations and an increasing number of customers to make electricity relatively cheap. However, there were big differences in the prices charged between the various companies involved until the National Grid was established in 1926. By 1925, the national average price had been reduced, especially for uses other than lighting.

Electricity became one of the few fast growing industries of the inter war years. In 1921, twelve percent of British households had been wired. In 1931, thirty two percent; and in 1938 sixty five percent had been wired. Cleaner air, convenience, time, labour saving and its versitility to perform tasks beyond any other form of energy were the elements which influenced and impressed the public. By 1939 almost three quarters of the homes in Britain had electricity supplied.

Victor Dale of the Electrical Development Association in 1925 was promoting the advantage of electricity while writing the following article in the Financial Times when he stated :

"Conversion to electrical methods in establishing populous areas will assist more than anything else to migate the smoke evil and progressively reduce the air-polluting emissions from domestic chimneys. Longer hours of "better sunshine" will be one only of the first results from more or less complete electrification in this country - the contention will not be lost on those who recollect the cleanness of the atmosphere in the Metropolis during the protracted miners strike of 1923."

Dale seems to have been predicting or perhaps hoping for the conversion from solid fuel to electricity as the alternative source of heating in the home, which would result in a huge increase in electrical consumption.

Electricity was initially used specifically for lighting. But the companies involved in its generation needed a continous demand to make the enterprise financially viable. They needed customers who would use electricity during the day. Heating appeared to be the most promising possibility for electrical consumption. Apart from open fires, no public building had any form of heating leaving a large market for manipulation for both the electrical generating companies and the manufacturer who would undertake the task of designing and producing electric heaters.

INTRODUCTION AND DEVELOPMENT OF THE FIRST ELECTRIC HEATERS

The first use for electricity was as a source of lighting, simple to use, with no unpleasant odours and no need for regular maintenance. However, the filaments used in early electric lamps were much better at heating than lighting, with around ninety percent of the electric current being converted into heat while only ten percent was used for lighting.

In 1896, Mr H Dowsing invented what was probably the first practical electric radiant heater, using the characteristics of electric lamps. He realised the possibilities of using the lamps to produce a portable heater which required no refuelling, or maintenance, produced no smoke, was clean and relatively efficient.

Dowsing used elongated light bulbs, about eight inches long and two inches in diameter connected in a row in front of a polished reflector. The lamps contained four 250 watt carbon filament bulbs that gave off heat and a pleasant, warm red glowing light. The filaments were enclosed in a "frosted" glass envelope, apparently to cut down on the amount of light emitted. The lamps were nicknamed "Dowsing Sausages" because when electricity passed though the filament the elongated form of the lamps and their colour made them look like sausages.

The Apollo luminous electric heaters of 1904 illustration 1 used four of the so called Dowsing sausages set against a polished relector and embedded in a cast iron casing with superfluous ornamentation and surface decoration of various styles which were characteristics of Victorian design. The heat output was controlled by two decorated knob switches on either side of the casing.

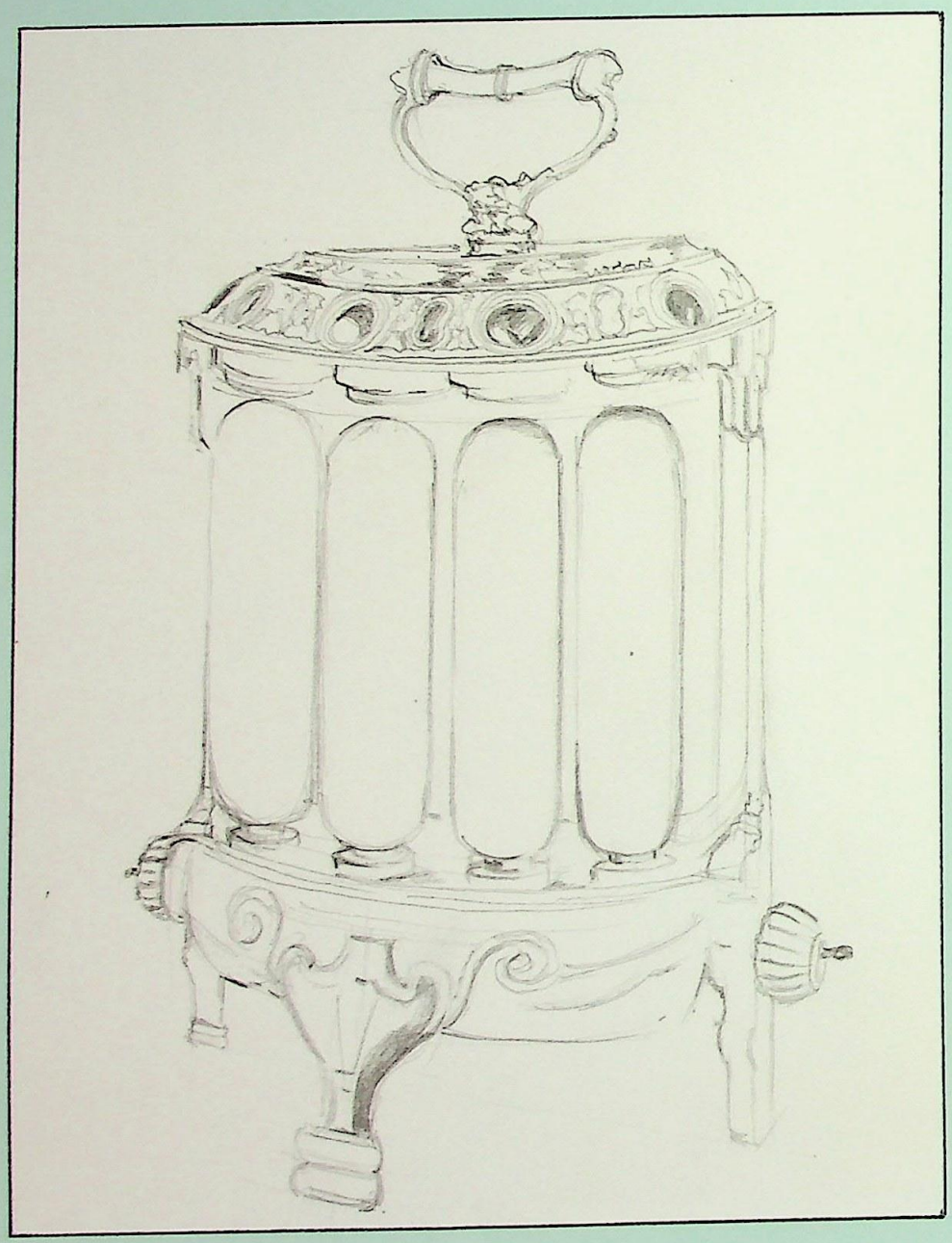


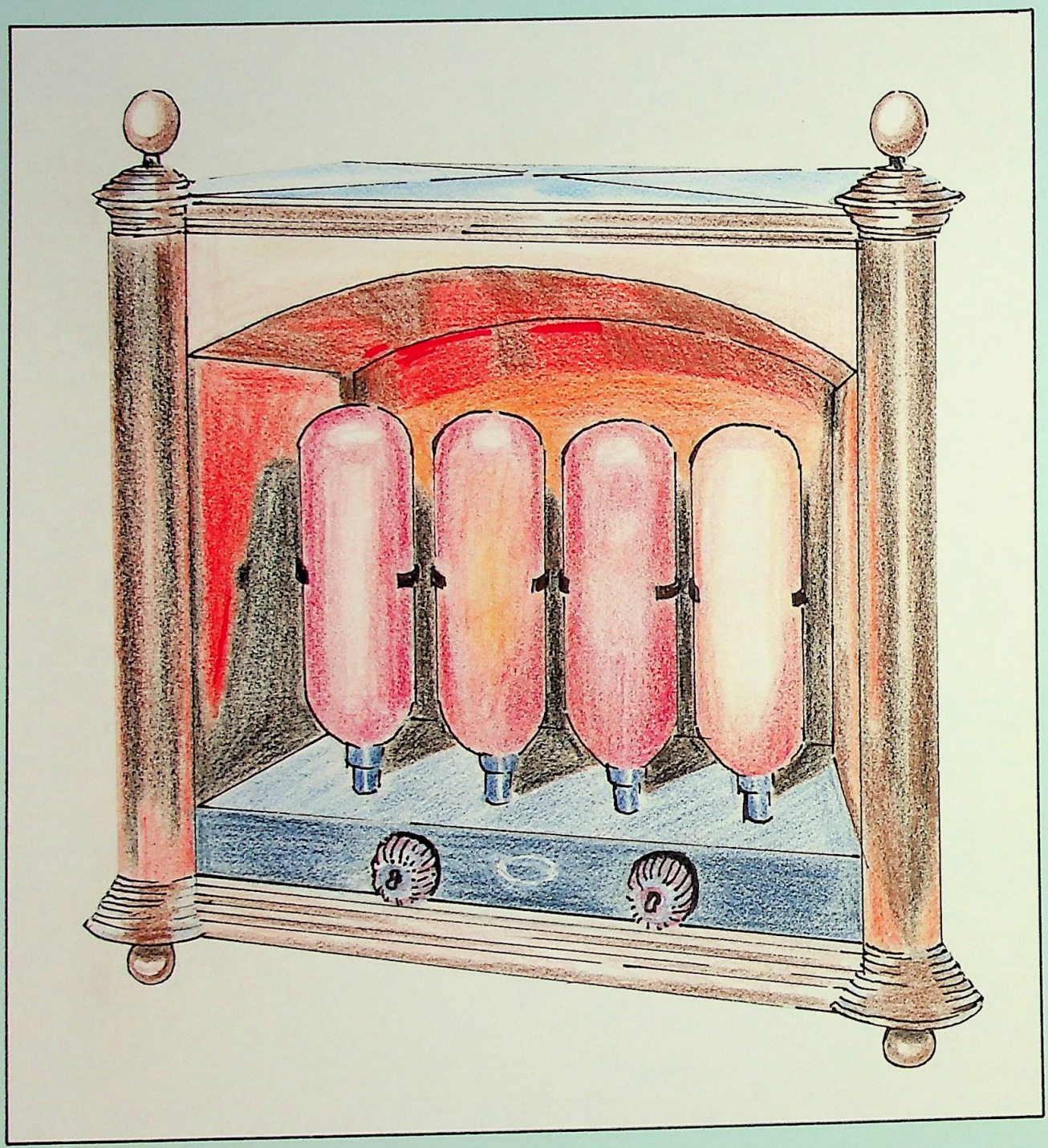
Illustration 1

However, there was a major flaw in the design of the heater. The reflector tended to focus the heat rays back on the bulb in a pulsating manner which caused the filament to sag and disintegrate. In some extreme cases the heat was so intense that it melted the glass envelopes.

However, it was a novel use of new technology where keen observation converted problematic areas into an advantage. The beauty of the invention was the possibility of using the bulbs not only as a direct source of heat but also in the form of psychological warmth created by the red glow given off by the lamps. The red glow was also an atmospheric light source.

The Dowsing lamp heater of 1912 illustration 2 also had four lamps set against a polished reflector in the form of a traditional fireplace with matching ornament of knobs, pillars and brass switches as controls. Although there were new products, requiring a new identity which was representative of the technology used, they fall back into the security of the traditional mode, which was to represent the pretentious aspect of subsequent electric fires.

Crompton and Co. Ltd. was one of the first companies to manufacture electric heaters. Put on sale in 1894, their heater illustrate 3 consisted of an electric radiant panel in which resistance wires were embedded in enamel in a cast-iron studded plate. However, they were



Illustrate 2

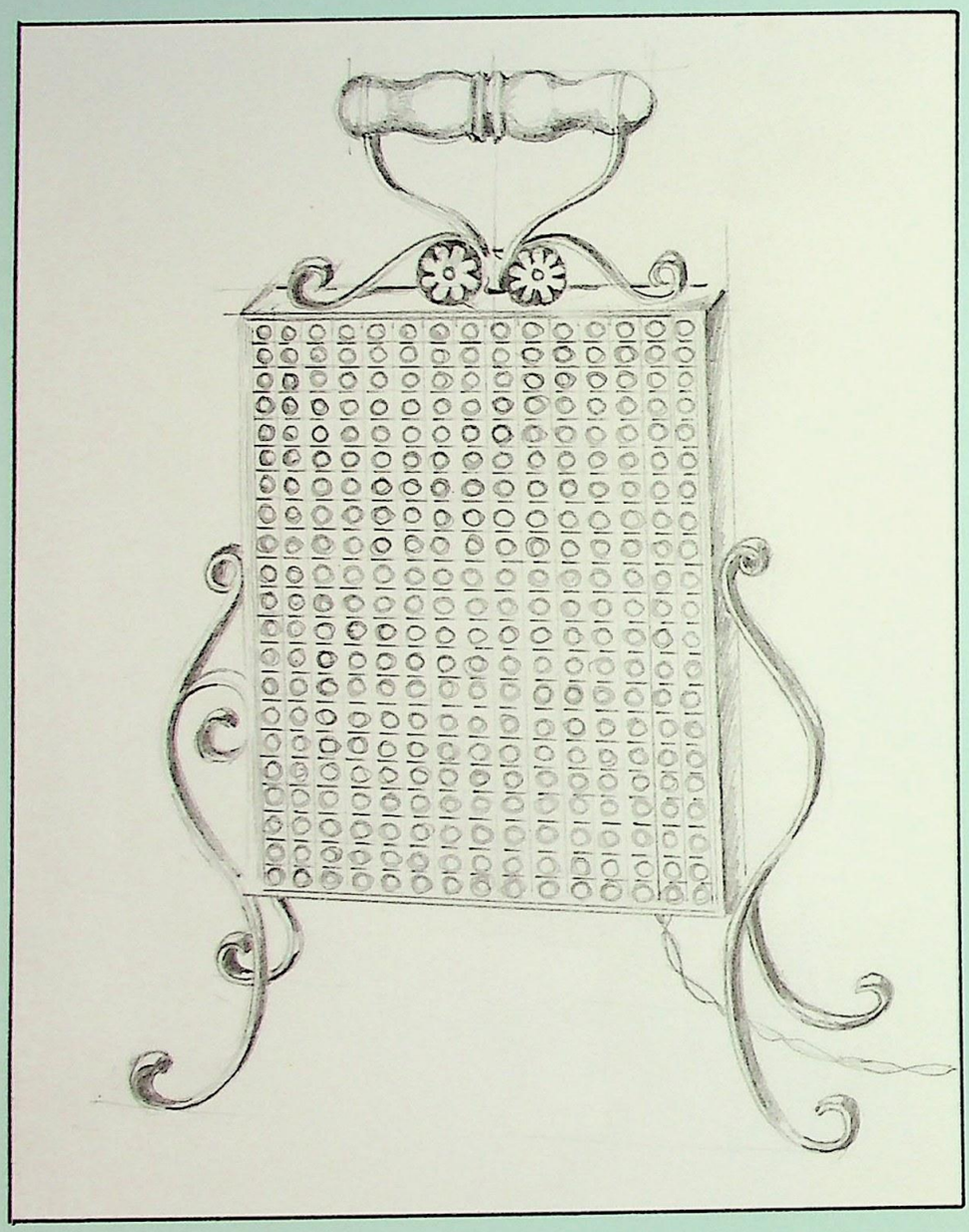


Illustration 3

not very successful because they were extremely slow to heat up and cool down, cast-iron being a relatively poor conductor of heat. The difference in the thermal expansions of the iron and enamel when heated caused them to break easily. They also rusted very quickly. Nevertheless, Crompton "Electric Fires" were bing sold for what must have been an astronomically high price of £3 in 1889.

It was an entrepreneur Charles Richard Belling, once an apprentice at Cormpton's firm, who not only observed the disadvantages of Crompton's heaters but also realized the possibilities for improvement. He had the idea of winding "Nickrome" resistance wire on the front face of a firclay former "which meant the wire was working at a red temperature in free air and heat from it was thrown forward".

TECHNOLOGICAL DEVELOPMENTS

"Nickrome" resistance wire was developed by A.L. Marsh of Illinois in January 1906. He developed the new metal by combining nickel and chrome producing an alloy which retained its strength at very high temperatures, was unaffected by exposure to the atmosphere and outlasted all other types of elements. Because it did not require protection from the atmosphere it could be seen to glow.

"Nickrome" solved all the problems of the early resistance wire which was made from iron. Iron had a number of severe disadvantages. Firstly it rusted when it came into contact with the atmosphere requiring it to be sealed. Secondly, because of its thermal expansion it could not be heated up and cooled down too often. This was extremely irritating because the whole idea behind such a source of heat was that it could be switched "on" and "off" when required, unlike the "heart warmth" coal open fire.

Belling's first heater, a multi purpose product capable of also boiling kettles and toasting bread appeared in 1912 Figure 4. The warning on the heater represents the unfortunate and ambiguous use of the term "Electric Fire" when it states "This fire is warmed by electricity so do not use a poker".

Belling's heater was not only a great improvement on Cromptons' but was much more competitive than another invention developed and

patented by C.O. Bastian in 1908. The Bastian heater consisted of a resistance wire element encased in a quartz tube, three eights of an inch in diameter which protected it from the atmosphere. The disadvantages of this type of element was the fragility of the tube and the high cost of manufacture. Because of the fragility of the tube it too had to be enclosed in a protective cage.

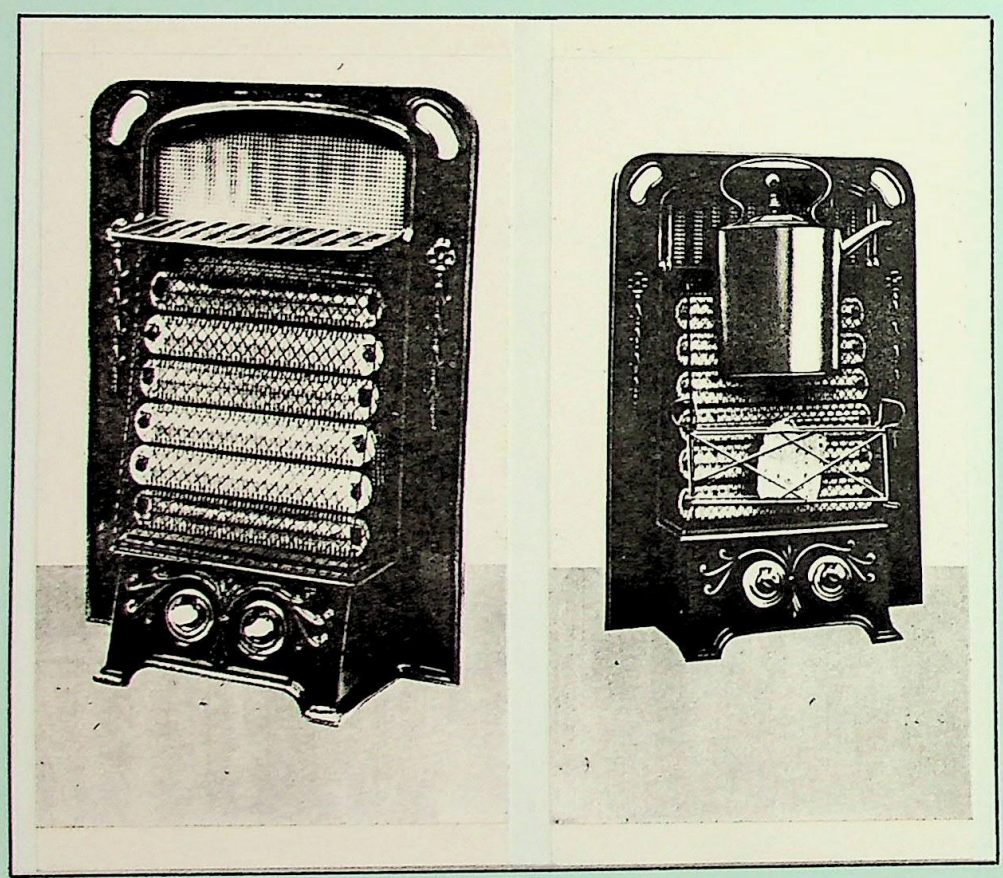


Illustration 4

The quartzalite fire of 1909 illustration 5 has the appearance of a grotesque animal with its small pertruding legs and a lengthy cable simulating its tail. Its formal aspects are embedded in the Victorian tradition. It appears to have the choice of two heat outputs and the two handles on top suggest ease of manoeuvrability although also suggesting weight. However, it does look dangerous not only in appearance but also functionally. The heater "sits" quite close to the ground and would require a reflector directly underneath the elements to protect the floor from catching fire. It was quite effective as a heater but was too expensive to be competitive.

A later development in the 1930's returned to the concept of the Bastian heater. The resistance wire was enclosed and protected by a silica glass rod which was to become one of the most popular and efficient types of heating element incorporated into electric heaters.

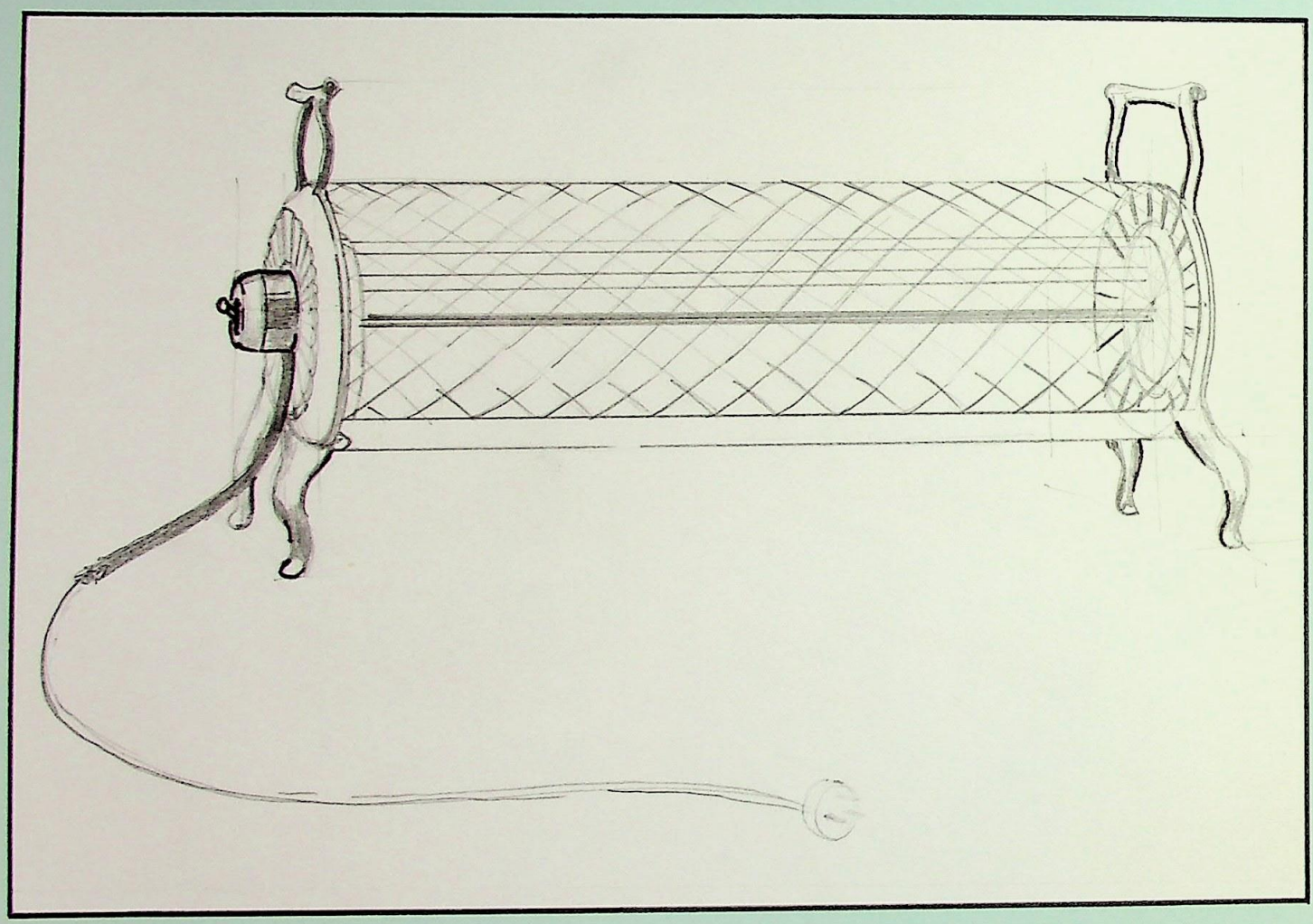


Illustration 5

THE ADVANTAGES OF ELECTRIC HEATERS

During the Victorian era when electric heaters were first invented and introduced the servant performed all the arduous tasks involved in house keeping. The servant was a source of extremely cheap labour representing an example of an inferior social class within the rigidly disciplined hierarchial family of aristocratic England. Therefore, there were few advantages for the rich to purchase applicances which were efficent and labour saving.

However, with the housing boom that following the first world war power sockets as well as lighting were introduced into many of the middle class homes. It was claimed that fireplaces and chimney's took up valuable space contributing to increased building costs and were the cause of most of the dust which had to be cleaned by the housemaid. Also, with the construction of flats and apartments electric heaters became popular because they offered several distinct advantages over other heat sources:

(i) they were easy to install and relatively efficient, unlike the open fire where almost seventy five percent of the heat was lost going up the chimney;

(ii) they were pollution free;

(iii) they were instant sources of heat only requiring the flick of a switch;

(iv) the source of heat could be moved instantly to any part of the room;

(v) they were maintenance free illiminating the arduous tasks of cleaning out the ashes, starting the fire and maintaining it with a continuous supply of fuel which required storage, not to mention the reduction in the amount of dust and dirt caused by "blow downs". Chimney construction and cleaning were also illiminated.

However, electric heaters were a luxury and it can be said that they still remain so. They had high running costs because of expensive electricity. They had to compete with the "real fire" obsession. The problem of disposing of refuse was created, garbage which would otherwise have been burnt in the fire. The introduction of the electric heater and cooker into the home was probably responsible for the introduction of the waste paper basket and the pedal bin. The Harrods catalogue of 1929 Figure 6 reveals the variety of electric heaters which were on the market, and their corresponding prices.

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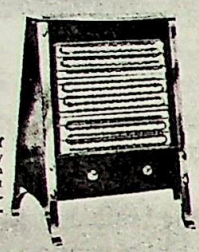
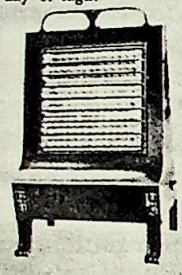
EL 521 PORTABLE MAGNET HEATER
A Pedestal Bowl Fire by means of which warmth can be radiated in any desired direction. This heater can be used on a lighting circuit. Current consumption 600 watts .. £1/-
Large size 30/-

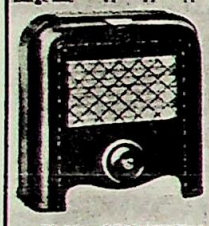


EL 524 MAGNET SHEET METAL FIRE
In Black and Real Bronze finish
2,000 watt size .. £2 3 0
3,000 watt size .. £2 18 0



EL 523 ART METAL MAGNET FIRE
Made in two sizes
2,000 watts .. £4 0 0
3,000 watts .. £5 5 0

EL 526
PREMIER BOWL FIRE
Well designed cast base, with solid Copper reflector. Excellent heater. Consumption 600 watts
11 ins. dia. Bowl .. 18/9
12½ ins. dia. Bowl .. 27/-



EL 522 ORNAMENTAL CAST IRON FIRE
Finished in Black stove enamel, or in vitreous Enamel. Brown, Green, Grey and White. One element controlled by a switch. Mounted on the front of the fire. Consumption 1,000/1,500 watts per hour .. 29/-

PLEASE STATE VOLTAGE WHEN ORDERING

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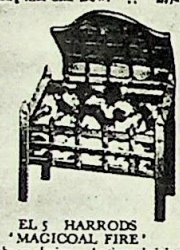
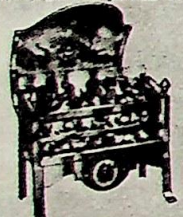


EL 5 HARRODS 'MAGICOAL FIRE'
Jacobean design. Antique bright finish (rustless). Size over all 20 ins. wide × 28 ins. high × 16 ins. deep £16 0 0
Maximum consumption 3 units per hour.' Controlled by 3-way switch



EL 26 HARRODS 'MAGICOAL SUNBEAM FIRE'
Bright rustless finish. A realistic effect of flames and smoke give a delightfully cheerful atmosphere
Maximum consumption 3 units per hour with 3-way control
Size 16 ins. wide × 26 ins. high × 13 ins. deep £10 0 0
Size 15½ ins. wide × 26 ins. high × 13 ins. deep £13 0 0

EL 525 MAGNET REFLECTOR FIRE
Handsome design constructed in ornamental sheet metal and finished in Real Bronze or Oxidized Silver
Real Bronze finish
2,000 watts .. £9 5 0 3,000 watts .. £10 5 0
Oxidized Silver
2,000 watts .. £10 10 0 3,000 watts .. £11 15 0

EL 450
HARRODS 'MAGICOAL FIRE'
Just like a real blazing coal fire, but the heat of the 'Magicoal Fire' can be regulated by a turn of the switch
Brass and Bright Rustless Finish
£8 15 0
(Max. consumption 3 units per hour)
Special finishes to order
Prices on Application

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Telegrams 'EVERYTHING HARRODS LONDON'

LONDON S W 1

Figure 6

RADIANT HEATERS

The "bowl fire" was one of the earliest, most interesting types of electric radiant heater. Peter Behrens in 1908 designed this type of heater illustration 7 for A.E.G. Germany and the U.S.A. were more willing to integrate product designer's skills into manufacture particularly in the emergent electrical industries where the British were much more reluctant. Behrens was responsible for the product identity of an industrial corporation designing everything from electric heaters to buildings in what was the first corporate identity programme. He gave this heater a product identity which distinguished it from all other types of heaters and heat sources.

The "bowl fire" expresses the products function and the technology used, remaining timeless in its simplicity where today it is a symbol of high advanced technology in the satelite dishes which transmit and receive signals from outer space.

The bowl fire in Figure 8 who's date of introduction is unknown was analysed. The heater consisted of a copper "dish" reflector which seems like an illogical choice of material for the purpose. Copper tarnishes quickly and is an inefficient reflector even when it is polished. Perhaps the ability to chrome plate metal was not available to the manufacturer or copper may have been the cheap alternative.

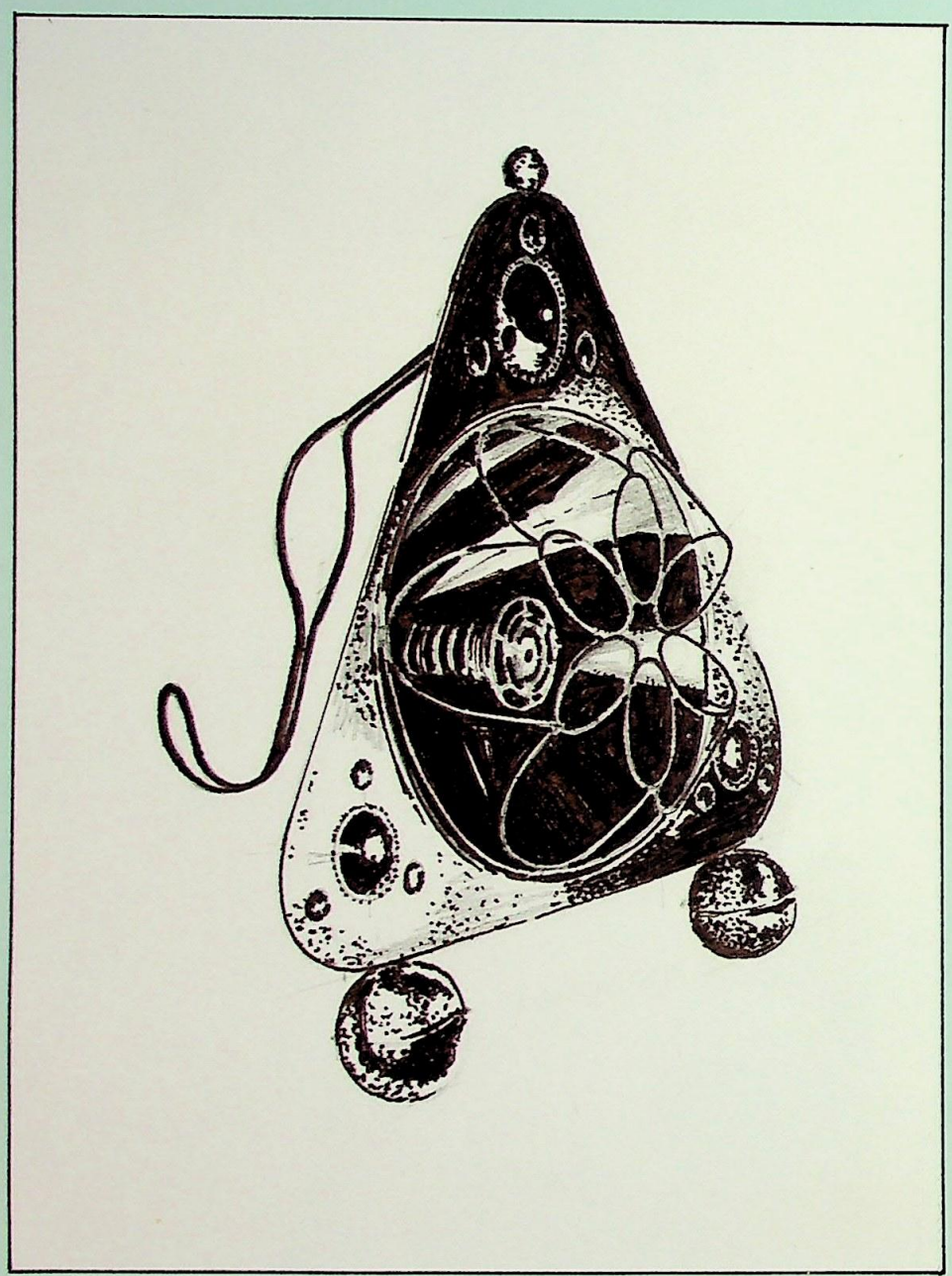


Illustration 7

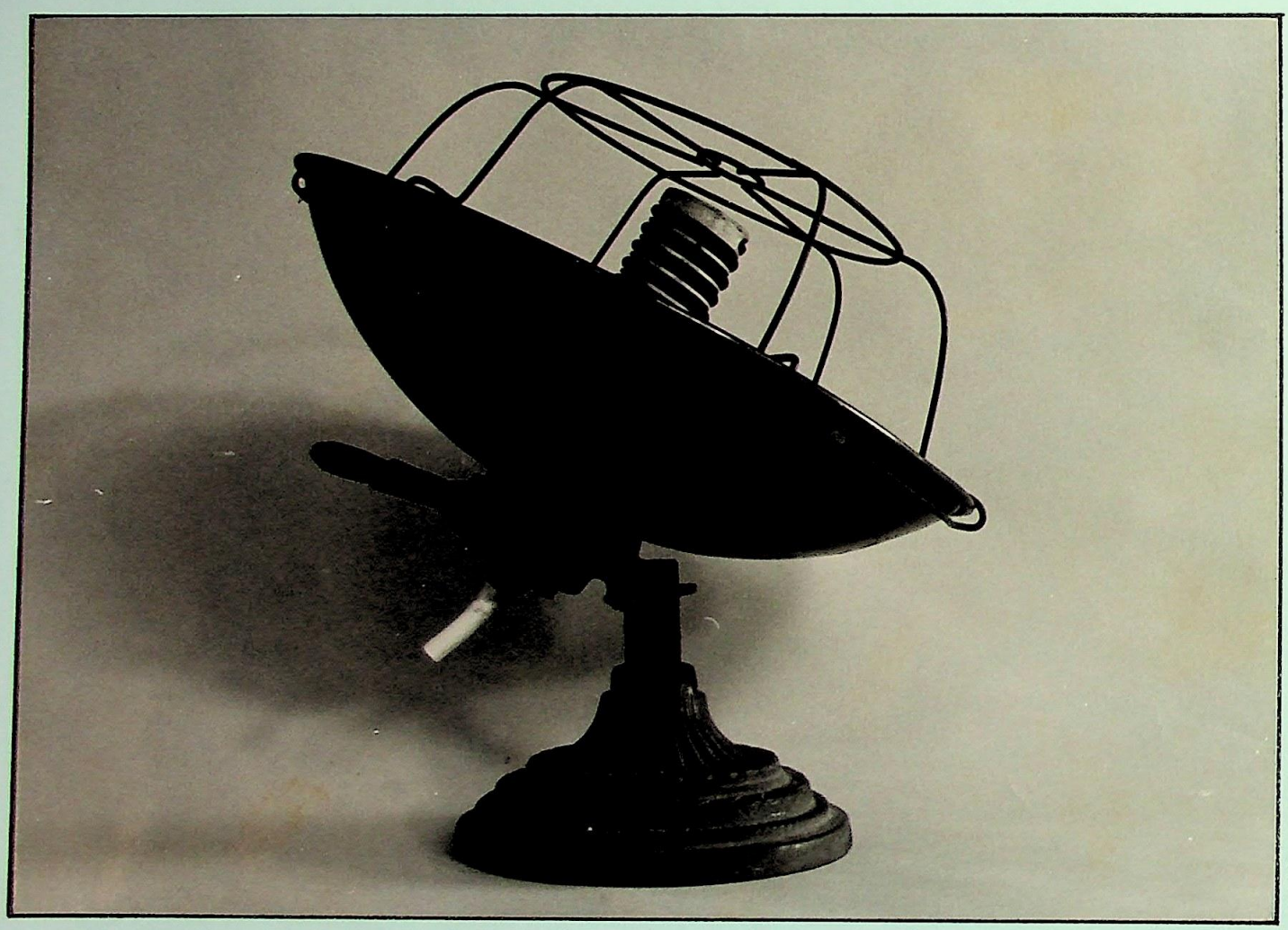


Figure 8

The bowl form represented the machine aesthetic advocated by the design purists where the lines were simple with a smooth surface, totally devoid of surface decoration. This was untypical of British design in the 1920's.

Simplicity, is what makes the heater so attractive. The form represents efficiency, suggesting a clean, uncomplicated, non toxic source of heat.

The coiled element is wound around a section of protruding fire clay Figure 9 conjuring images of 1950's science fiction ray guns. This is perhaps the most unpleasant aspect of the design, where it produces the feeling that you are going to be vaporized. It provides the heater with its only unfriendly aspect.

Nevertheless, this heater was very popular. It was advertised in the Harrods catalogue of 1929 Figure 6, where two versions appear. There was however, an aesthetic contradiction associated with the heater which was examined. There is an enormous contrast between the heavy, cast-iron decorated base and handle, typical of the Victorian era, and the simplicity of the "modern" bowl shaped reflector, Figure 8. There were designs available however, which had simple elegant unadourned bases as can be seen from the Harrods catalogue.

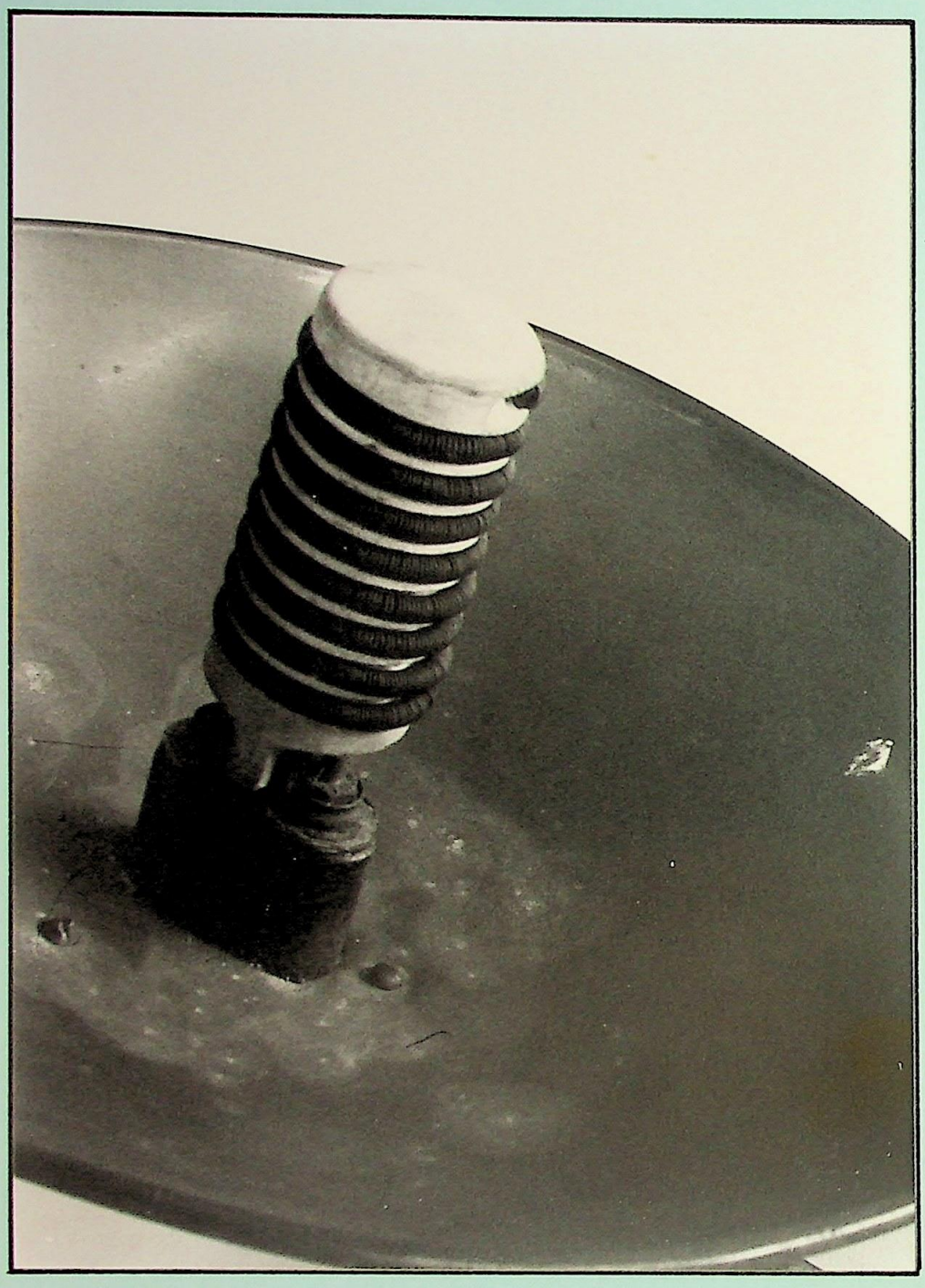


Figure 9

The production techniques involved in the heaters' manufacture and thus the retailing cost probably determined the resultant form more so than a desire on the part of the manufacturers to produce a "modern design". A bowl with surface decoration would require a complicated mould which would take longer to produce by the mould maker and would consequently increase the cost. It was probably for these reasons that such an unintended sophisticated form emerged.

The element can be manoeuvred and directed into any desired position. The protective wire grid was very flexible and could be clipped and unclipped with speed and ease. This would have been necessary to polish the copper reflector. The heater was small, increasing its changes of being knocked over. It was therefore essential to have the grid protecting anything from coming in contact with the element. The electrical cable is connected into the rear of the reflector. The reflector was attached to the base by a simple nut and bolt which allowed the heat source to be tilted in any desired direction.

This type of heater was still very popular in the 1950's where the design remained almost totally unchanged. It probably progressed from a technological point of view, where the reflector was chromed and the base moulded from a plastic.

CONVECTOR HEATERS

The convector heater first appeared in 1910. Its heating mechanism was concealed and basically consisted of air being heated by passing it over red hot elements. Although it was relatively effective at heating it was not very popular because the necessary reassuring "red glow" was absent.

The English tradition of the "red glowing" coal fire dates back to the seventeenth century. Coal had become the main fuel. As long as it remained cheap with a large surplus of servants to carry out the filthy duties involved, it was of little interest whether the fire place was inefficient and unnecessarily large. In Germany and other European countries, free standing stoves were much more common. They did not agree with the English preoccupation for visible flames because the fires in the stoves were more a source of heat than the focus of attention.

Many people were unwilling to sacrifice their open fires for electric heaters because many of these heaters did not glow. And so, it was the case with convectors. During the first world war the war ofice required a heater which was efficient, reliable, safe and easy to install. Radiant heaters and stoves were thought to be too much of a fire hazard for the hastily built wooden barracks. The convector heater proved to be the answer and the war office purchased thousands, proving their superiority over other forms of heaters.

But it was rejected in the consumer market because of a traditionally preconceived idea of what an "electric fire" should look like irrespective of how efficient and effective the appliance was at heating. However, there was a disadvantage in the time it took the early convectors to heat up and they were also akward, bulky items.

In 1929, Robert Gordon had the idea of positioning an electric fan at the base to increase convection currents and reduce the overall size but nobody else saw the possibilities of such a concept and were unwilling to financially back his invention. In 1937 Belling incorporated a fan into one of their convector heaters illustration 10 an although it was effective it was rather noisy. It was not until 1953 that Bruno Eck of Cologne made a lightweight tubular fan which was small, compact and quiet being powered by a small electric motor.

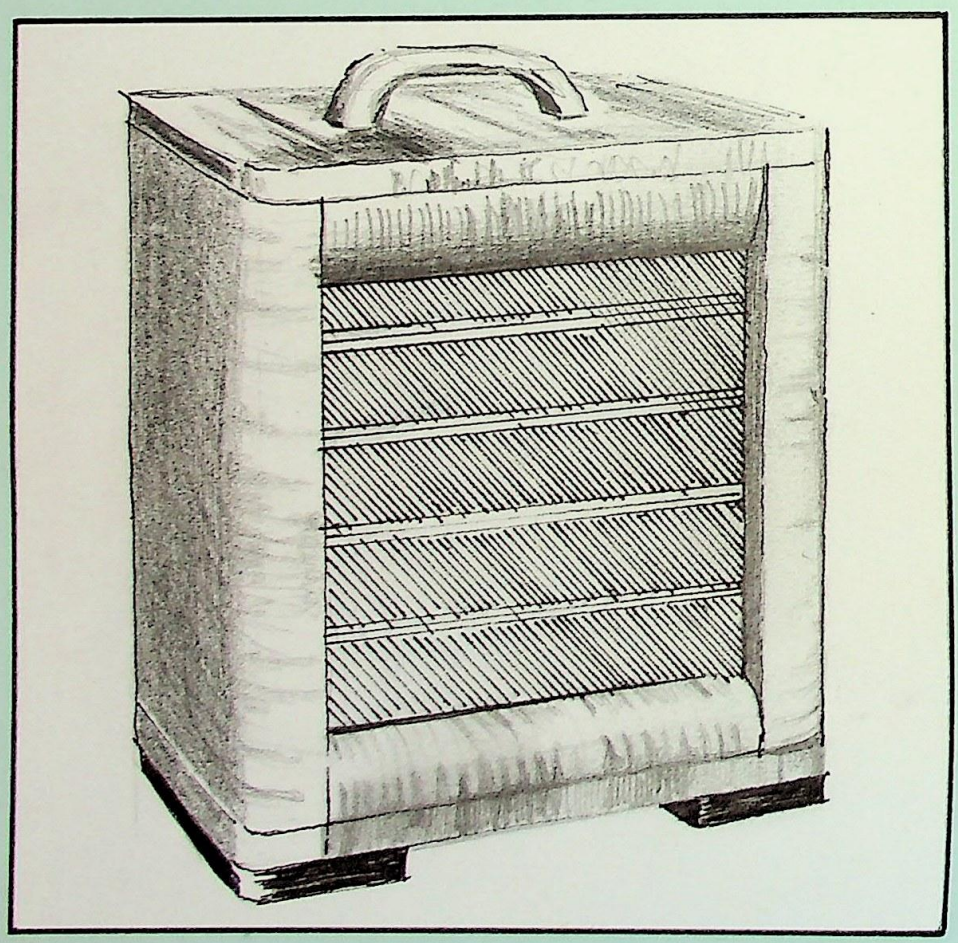


Illustration 10

FUEL EFFECT FIRES

Mr H H Berry was responsible for the invention of the "fuel effect" fire around 1920. It was a design born out of misery. He was lying in bed while trying to recover from the flu. He became totally irritated by the housemaid constantly coming into his room to refuel the coal fire. He designed coloured, semi-transparent imitation coals, which allowed a flickering light to glow through, attempting to simulate a real coal fire. The fluctuating red glow was produced by using the heat convection currents rising from a red lamp to rotate a slotted aluminium wheel.

The Berry "Magicoal" electric fire illustration 11 was introduced in 1920. This latest gimmickery was much to the delight and taste of all the open-fire fanatics. In later models fire dogs were introduced to add that extra element of realism, possibly accompanied by matching poker and tongs. It could also be set into the traditional fireplace.

Imitation coal and log "electric fires" still remain extremely popular and continue to outsell many modern heaters. However, many design purists and historians despised them for being totally pretentious and in bad taste. To them, the design violated almost every principle of the "Modern Movement". They were advocating "form follows function and truth to materials" designing an aesthetic of clean lines and smooth surfaces symbolising efficiency which was expressive and representative of the technology used.

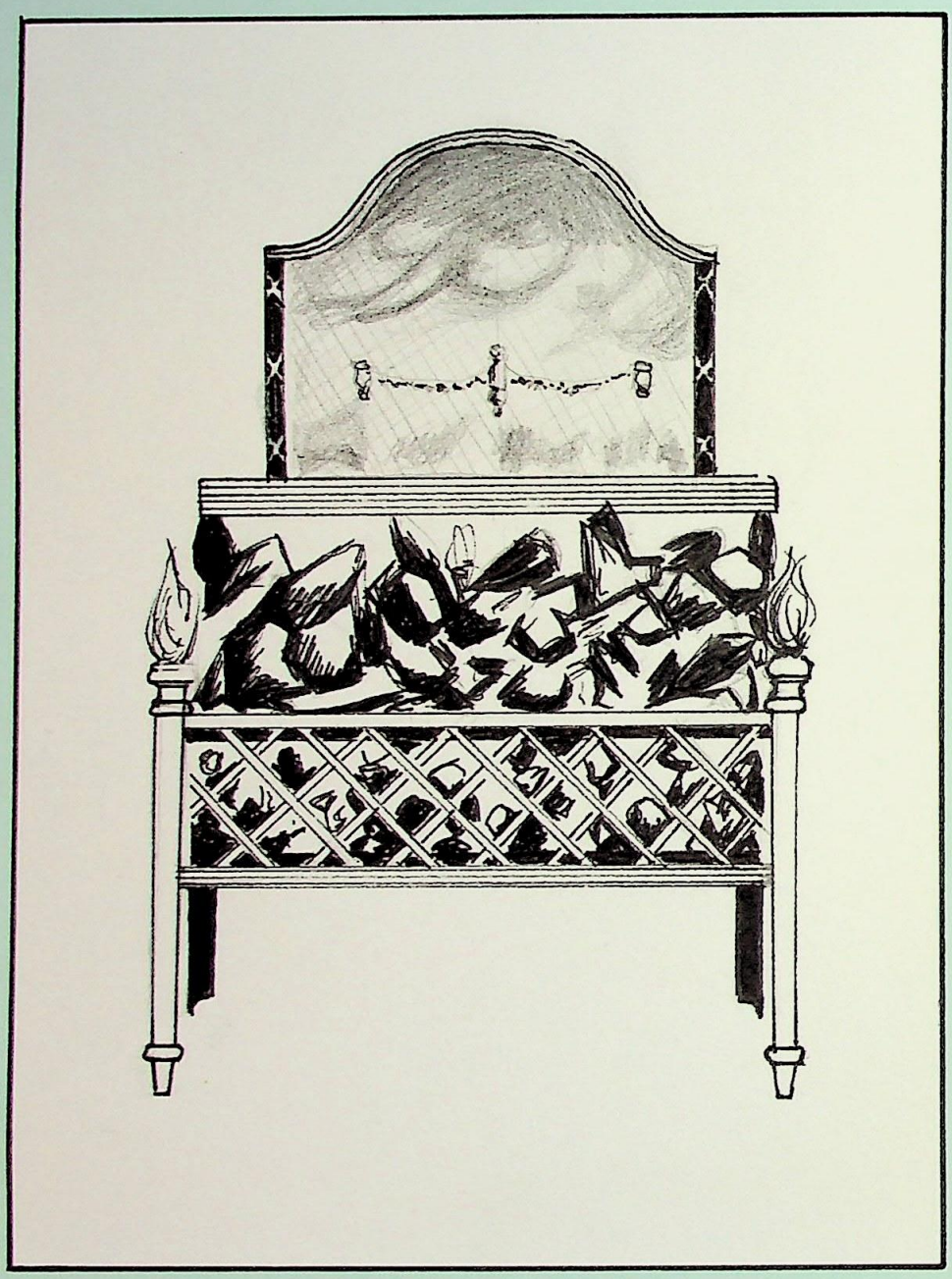


Illustration 11

From their conception, electric heaters had suffered from an identity crisis which had rarely been successfully resolved until up to the 1930's. But even in the present time this identity is still in question.

A very recent survey carried out by a marketing research company questioned working class and middle class groups about their preferences when purchasing a gas fire. Working class respondents wanted a combination of a coal fire and a piece of furniture, the middle class a combination of coal fire and something "invisible". Neither class had the concept of something which had its own rules of elegance.

Both groups liked gas fires which imitated the "heart warming" open firee with red glow and flickering flame. The manufacturers were satisfying this demand with imitation plastic logs and coal illuminated from below by coloured bulbs and spinners.

Crisp and Wilson, the design consultancy who commissioned the survey in 1984 answered market needs by designing the gas fire in the traditional hearth manner with its mock antique surround, complete with Georgian fender, minature Adam urns, beaten copper hood and fleur de lys motif. Wilson admitted "its totally bastardised" but defended the design by saying it was what the market research showed was wanted.

Although the article was related specifically to the design of a gas fire it is still very relevant to any other form of heater which has to compete with the tradition of the solid fuel fire and the primary source of warmth. Gas fires have a justification, however small, to imitate coal fires more so than electrical heaters do because at least there is the presence of a real flame with its tiny fluctuations. This article reveals why imitation fires have been so popular for so long.

The pretentiousness of imitation fires is quite obvious and cannot be denied. However, these heaters do perform their function quite well not only producing a radiant heat from the elements but also providing a valuable psychological warmth created by the red glowing light. This simple aspect has been incorporated into many so called "sophisticated modern" electric heaters. The annoying aspect of the imitation fire is that even if the elements have been switched off the bulb remains lit, leaving a cold and particularly cheerless travesty of a genuine fire. The tradition of the open fire with its romantic associations has been a stumbling block for the establishing an identity for many electric heaters. They have been often rejected by the consumer irrespective of how efficiently they performed as a source of heat.

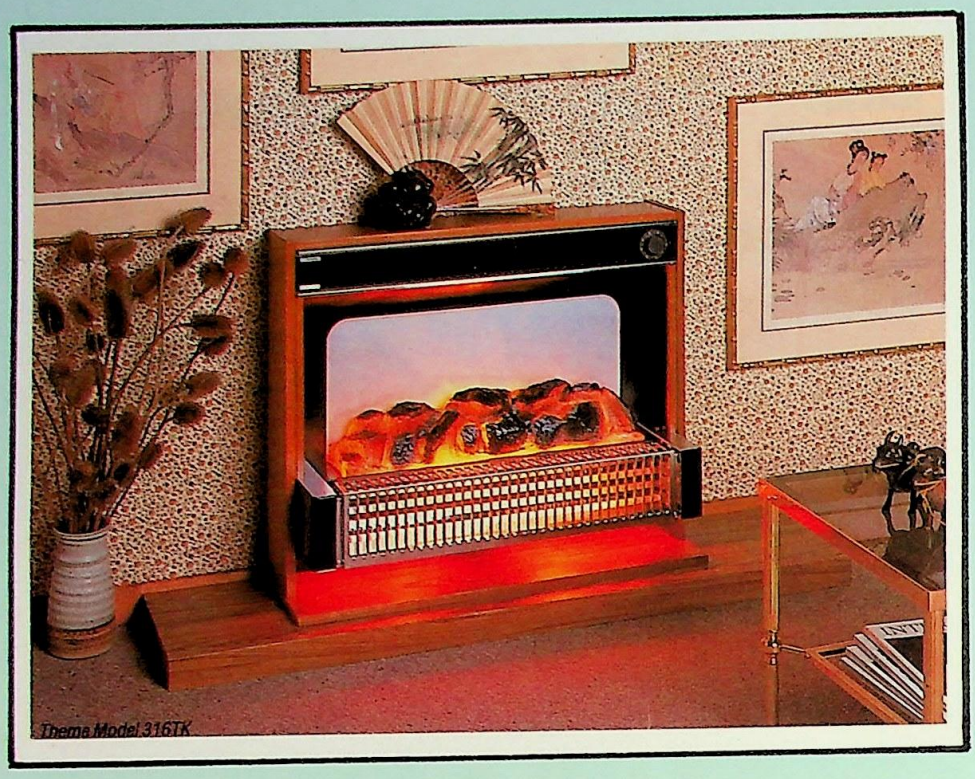


Figure 12

Figure 13

Dimplex Imitation Fires of 1986

BAR RADIANT HEATERS

An early Ferranti heater from 1927 Figure 14 consisted of two elements whose warmth was supposed to be enhanced and directed by a curved chromed reflector. The "fire" also had the option of being built into an existing fire place. There were a number of design flaws in this model. One element was placed almost directly behind the other making it self-defeating in its purpose as a source of heat. The parabolic reflector was much too deep. the heat was pulsating between the elements and the reflector, projecting very little heat outwards while the reflector got very hot. On examining the heater, scorch marks were found at the rear of the heater Figure 15 caused by excessive heat.

The reflector should have been shallower. The spacing of the elements was resolved in subsequent models by positioning them in the vertical plane. To leave it free standing in a room would be dangerous because anyone trying to manoeuvre it when switched "on" would be burnt by the hot rear surface.

However, the entire form was one of simplicity with little decoration apart from the ends of the support between the two feet. The feet and the reflector were uncomplicated in both form and construction although unnecessarily heavy.

Apparently, when introduced in 1927 this heater was rejected by a public who could not tolerate such inornate simplicity. Naturally,

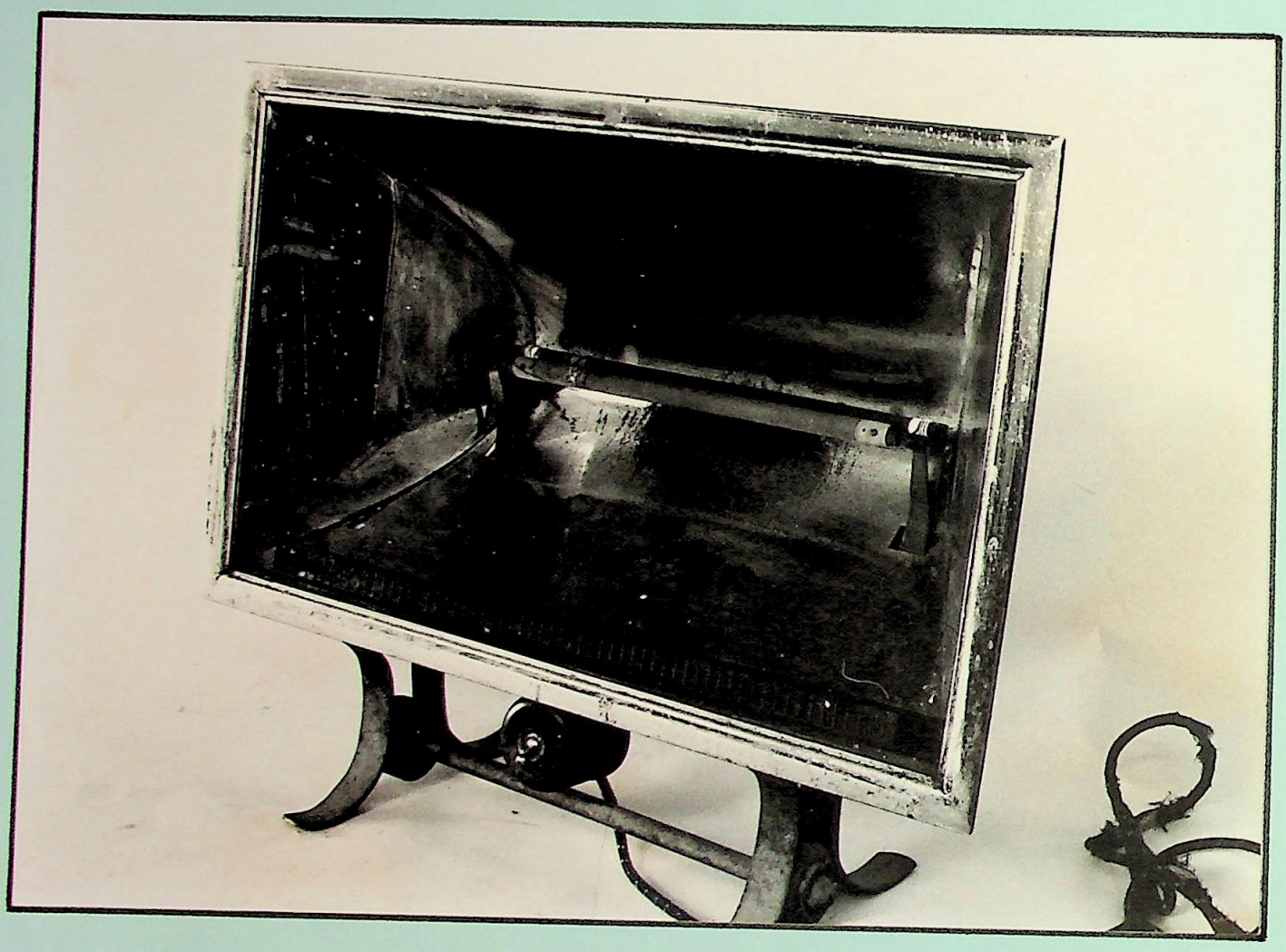


Figure 14

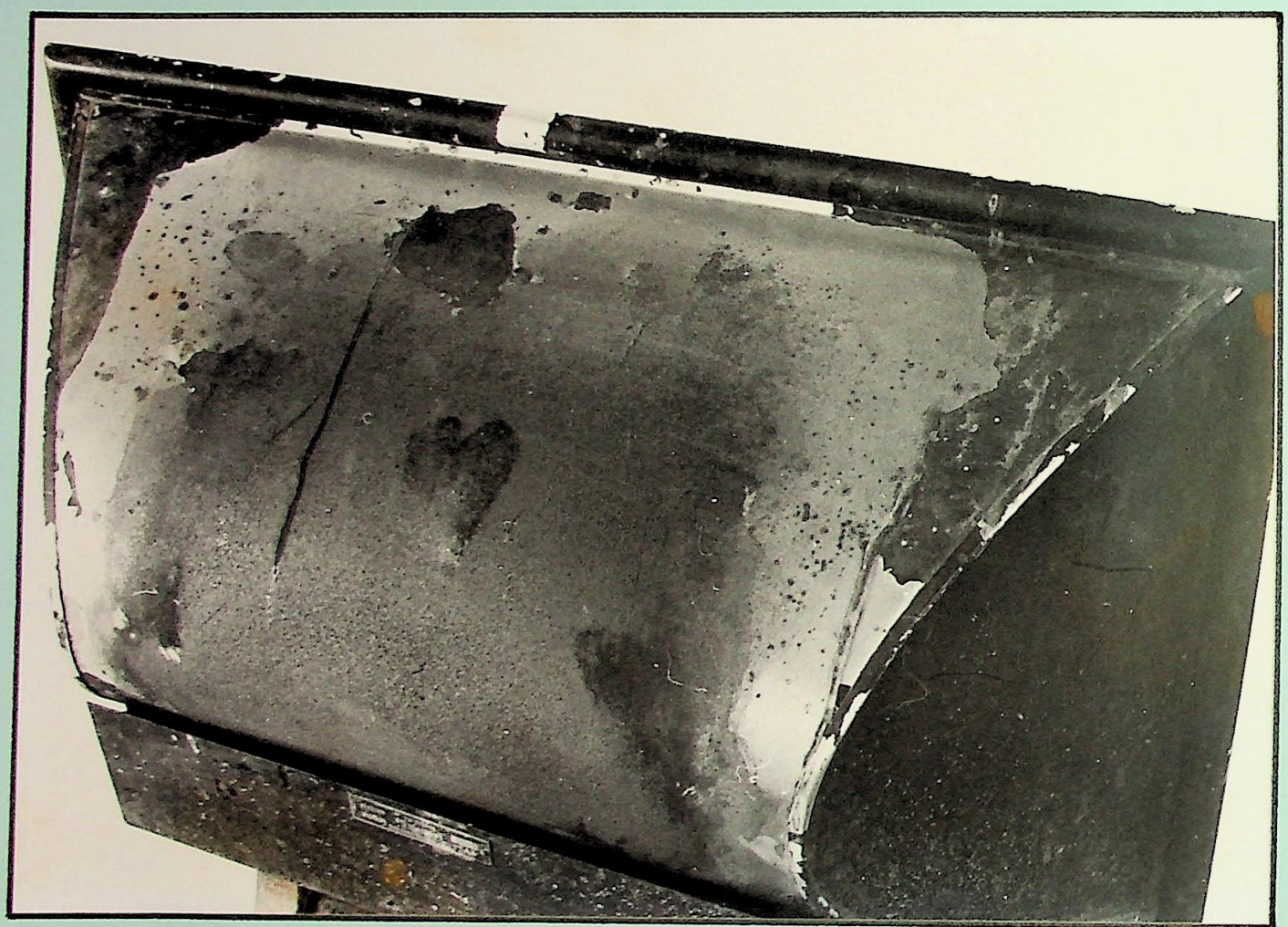


Figure 15

the manufacturers adjusted to public taste and enclosed the elements and reflector in a metal frame with vaguely Georgian connotations. Two fire-dogs were also introduced to give the traditional authenthicity of an open fire. People felt that the heater was an inadequate symbol no matter how efficient it was at heating. It took another twenty years to shed such pretentiousness and return to its original simplicity but provided with a protective metal grid. the 1927 version was an enormous improvement on the grotesque radiant, convector heater introduced by Ferranti in 1919 (Illustration 16).

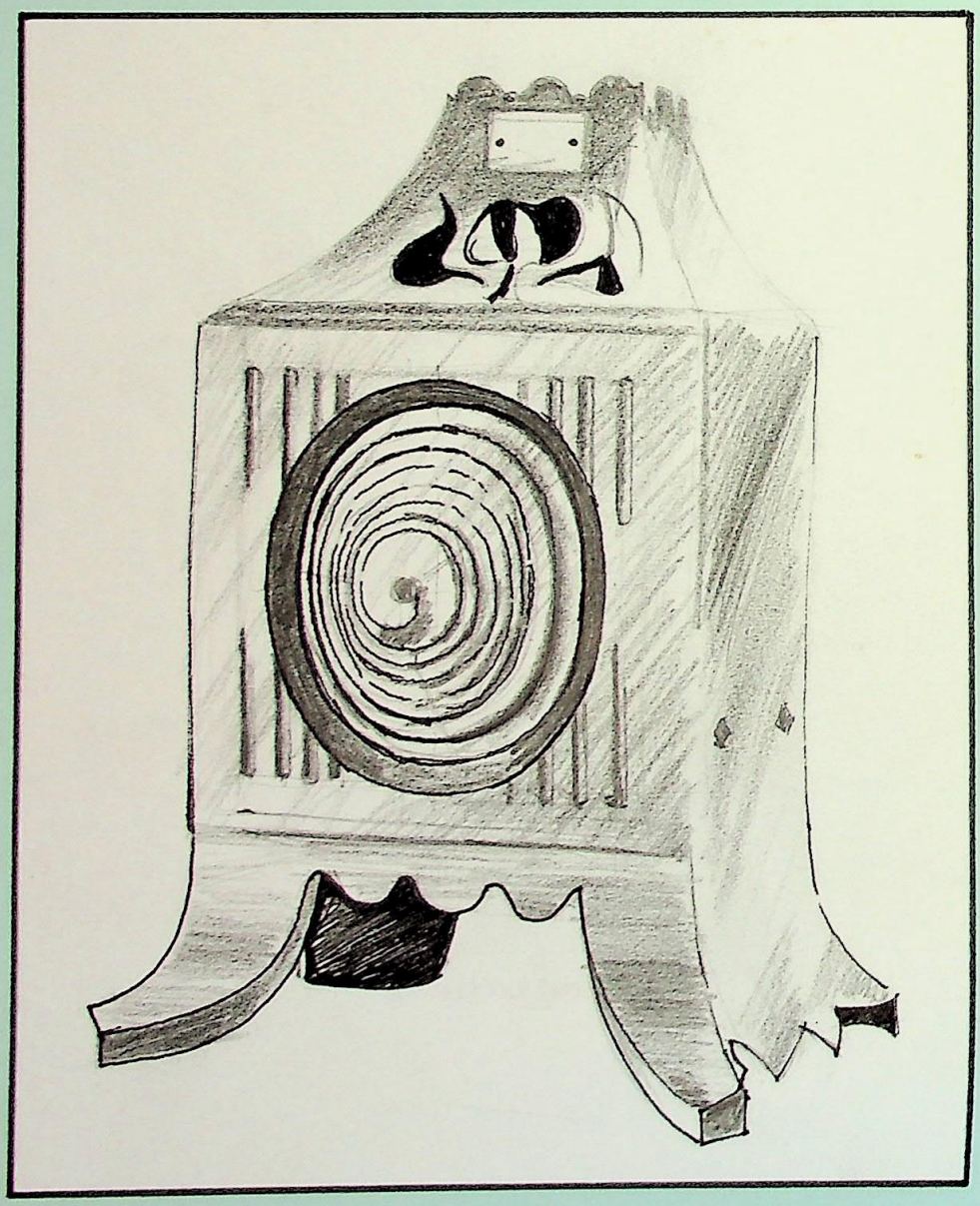


Illustration 16

THE 1930's

In the 1930's in Britain there was a striking increase in the number of designers becoming involved in industrial product design, not only in the traditional craft areas but also in the advancing technological based industries. It was the beginning of the introduction of industrial design into engineering. However, the number of "designer products" were extremely limited. Nevertheless, these products were very important from two points of view. Firstly they displayed the quality and functionalism of the design solutions. Secondly they proved the designers capabilities and competence, as being of great value to society. These facts were being increasingly recognised by industry.

The 1930's was also a memorable period for design patronage, which included such legendary patrons as Frank Pick, Chief Executive of London Passenger Transport, Alistar Morton at Edinburgh Weavers and Frank Murphy of Murphy Radio's.

An example of the spirit of the time was the Thermovent Electric convector heater of 1937 Figure 17 which was designed by Wells Coates for E.K. Cole. This famous heater had a number of very interesting design aspects.

The front, top and side panels was a one component compression moulding in phenol-formaldehyde (Bakelite), a thermosetting plastic, which is stiff and stong but brittle. It has a maximum service temperature of about 150 C which made it very suitable for the

application. However, the colour range is very restricted to dark browns and blacks. The colours gave the appliance a very weighted appearance but gives it a stable look.

This main plastic body has got contrasting smooth radiused surfaces and hard edges. The overall form is of extreme simplicity and box like, but being wider in the bottom and tapering in at the top. It seems a little strange that Coates should have kept these hard edges because the form would have been more consistant and interesting if they had been radiused in the same manner as the way the top surface blends into the front. It would have been much more in keeping with the spirit of the time and the streamlined form.

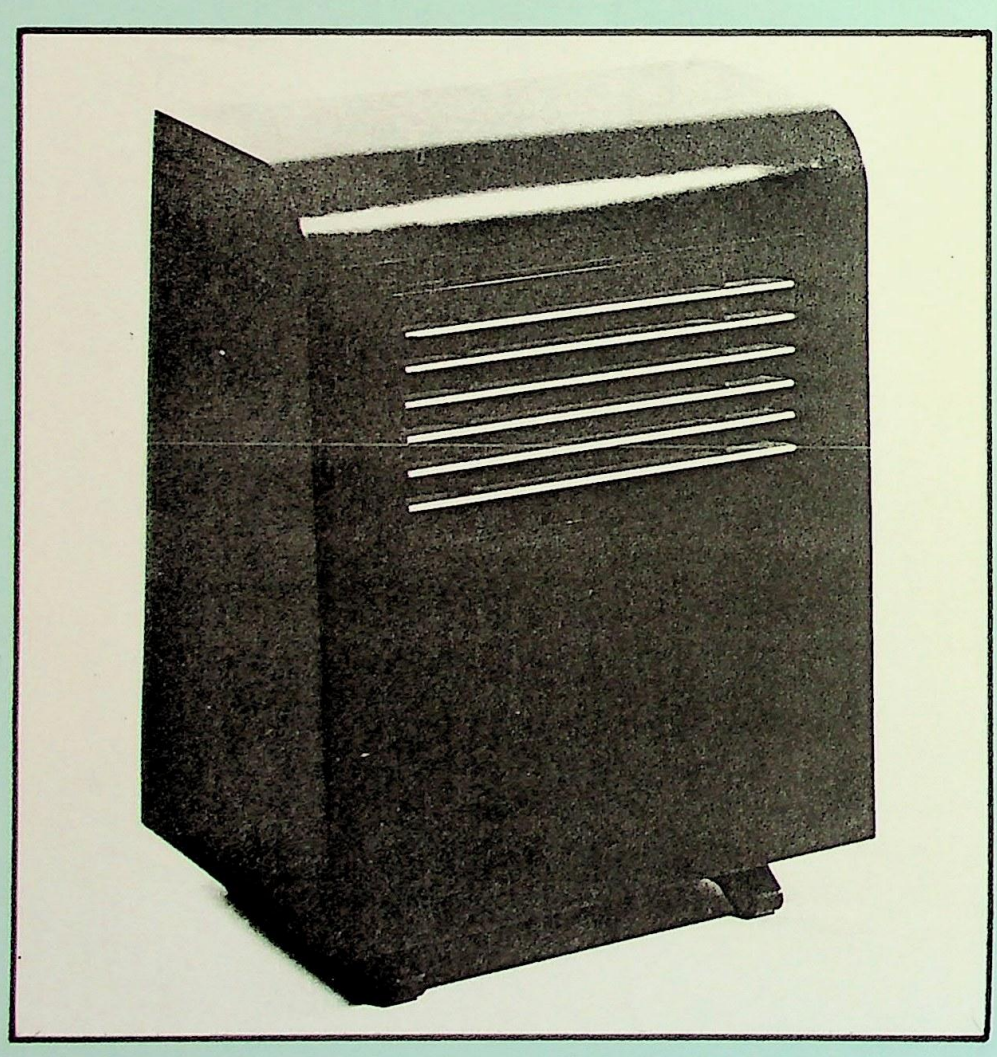


Figure 17

At this point it is very interesting to compare the Coates heater with that of a Raymond Loewy design for a moulded fan heater for GEC in 1938 illustration 18. Loewy's heater is much more streamlined although his radii are much smaller than that used by Coates.

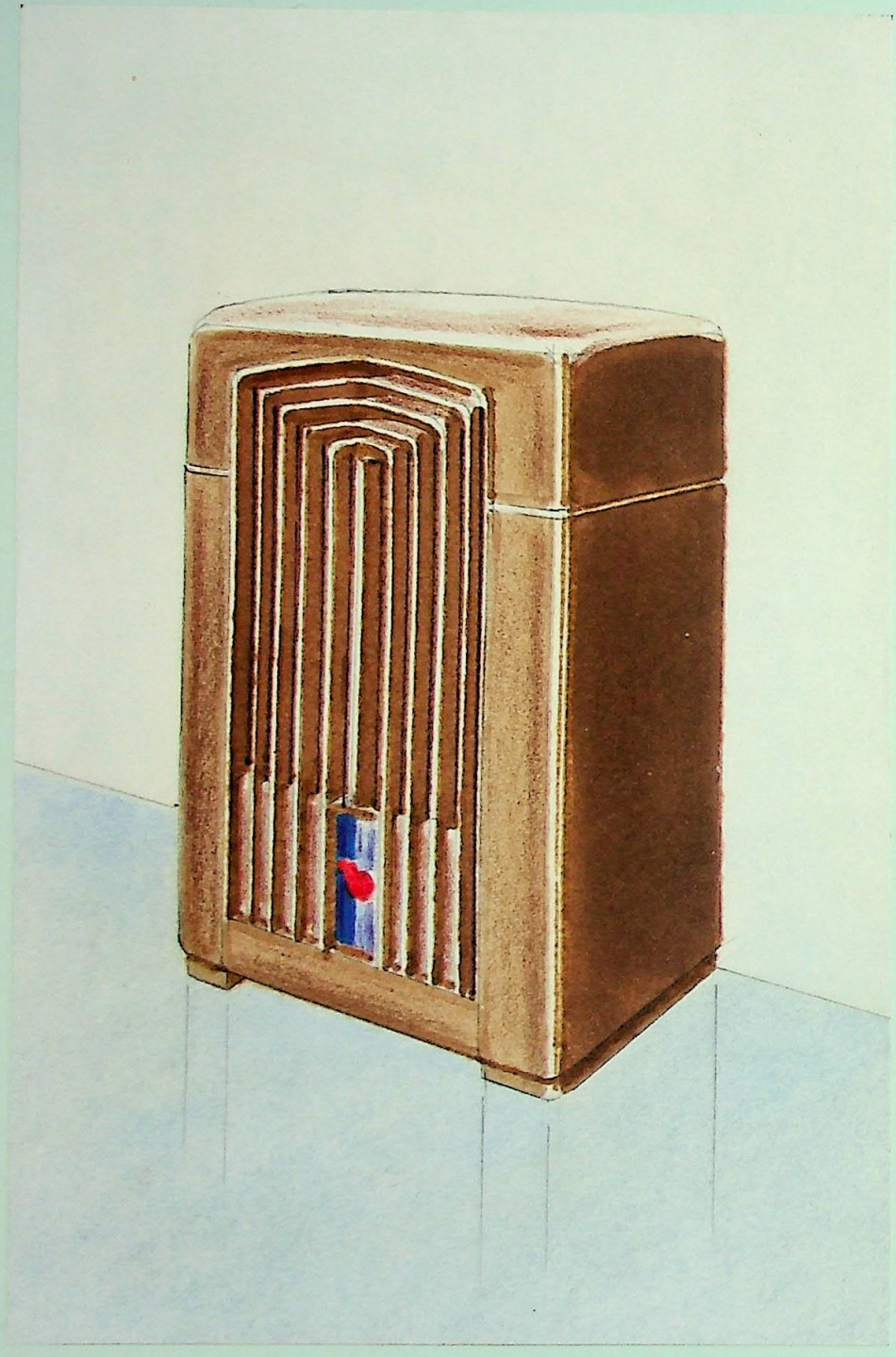


Illustration 18

Loewy also seems to be much more aware and informed of the capabilities of his materials and the production techniques involved. He seems to have divided the outer shell into three or more components which are moulded separately and are then assembled. These divisions can been seen by the split lines which he has included in his rendering. He also proposed the moulding of the fins, which allows the heat to be extracted, to be moulded in plastic. However, it is not clear if the heater was ever produced and may have only been a concept which would have required modification. Nevertheless, bakelite would have been suitable for the service conditiions involved.

The form of the heater has an architectural aspect about it and is related to the art Deco style. The fins look as if they are the supports for an enormous window frame which extends from the ground floor right to the roof.

The control for regulating the heat, although very distinguishable from the rest of the housing in both colour and form seems to be placed ackwardly, directly in front of the heat source. The feet of the heater are blended into the moudling, providing a very stable unobtrusive base, very much in the style of the "coldspot refrigerators".

Stuffy atmospheres are created when there is a significant difference between the upper and lower air in a room. Loewy's design tries to take this into account by extending the convector fins down to the

ground as far as possible in order to give a more consistent and even heating of the environment. He extended the fins down to the base although they are sealed from the top of the switch downward. The front face of the heater is more balanced and consequently more attractive.

By comparison, the Coates heater would be more liekly to create a stuffy atmosphere, an assumption which is further strengthened on analysing the convector mechanism Figure 19. It projects the heat outwards and upwards.

Cost may have been the primary reason for not producing a more sculptural form due to the very expensive tool and mould costs for compression moulding. A very simple uncomplicated box mould would have been much easier to produce requiring less time and skill making it less expensive.

The heater was disassembled and its individual components were analysed. The bakelite housing had supporting ribs which strengthened the side panels and provide holes for small rawlbolts that were used to connect the plastic housing to the back plate. The heat convector mechanism was bolted to the back, sheet metal plate Figure 19 and 20.

A rawlbolt with internal threads illustration 21 was wedged into holes left in the bakelite ribs. The back plate was then attached by

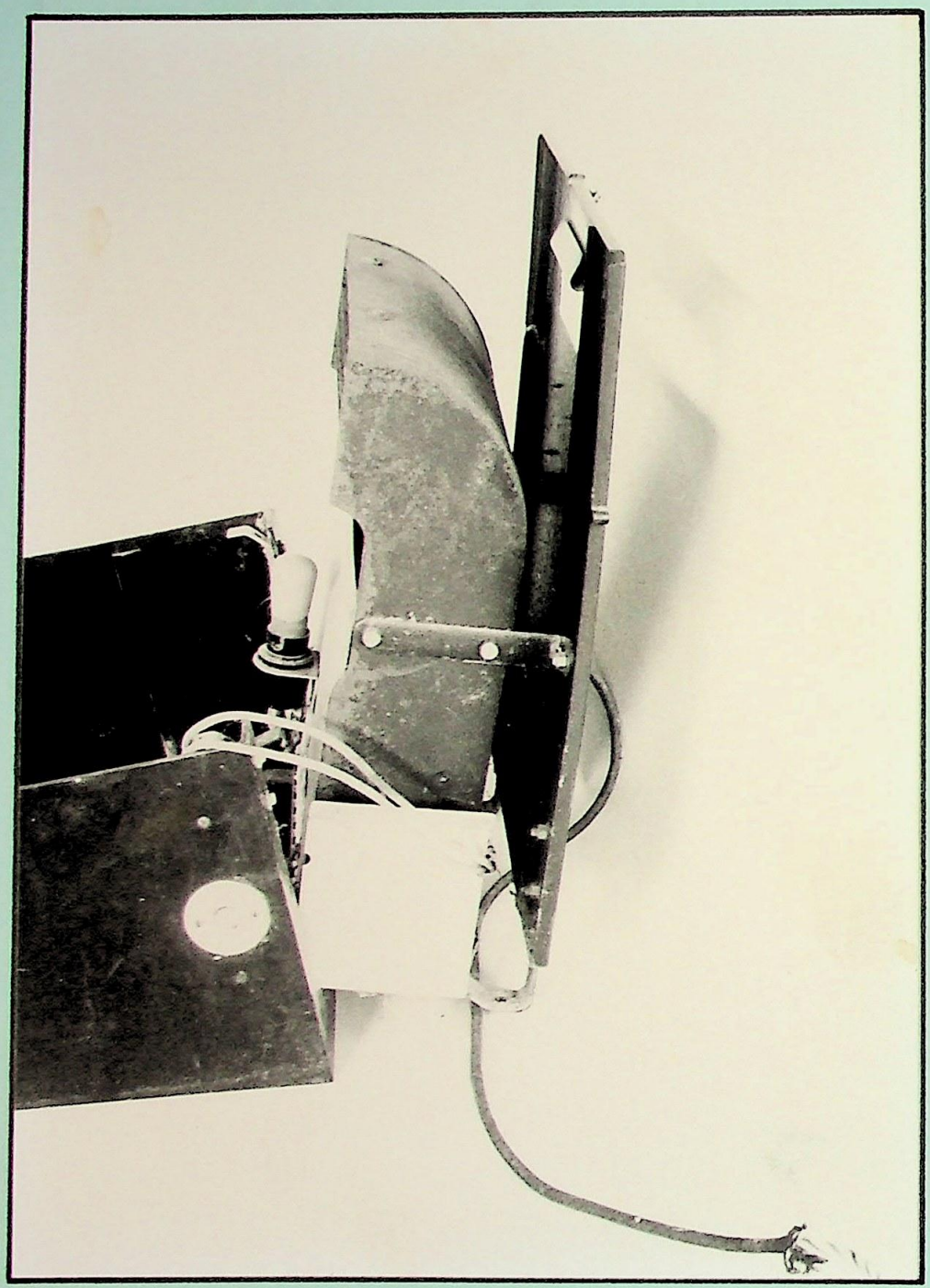


Figure 19

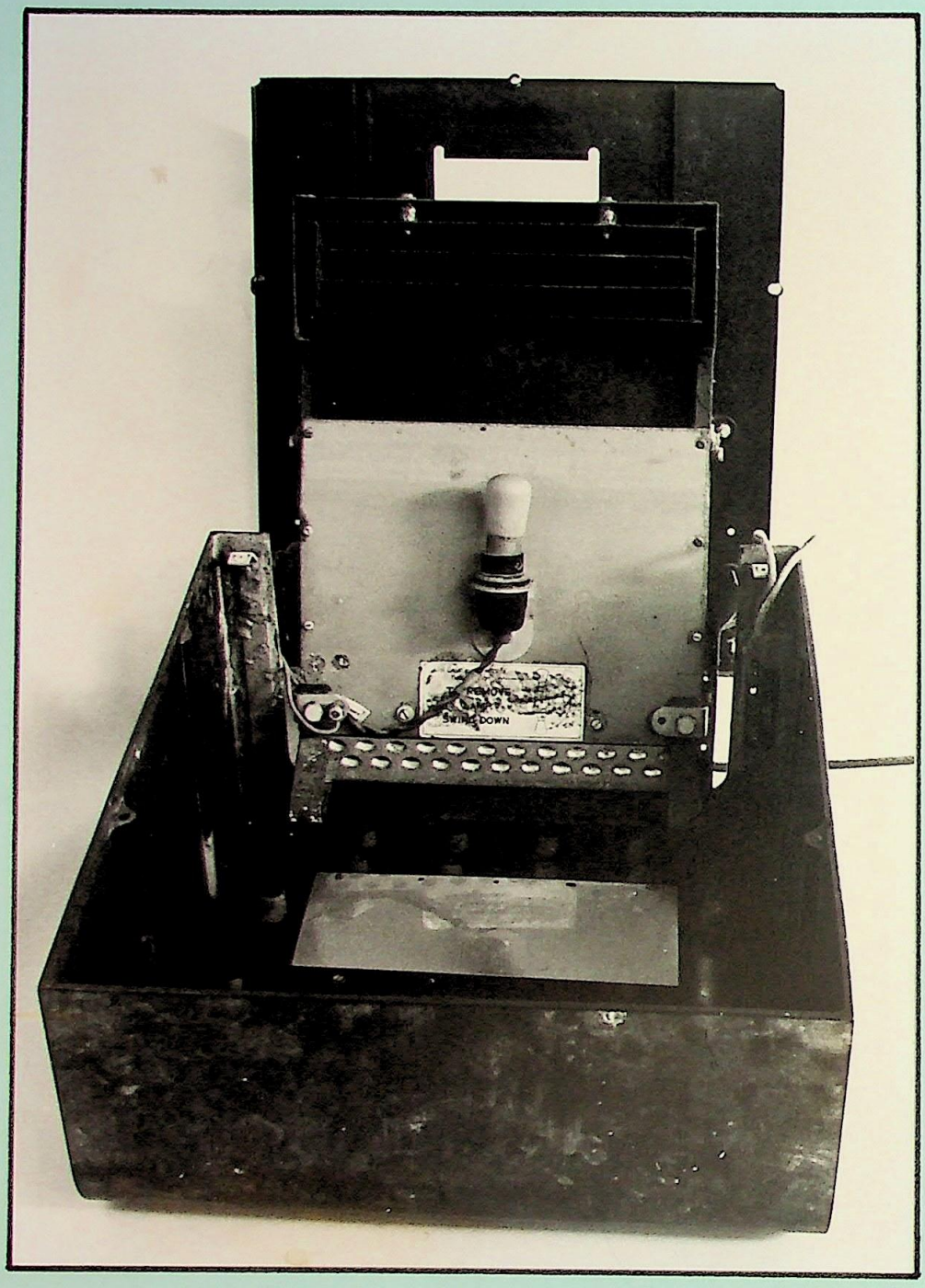


Figure 20

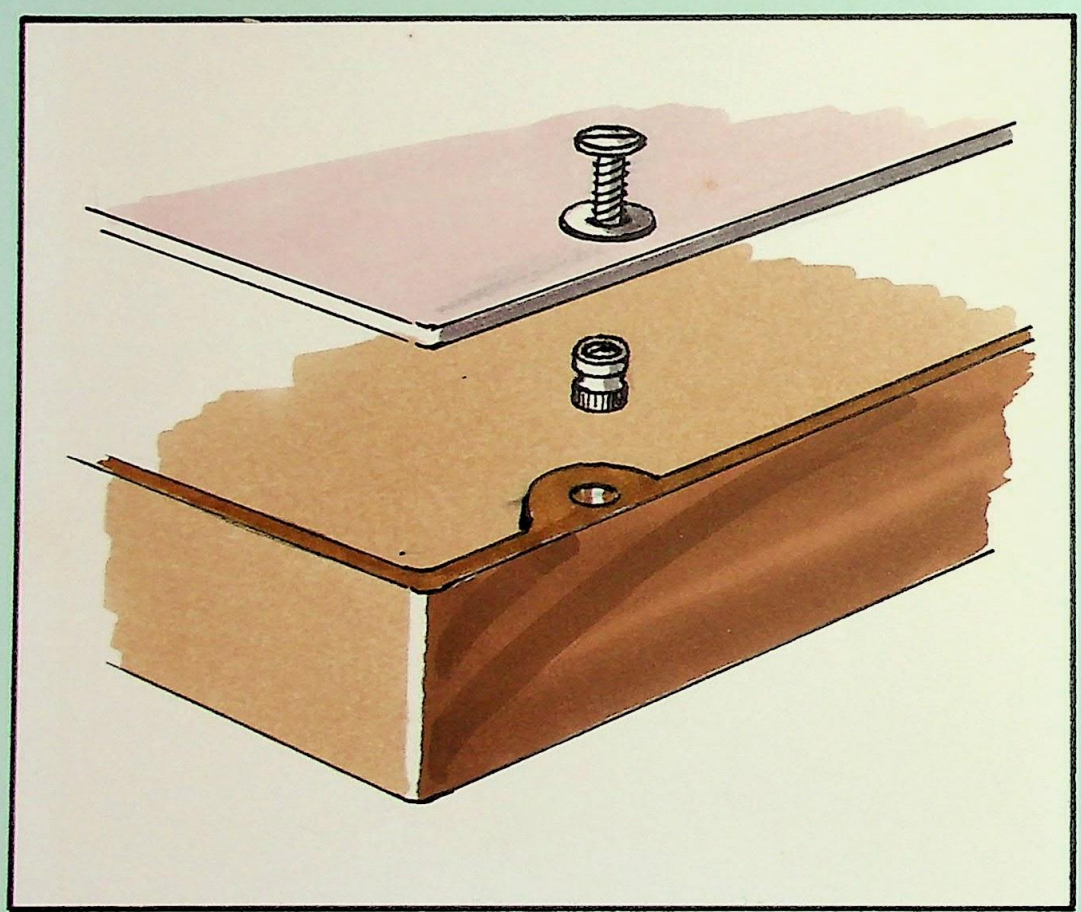


Illustration 21

screwing a bolt with washer down into the rawlbolt. The fixing system was totally reliant on how well the rawlbolt was jammed into the bakelite body.

One of the most interesting components is the convector mechanism. The form of the component represents and expresses its function and how it works. A front and side profile are shown in Figure 19 and 20. One can see where the heat is generated and how it rises and is projected outwards into the environment. This form would have been much more suitable for the exterior shell.

Another component of interest was an orange bulb positioned in front of the convector mechanism. Reflectors were placed to the front and rear of it probably to reflect and project the pshchologically warming orange glow upwards where it could be visible. These reflectors also protected the bakelite casing and the bulb from the excessive heat of the convector mechanism. The heater would have been more compact if the bulb had not been included.

Unlike Loewy's design the grill was made from a metal. It was fixed on the inside of the plastic body. However, on the heater that was examined, cracks were evident in the plastic at the corners of the rectangular opening Figure 22. This may have been caused by excessive heat and being continually heated up and cooled over a long period of time. The heater was designed in the "modern style" advocated by

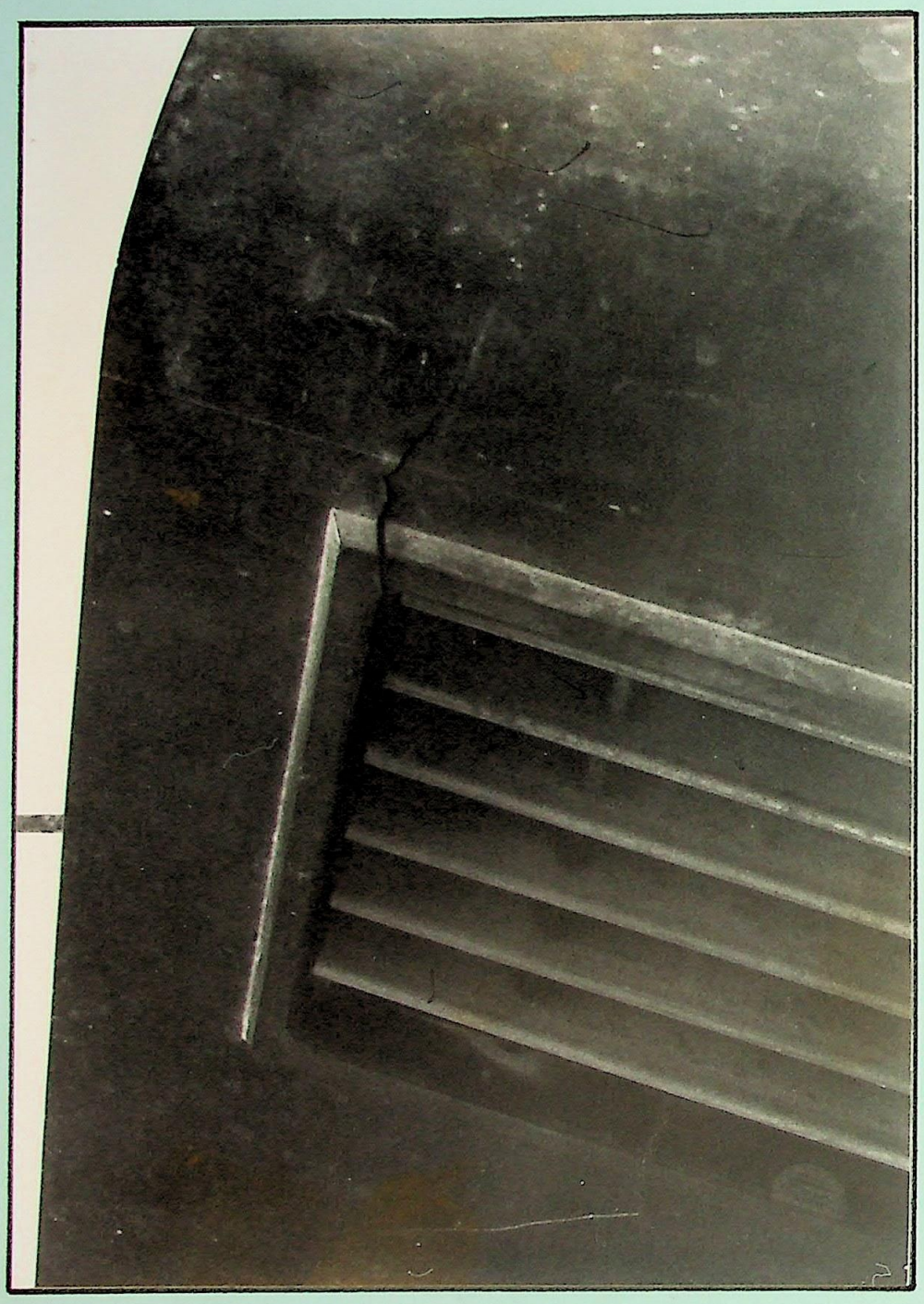


Figure 22

Nickolaus Peusner and other members of the D.I.A. It incorporated the simplicity of the "machine aesthetic" without indulging in unnecessary surface decoration. It was unpretentious consisting of a cleanline form which gave it the appearance of being functional and efficient. Figure 23 depicts an electric convector heater designed by Christian Barman for H.M.V. in 1934. It has the appearance of a large untensioned spring or diaphram which is capable of being compressed.

It was a design which embraced the modern aesthetic with its minamilist approach, representing a pure sculptured form in a chromium metal finish. it appears to have convection vents at each of the four levels. Its sleek form and use of materials give it a high-tech appeal. suggesting a sophistication in its simplicity, while also expressing efficiency and safety.

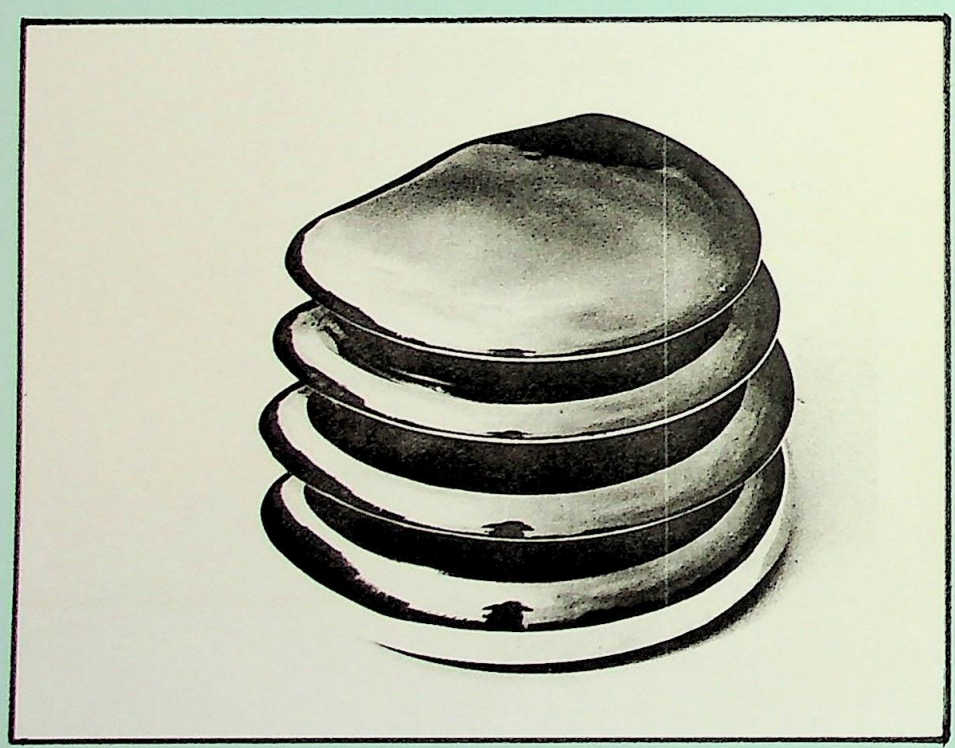


Figure 23

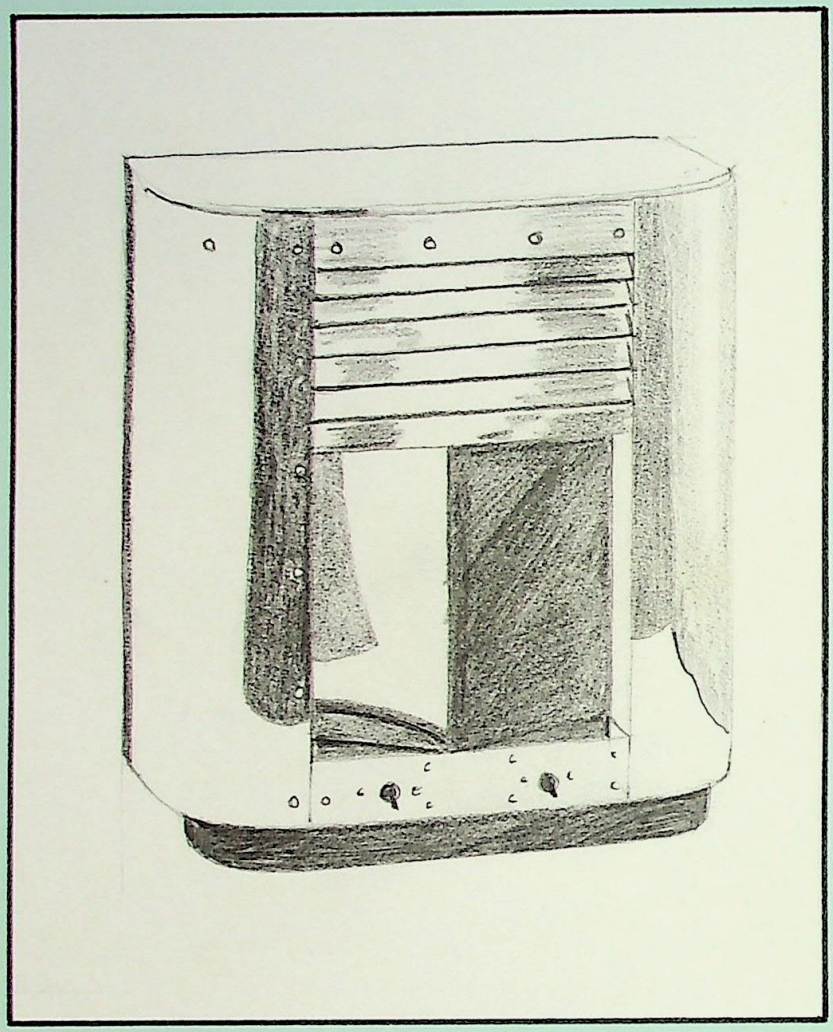


Illustration 24

Electric heater designed by Wells Coates for

Jack and Molly Pritchard's Apartment 1934

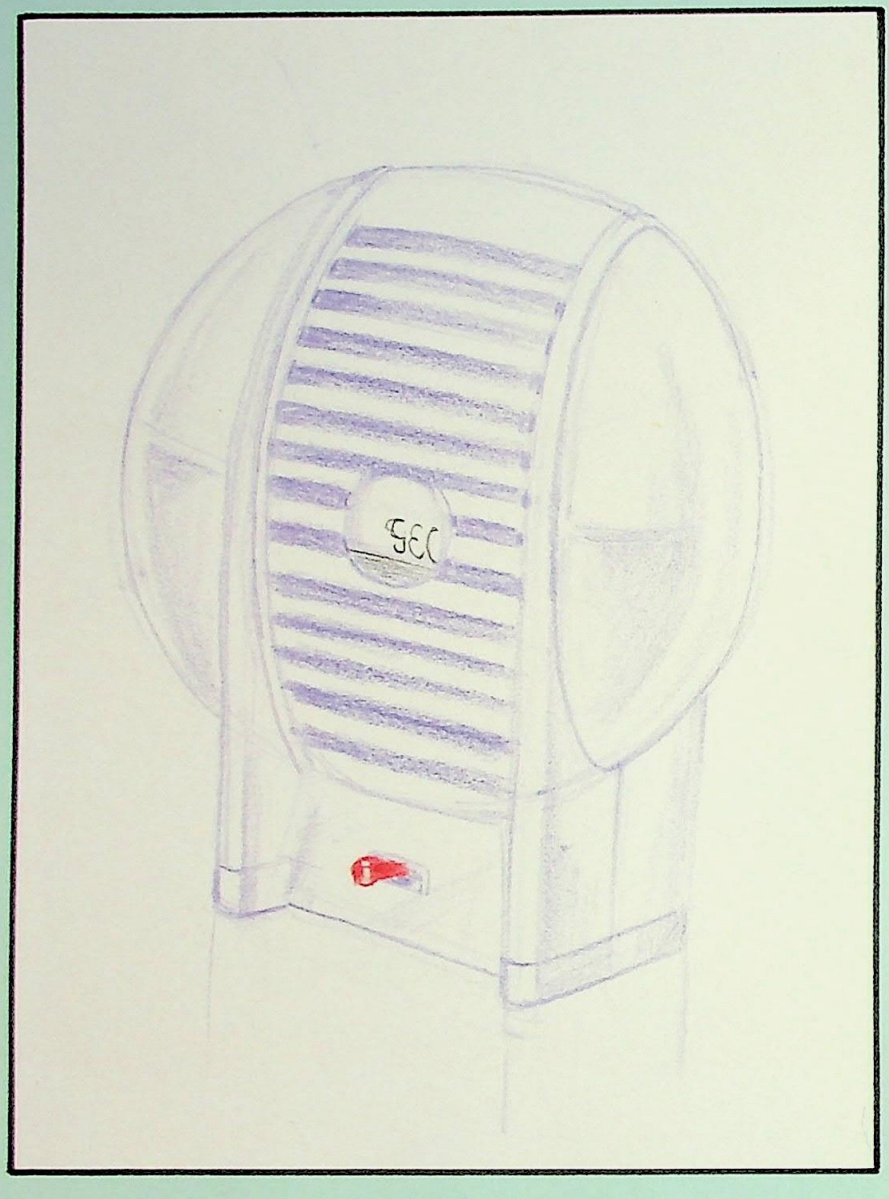


Illustration 25

A Raymond Loewy design for

a fan heater in 1938

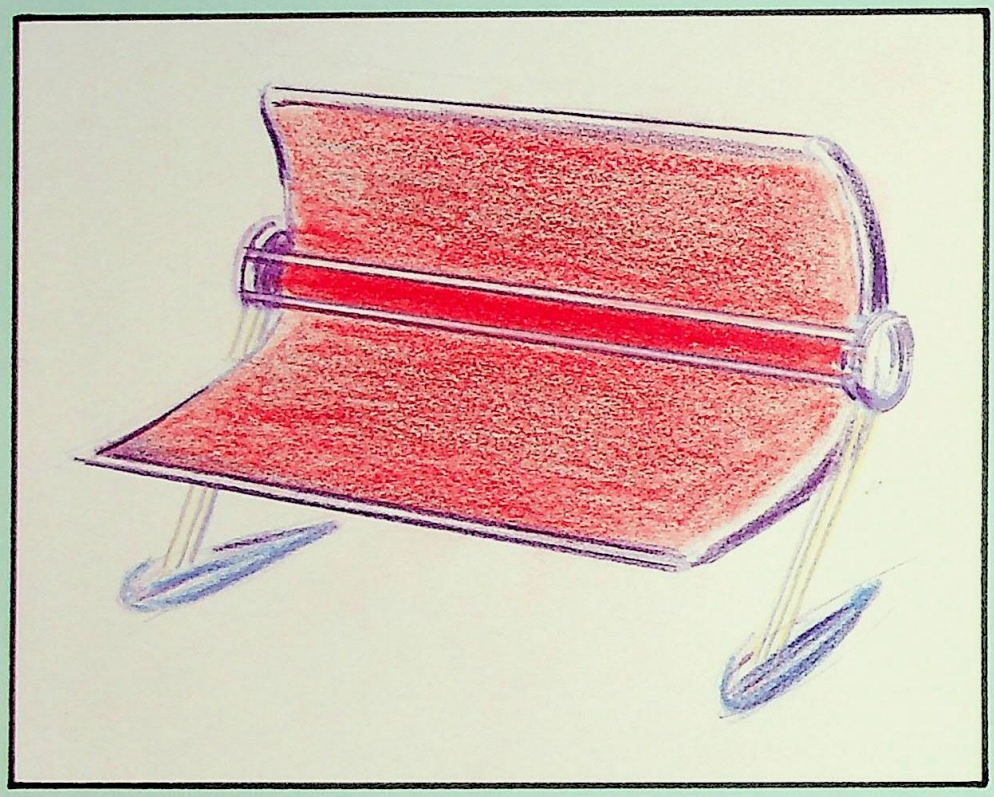


Illustration 26

Electric radiant heater designed

by Raymond Loewy in 1939

THE ELECTRIC STORAGE HEATER

The idea behind the electric storage heater was the consumption of "off peak" electricity. The "off peak" period was introduced to encourage a greater consumption of electricity between the hours when the industrial demand fell off, by reducing the cost per unit. The storage heater stored the heat in the "off peak" period and then gradually released it throughout the day, when it was most required.

The idea was initiated in the 1930's, but in order to be practical it required a suitable material capable of storing the heat. By materials research, it was established that magnesium silicate or stearite, more commonly known as soapstone, was one of the most successful heat storage material and was therefore incorporated into storage heaters. Although soapstone was incredibly heavy it did not split when elements were inserted and it was comparatively cheap. The system was only a marginal success but became popular again in the 1950's. However, only users consuming a large amount of electricity were in a position to negotiate for a preferential "off peak" tariff, which was expensive. Therefore, its use was restricted for domestic purposes, except in situations where a number of dwellings were treated as a single development.

Nevertheless, in the post war period, "off peak" heating through storage heaters offered a home heating system that was cheaper and easier to install than most other types of systems i.e. solid fuel radiators and central heating.

AESTHETIC CONSCIOUSNESS

William Morris and the Arts and Crafts idealists saw the low aesthetic level of industrial products in the victorian era as a direct reflection of social and spiritual debasement caused by the machine age. They sought design reform through the revival of craft attitutes which were more compatible with mediaeval guilds than a modern world of rapidly changing technology. They failed in their objectives.

The Ministery of Reconstruction's 1919 art and industry's pamplet expressed hope of a greater involvement of industrial design in the future production of "modern" products while also acknowledging the generally low levels of public aesthetic consciousness. It admitted that public pressure for good design was virtually non existant. Perhaps this was because the public did not know what constituted "good design". Futhermore, it stated, that without aesthetic education, the public would remain satisfied with low standards of design in mass production, purchasing by the attraction of low prices rather than quality or fitness for purpose. This was a legitimate excuse by the public. The purchase of such goods was restricted to the higher income brackets. Quality domestic appliances were beyond the financial scope of the working classes.

The ultimate concern for large profits in manufacturing industry had widespread effects on all sectors of the community. The Minister of Reconstructions in 1919 stated : "On the capitalist who thinks only

of the dividends, on the workman who has no interest in the inferior think he helps to make, on the distributor who cares not whether it is good or bad so long as it sells and gives him his profit, on the purchaser who takes the nasty thing home and lives with it. All the effects are bad, must be bad, but the effect on the public is the worst".

The situation prevailed into the 1930's. Even by 1937, British manufacturers had not generally recognised the importance of the designer's role in the mass production of goods. In that year, Nickolaus Pevsner's "Enquiry into industrial art" his survey of English industrial design, condemned ninety percent of English industrial products as "artistically objectionable" a situation which had begun more than a century earlier.

He felt, like many other protagonists of good industrial design that the integration of design into industry was far less prevailant in Britain than in many European countries.

Pevsner called for a more painstaking and systematic market research to discover what it was that constituted public taste. He wanted a greater commitment on the part of the manufacturers to understand and promote modern design. In common with the 1937 report on "the designer in industry" he put the blame on the wealthier sectors of society claiming that the most serious obstacle to the adoption of a modern movement style lay in the attitudes of the upper class, who

were distrustful of anything new, who tended to favour period decoration furniture and other products which were embedded in the security of the past. This was particularly evident in the historicising eclecticism of many expensive electric fires which were opposed in spirit to modern industrial art, an example of which was the G.E.C. "Magnet" ornamental fire Figure 27 and advertised in the Harrods catalogue 1929.

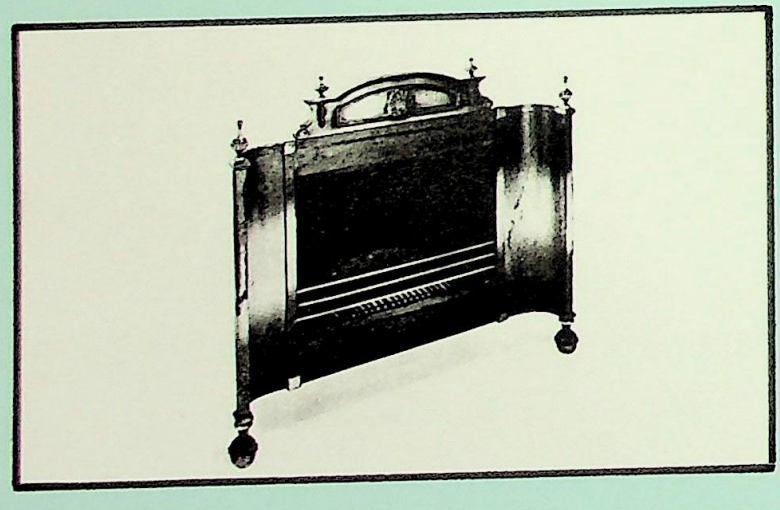


Figure 27

However, Pevsner suggested that such snobbery could be a great deal of aid to the modern movement in England if only more members of the upper class would give up "chippendale for modern furniture of equally high craftsmanship and design". He stated : "at present it appears to be the professional class mainly and a small minority of wealthy merchants and industrialists who uphold the modern style. Still their taste is bound to filter down by degrees into the detached houses of the poorer middle class".

Nevertheless he reported that the cheaper end of the market often yielded well designed products, devoid of unnecessary ornament, as with many inexpensive electric and gas fires. With new materials such as plastics, ornamental forms would have been more costly to produce.

Herbert Reed felt that the high import duties introduced in 1932 were partly to blame for the prevalent poor state of design in many of the established industries since they restricted foreign competition and therefore applied no pressure on the manufacturer to reconsider the importance of design in industry. He revealed, how such industrialists were trying to defend and protect their inferior products against superior foreign competition through the repeated raising of import tarrifs. While this situation prevailed the consumer had to be contented with low standards of design. The introduction of art into industry was often dismissed because it was claimed that artists knew little about the techniques of mass-production and as a result he was often employed as a cosmetist for products.

The Council of Art and Industry's Report in 1937 identified the retailer as one of the main culprits responsible for the general low levels of public taste. It was the retailer who was in the powerful position of dictating what the consumer wanted and also conveying his preferences to the manufacturer. However when the public do convey their preferences in market research surveys, it is often dismissed by design purists, if it does not conform with their ideas of good taste, by claiming that the public are visually unaware, have no appreciation of art and are aesthetically non conscious. This has been the case with imitation electric fires.

The Post War Years

Many of the electric heaters available in the forties and fifties were direct deviations of those designed in the earlier part of the century, revealing a considerable lack of design input and imagination.

An article in Art and Industry in 1945 stated that although British goods were generally considered to be superior in terms of workmanship, they were thought to be inferior to those produced in the U.S.A. in terms of modernity, ingenuity, imagination, visual appeal, service, spares and packaging. Swedish, German and Swiss products were also rated higher than Britains.

Neville Ward, in his Design Review (A Survey of Gas, Oil and Electrical units) in Architectural Review of May 1953 attempted to explain why British products in this area were so stale and sterile when he stated :

"Change in design in all these forms of heating has been painfully slow, so that this article is in the nature of an extension of the 1946 survey. The generally poor aesthetic standard in domestic heating equipment is all the more strange when it is realised that many of the firms producing the heaters also manufacture excellent light fittings. Clearly tooling costs are high and there is little incentive to consider new designs when national policy is to direct demand away from the product. Yet, it is regretable, in view of the physical and social importance of space heating, that there should have been such a lamentable failure to advance."

The ferranti bar heater of 1927 and the bowl fire reappeared in the 1950's totally unchanged in form but with slight modifications. However, many of the small modifications would have been due to technological advancement in materials and production methods.

Inset radiant electrical fires with wire safety grills were also very much in evidence although again designed in the 1930's, illustration 28.

However, there were a few exceptions. The Burton fire designed for H.M.V. Household Applicances illustration 29 was one of the more distinctive electric bar heaters. It had a beautiful sculptured form as a reflector which was specially moulded to give a wider angle of radiation. The base complemented the reflector with smooth large radiied surfaces. The element was adequately guarded by three chromed bars which also gave it an appearance of quality and efficiency.

Ther Ferranti "Safara" illustration 30 designed by W.N. Duffy was one of the most interesting designs. Mr Duffy was also responsible for the earlier Ferranti of 1927.

The heater was fitted with a mercury safety switch which turned off the current in the event of it being knocked over or tilted more than fifteen degrees from the vertical. It had a very simple unobtrusive form, with curved metal feet which gave it elegance, balance and stability. The form would also have simplified manufacture. Its

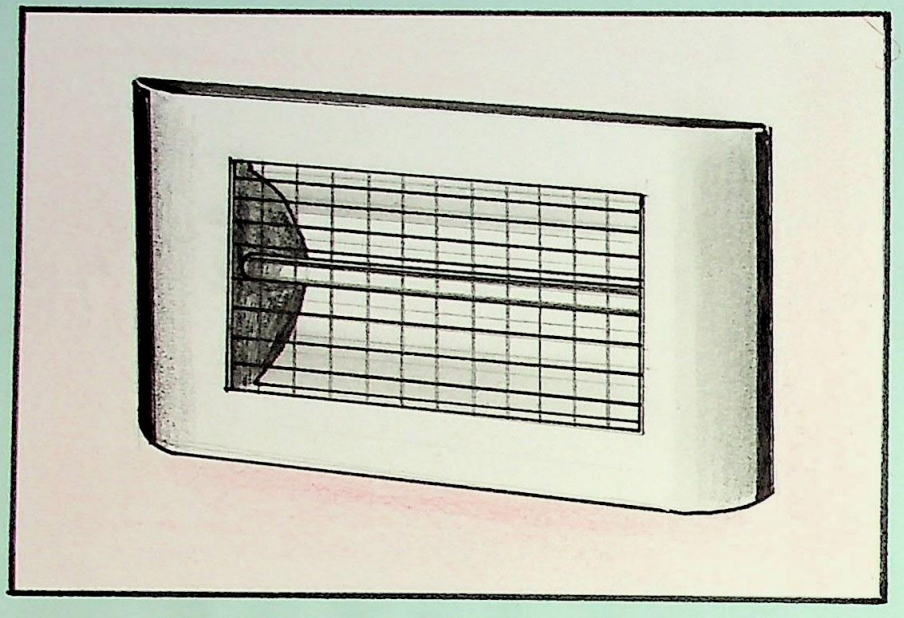


Illustration 28

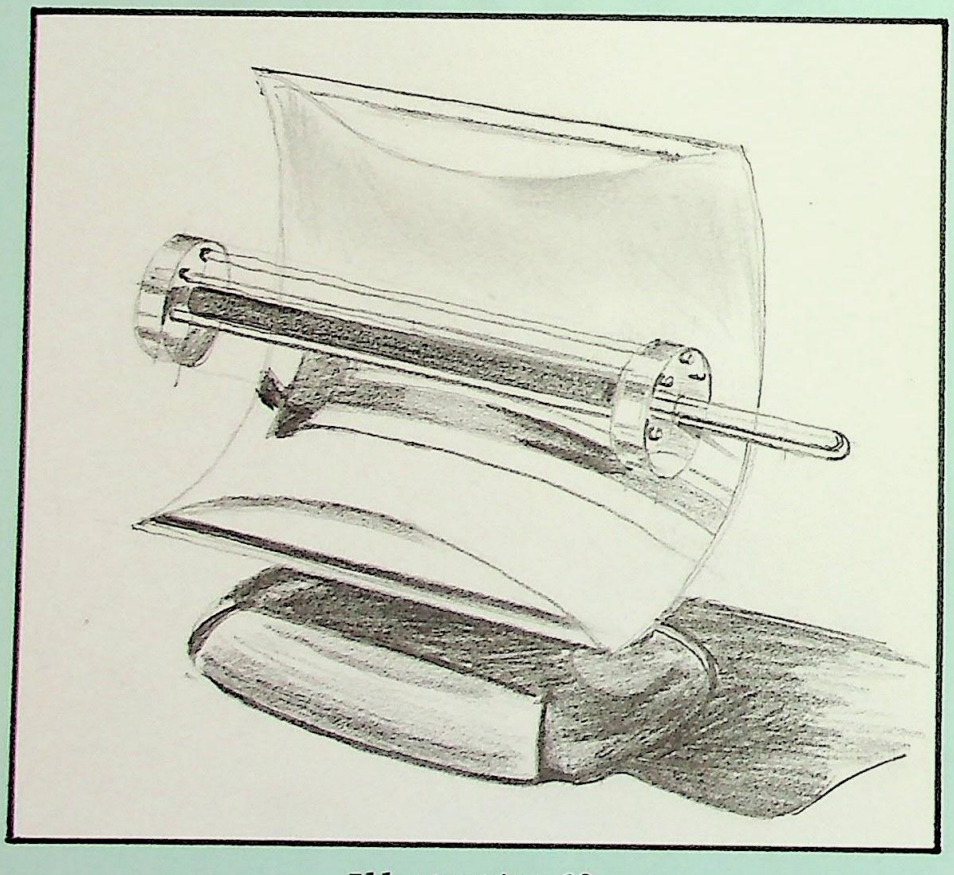


Illustration 29

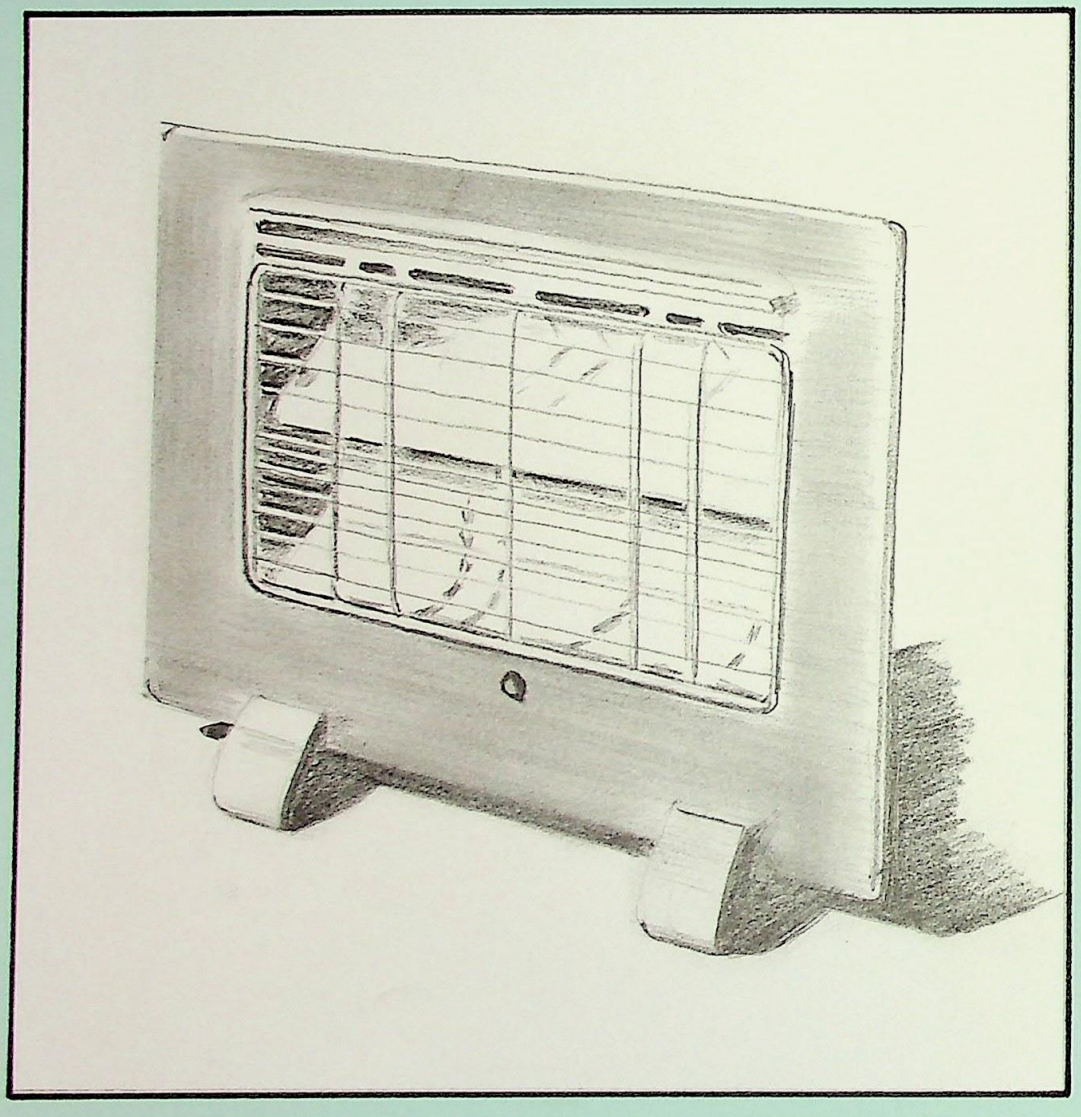


Illustration 30

appearance suggests that it was pressed from sheet metal. It was a modern design for a reasonable price of £13.175 7d in 1953. In comparison to the Burton fire at £17.55 10d it offered much better value with its built in safety features.

Oil filled electric radiators became very popular in the mid forties and fifties. The heater took on the appearance of its competitor, the traditional central heating radiator. This was for purely functional reasons rather than a desire to imitate a traditional form. The electric radiator gave the characteristics of a central heating system but with a non-existent instillation cost. They were thermostatically controlled and fitted with castors for ease of manoeuvability.

Oil replaced water as the heated fluid because it did not evaporate, having a small thermal expansion. It thus illiminated the danger of a possible build up of explosive pressure caused by evaporating water. The oil was contained in a continuous tube which extended throughout the interior of the heater.

During the fifties the trend was towards the design of a radiator which blended so well into its surroundings that it became obscured and almost unidentifiable, illustration 31 is an example of this trend.

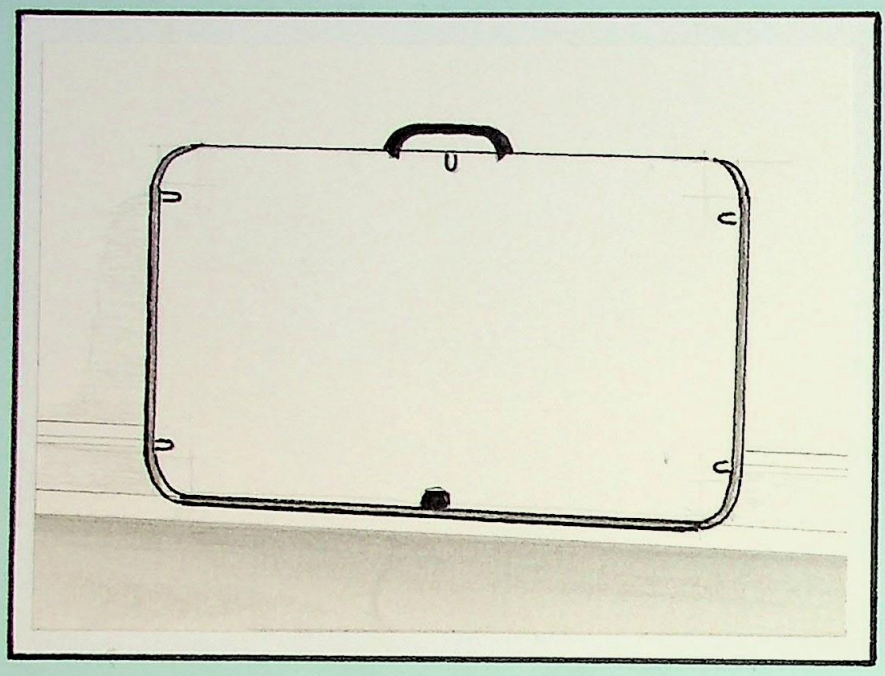


Illustration 31

Figure 32

To gain maximum heat output, a maximum surface area of the outer surface had to be exposed to the atmosphere. It was for this reason that the very pleasing fish bone form emerged, Figure 32. Other examples of the oil filled electric radiator are Figure 33 and Figure 34.

Around 1957, the new technology of heating with infro-red light was introduced. The infra-red source was contained within a silica tube. Although it was a new technology the heaters still retained the bar heater arrangement of curved reflector and protective grid for the heat source, similar to Figure 35.

However, more manufacturers were now very much aware of the value of employing an industrial designer. Falks Ltd. in 1962 employed an industrial designer to translate the technicians specification into a sophisticated, clean, functional design.

The Falks "Cavalier" outset heater illustration 36 had two silica tube elements producing infro-red heat. The reflector projected the heat outwards preventing the convection currents coming in direct contact with the wall immediately above the heat source. This was often the cause of the unslightly grimy areas on walls.

These heaters were intended for high level wall mounting and were ideal for kitchens, bathrooms and nurseries where they were well beyond the reach of children.

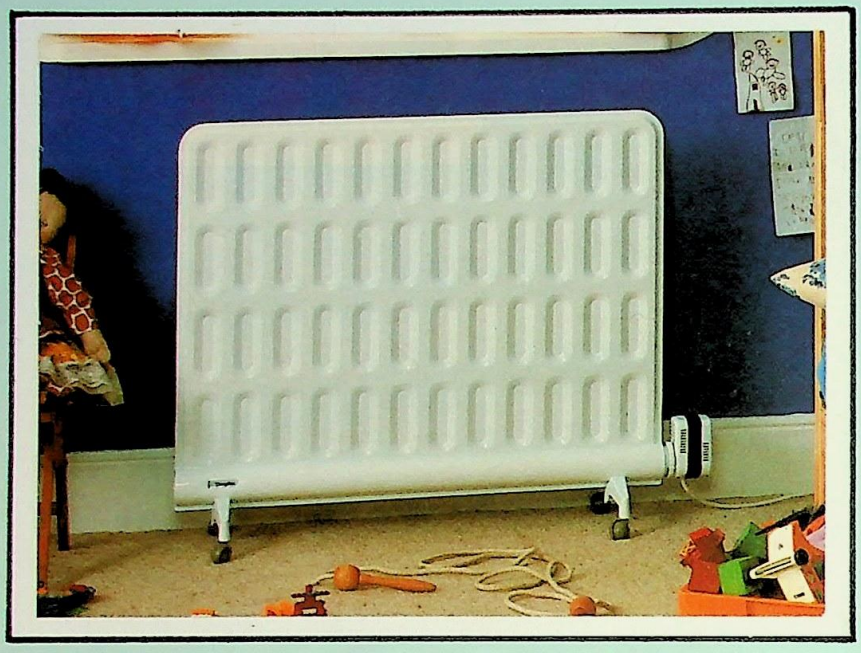
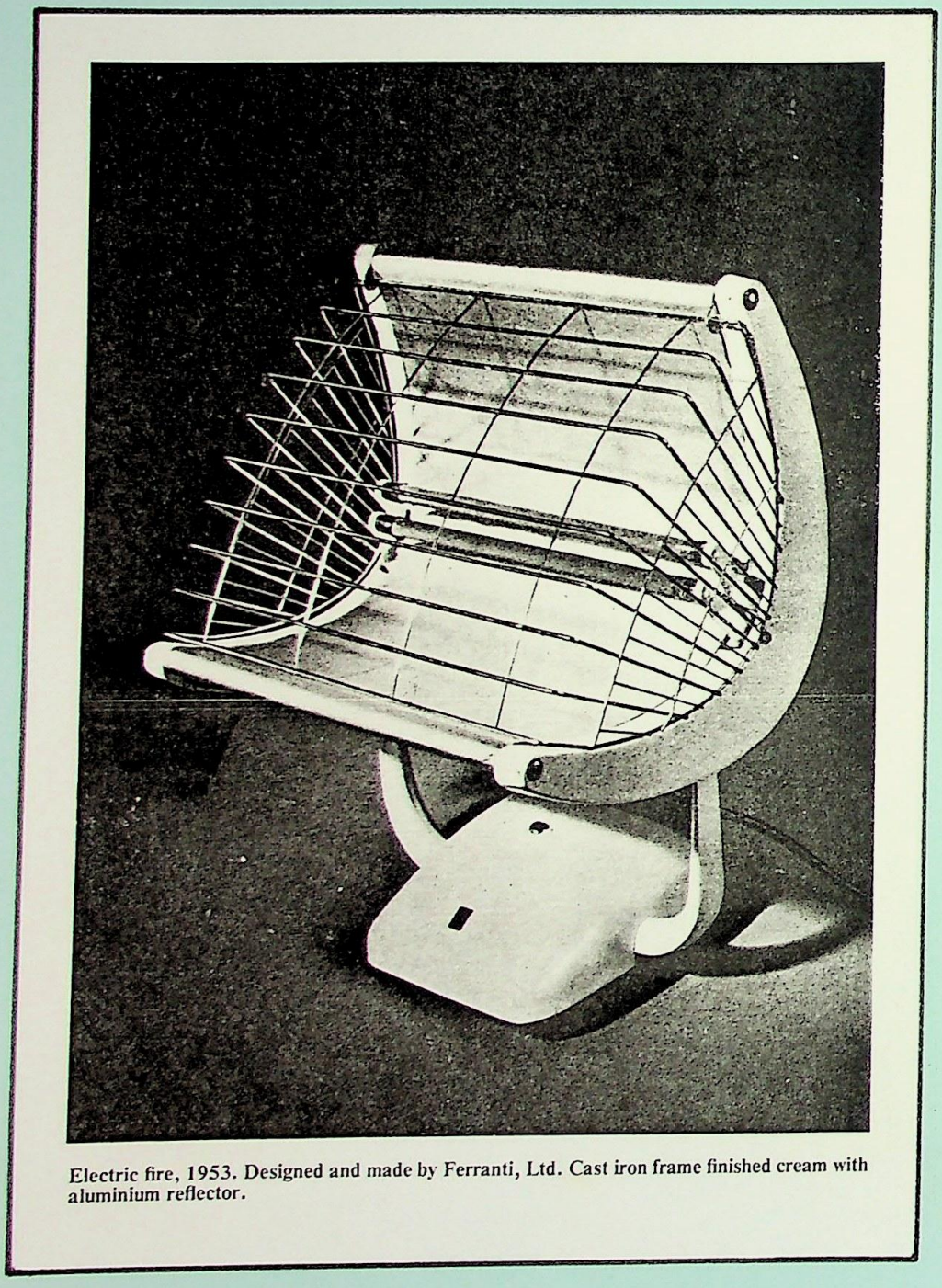


Figure 33

Figure 34



Electric fire, 1953. Designed and made by Ferranti, Ltd. Cast iron frame finished cream with aluminium reflector.

Figure 35

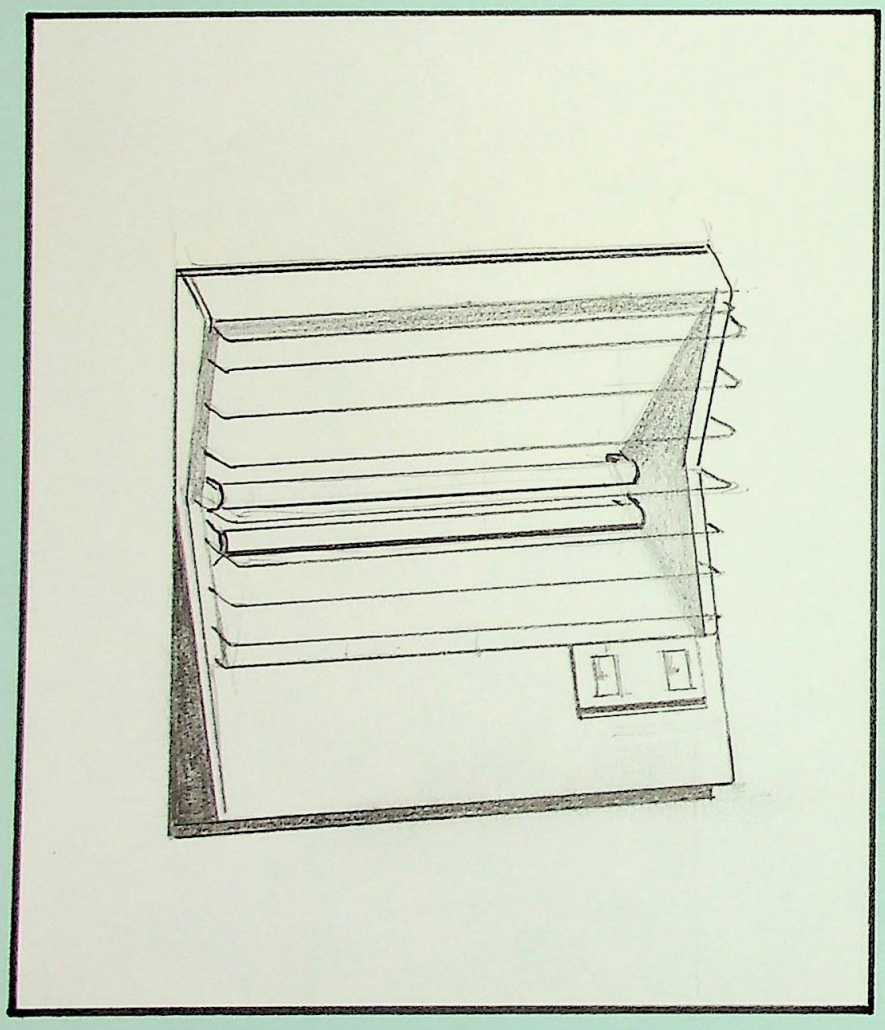


Illustration 36

The 1960's

Many electric heaters of the early sixties had incorporated space imagery. The contrived image was one of technological advancement in a new space age. The Sofona "Spacemaster" convector from 1961 illustration 37 is a perfect example. The heater's form resembled many of the probes sent into space by N.A.S.A. and those seen in science fiction films and television series. It also had a number of similarities with the bowl fire. It's circular disc, heat emitter, also conjure up images of beaming technology. It has a similar protective grid. It is the heaters feet, the thin rods, which give it the appearance of a space vehicle and resembles some of the space technology even used in the present time.

The Braun heater of 1962 illustration 38 was part of a house style that was famous all over the world. The company had a range of products, exhibiting a number of common elements. These elements were distinct family characteristics, so unmistakably Braun as to make the trademark almost unnecessary.

Braun had created an image of a sophisticated dual-grey technological box by incorporating a simplicity of form and line, adopting a minimalist approach. It also achieves this through the use of colour, distinguishing the different surface components. The heater is a rectangular box with a carefully chosen arrangement of slots breaking the surface and adding interest to an otherwise uninteresting form.

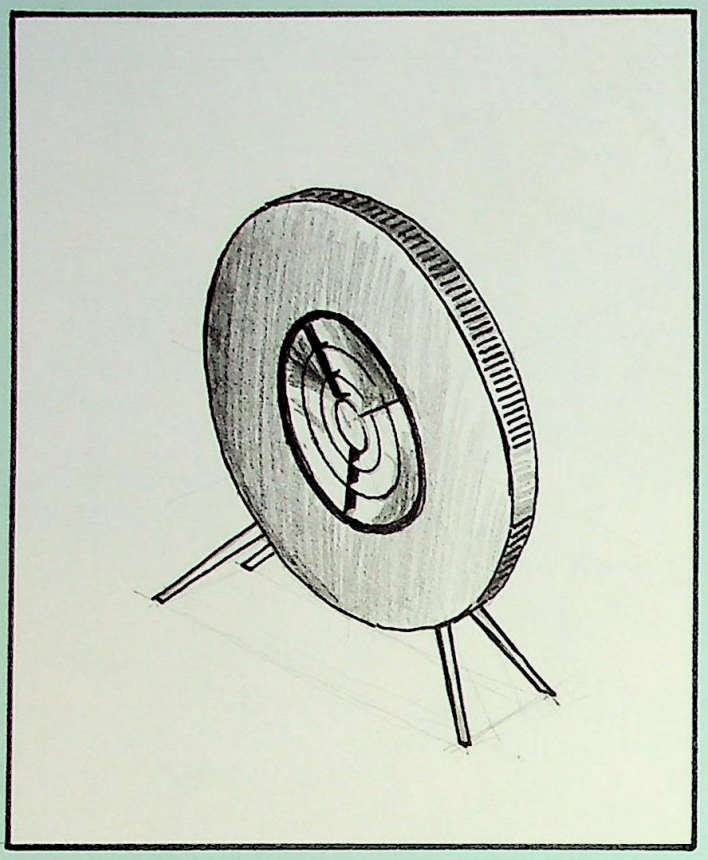


Illustration 37

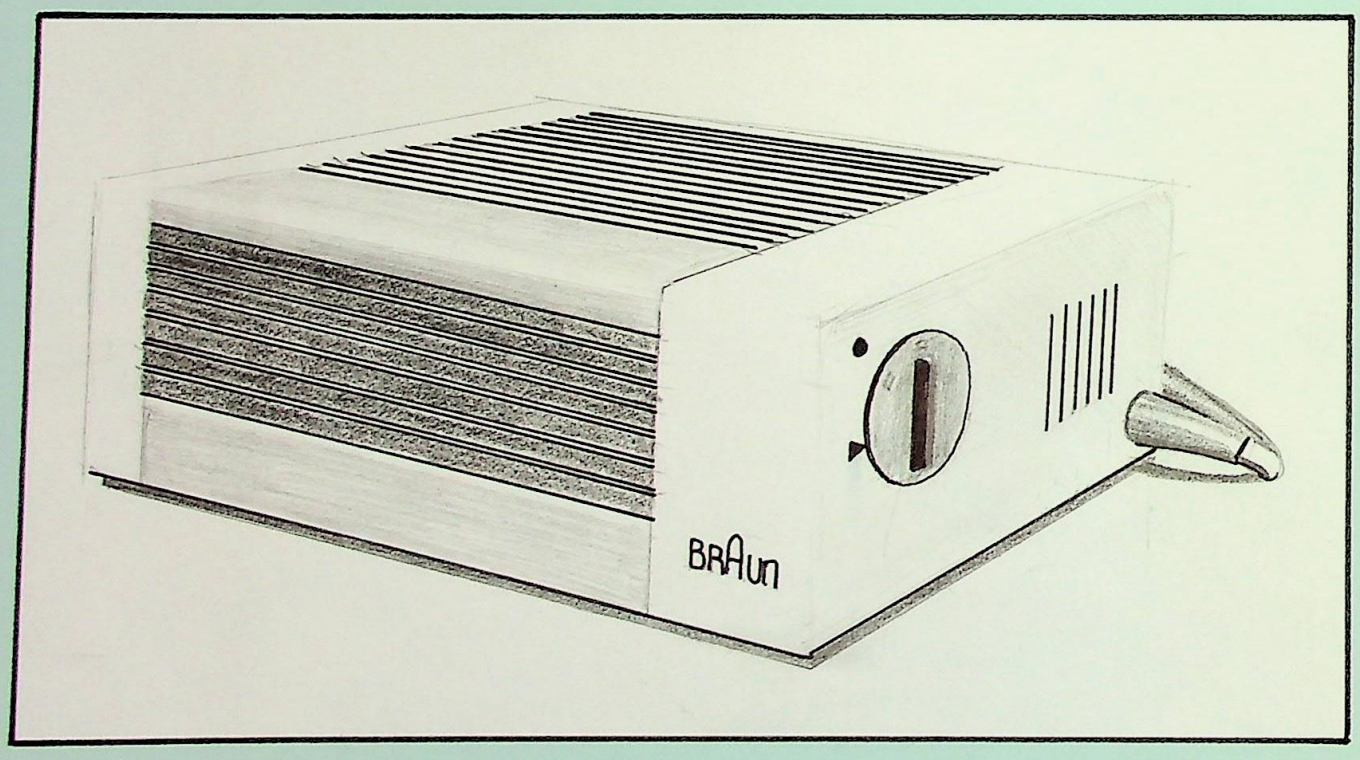


Illustration 38

Arthur Braun, Erwin Braun and Fritz Eichler were awarded the 1962 Compasso d'Oro for developing a new conception of industrial design at a managerial level and for commissioning quality designers such as Hans Gugelot, Dieter Plams, Herbert Hirche and Gerhard Lander. They reinforced and enhanced Braun's reputation, the popular myth of unshakable reliability.

The new G.E.C. convector heater of 1964 illustration 39 was described in advertisements as being in the new contemporary style. The entire outer housing was produced from pressed sheet metal. The only evident plastic component was the control knob for regulating the heat output.

Although the form was restricted by the material choice and the production technique involved, the heater has a satisfying appearance. The form was further enhanced by the open grids which allowed air to circulate. The air entered the openings at the bottom, passed over the hot coiled wire elements and re-entered the atmosphere through the top openings. These openings broke the surface and added interest to the form. It is a pity they were not more adventurous with the choice of colour, choosing a safe conventional brown.

However, in comparison, L. Bonfini, although experiencing the same restrictions of material and production techniques, has been much more adventurous in the exploration of form. And consequently, he has designed a much more distinctive heater illustration 40. He has incorporated a half cylinder into an angled rectangular form. The

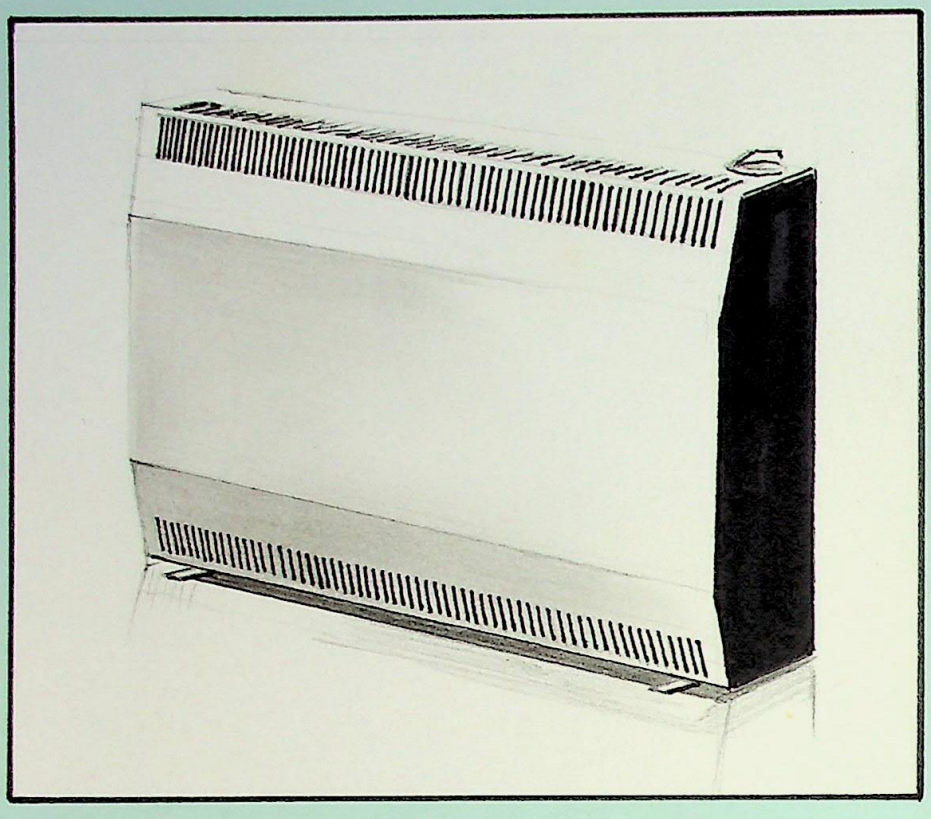


Illustration 39

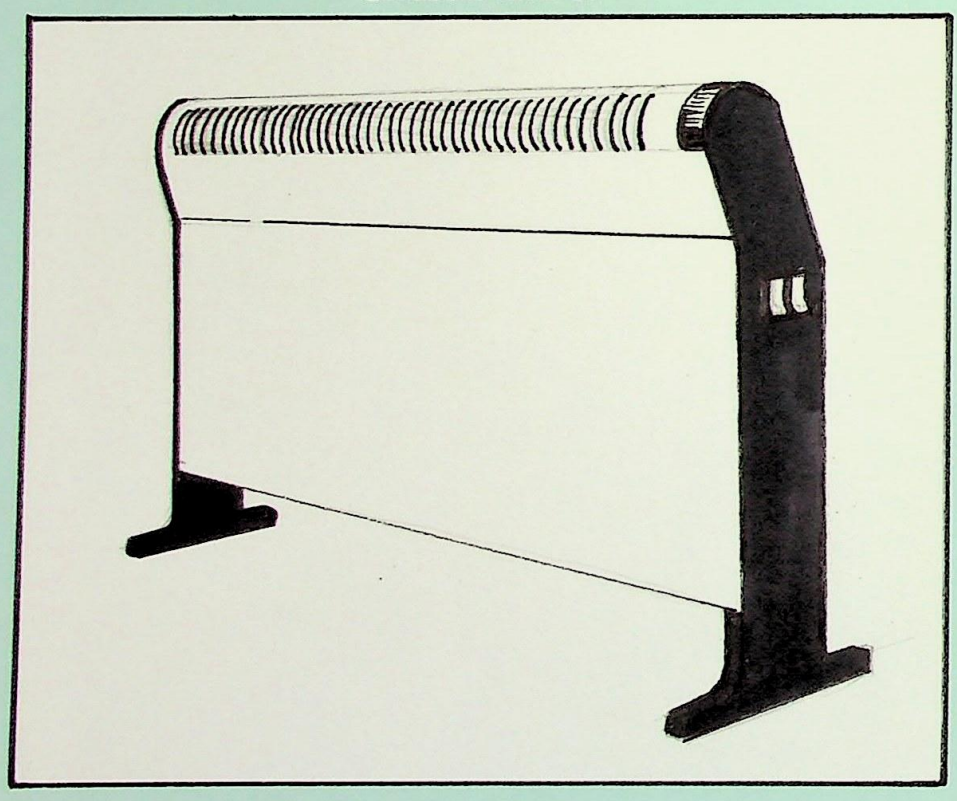


Illustration 40

choice of neutral black and white colours give the illusion of lightness while distinguishing individual components. The legs are visually extended upwards into the rectangular body of the heater by the use of colour giving it a very stable appearance.

Sheet metal has always been a cheap solution to meet the service requirements for large paneled areas. It gives good rigidity and it can take abuse. Plastic's have problems when moulding large areas while the materials and the production techniques are extremely expensive. It is for these reasons that the rectangular shape continues to reappear for example in Italian DeLonghi heaters Figure 41, although it has a sophisticated appearance through slight subtle adjustments. This is also true of the dimplex wall mounted heater Figure 42. Many of the convector heaters consists of pressed sheet metal rectangular box shapes, differing from one another through slight variations.

The fan heater has become one of the most popular types of electrical heater being small, compact and able to heat a room quickly and efficiently. David Brunton designed a fan heater for Belling in 1970, which resulted in a turnover of 6 million units and set the standard for other competitors to match Figure 43. Box forms were now dominating the market demonstrating boring design and lack of imagination. It also revealed an unwillingness to venture beyond the "safe" boundries of convention.

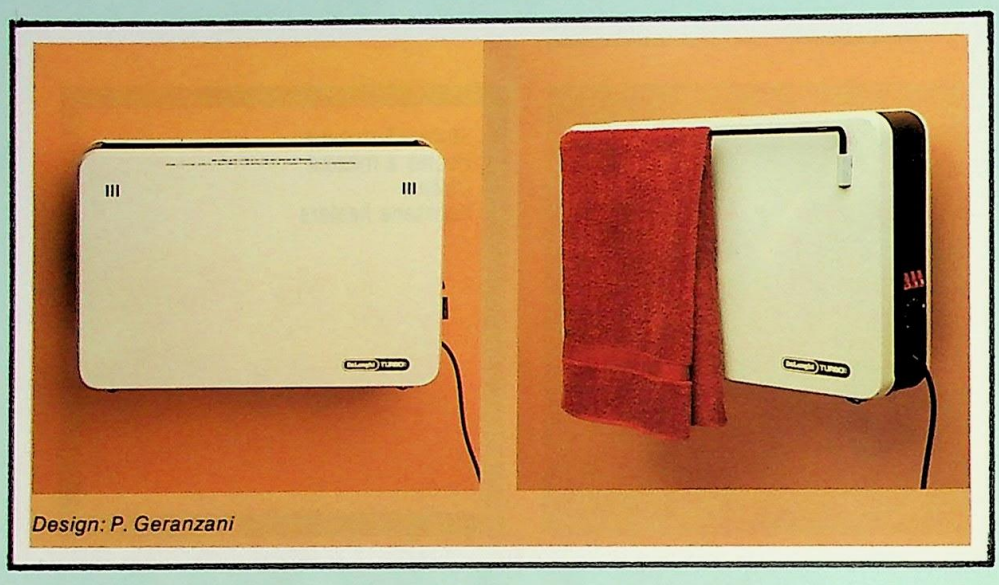


Figure 41

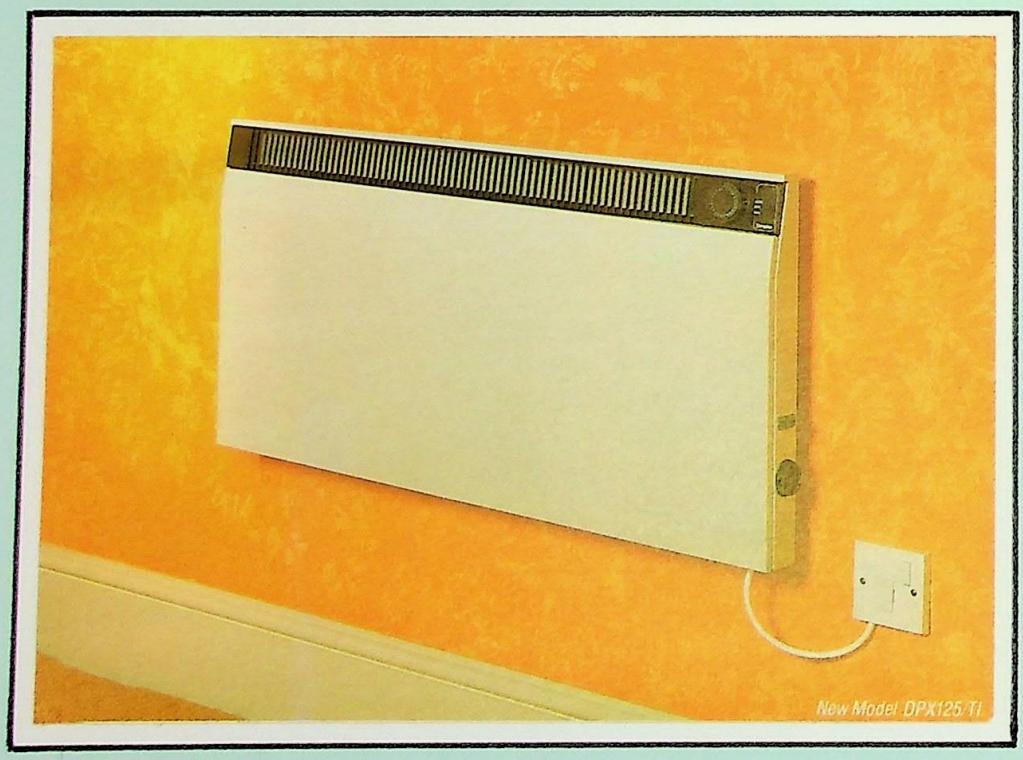


Figure 42

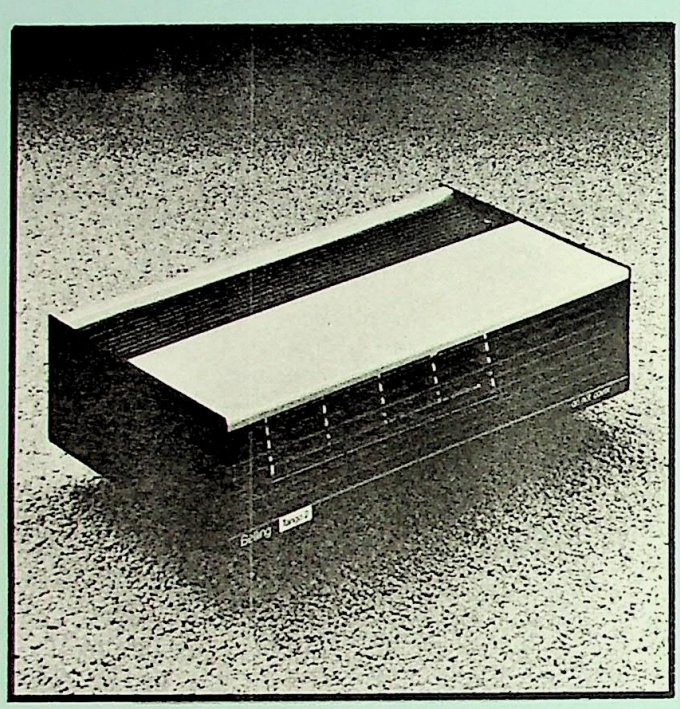


Figure 43

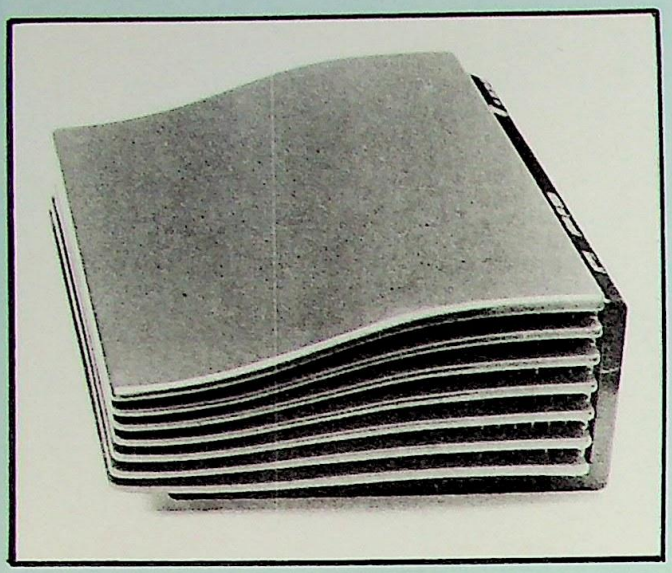
Beyond Conservative Boundries

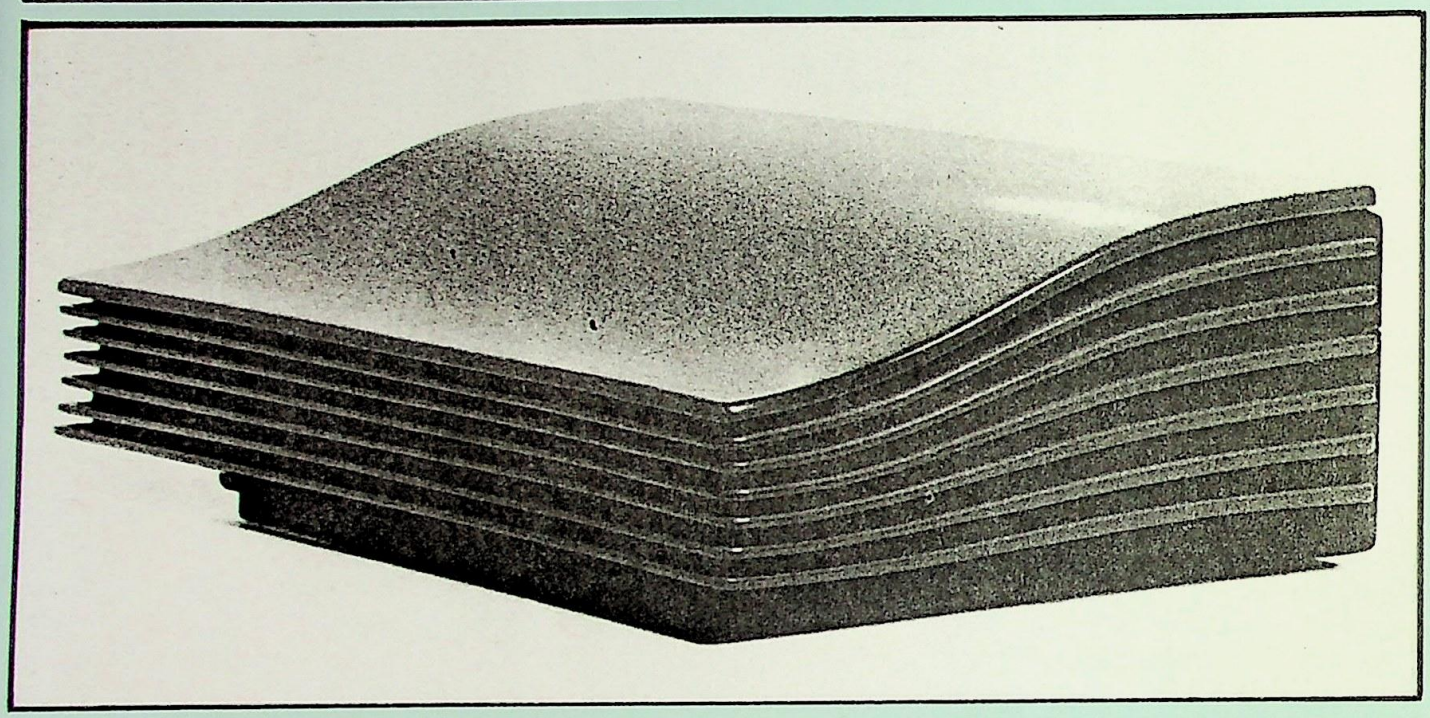
The hoover domestic fan heater Figure 44 designed by Bill Moggridge and Allister Ewen in 1973 was to consolidate the small market share held by the company in this product area. Hoover were unable to compete in their market on price. They therefore commissioned Bill Moggridge Associates to design a new up market fan heater which would have a distinctive appearance and would also appeal for its novelty.

Bill Moggridge stated :
"As an industrial designer, I am most interested in the "people" part of the design - who will use the product, why, where, how and when, what do people want from the product, what will make them like it and what aspects of performance will matter to them?".

He designed the heater with the above criteria in mind. The form convey's the heater's function and tries to express the air flow, being sucked in at the sides compressed and forced forwards through the heat exchanger and then projected out into the environment.

However, the form suggests that air is sucked in at the rear of the heater and is then projected forward. The side frames were to be produced from compression moulded phenolic. Entruded aluminium with pierced slots was chosen for the front panels probably because it was the part most exposed to direct heat. Pressed mild steel was recommended for the top and base. A.B.S. plastic was specified for the rear moulded handle.





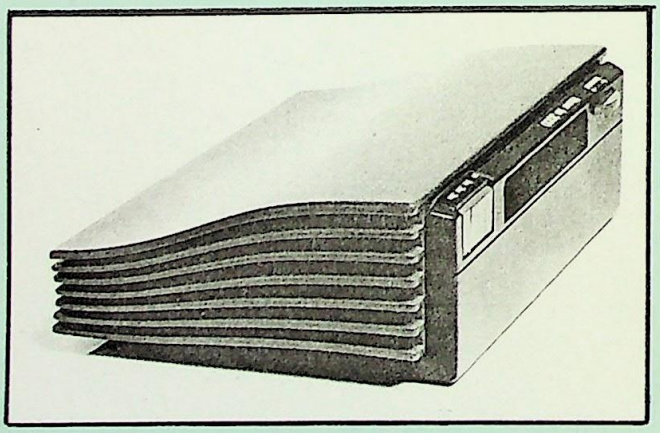


Figure 44

Although the design appears to satisfy the Hoover brief, being extremely imaginative and distinctive, it was never put into production. Perhaps, Hoover thought the design was too novel and radical in form for an unprepared conservative public.

Two of the most radical electric heaters were designed not surprisingly by R.C.A. students. Windried Scheuer, won the Cycolac A.B.S. Award in 1981 with his design for a fan heater Figure 45. The use of A.B.S. plastic gave him the freedom to explore form. The plastic satisfied the service conditions of heat resistance and impact strength while giving an excellent surface finish with a wide variety of colours.

The judges made the following comments :

"The design clearly illustrates the different functions - the switch, the asymmetric fancase and the supporting legs. The product is easily identifiable as an electric heater and obviously works on the radical principle. The entry has a post-modernistic aura about it and is a first class application of design where the external form follows the internal mechanical functions."

However the product is not immediately identifable as a heater. The radial top surface, the rectangular shape and the legs give it the appearance of a minature grand piano. Nevertheless once it is established that it is an electric heater, one can immediately understand, through its expressive form where the heat is generated, circulated and emitted.

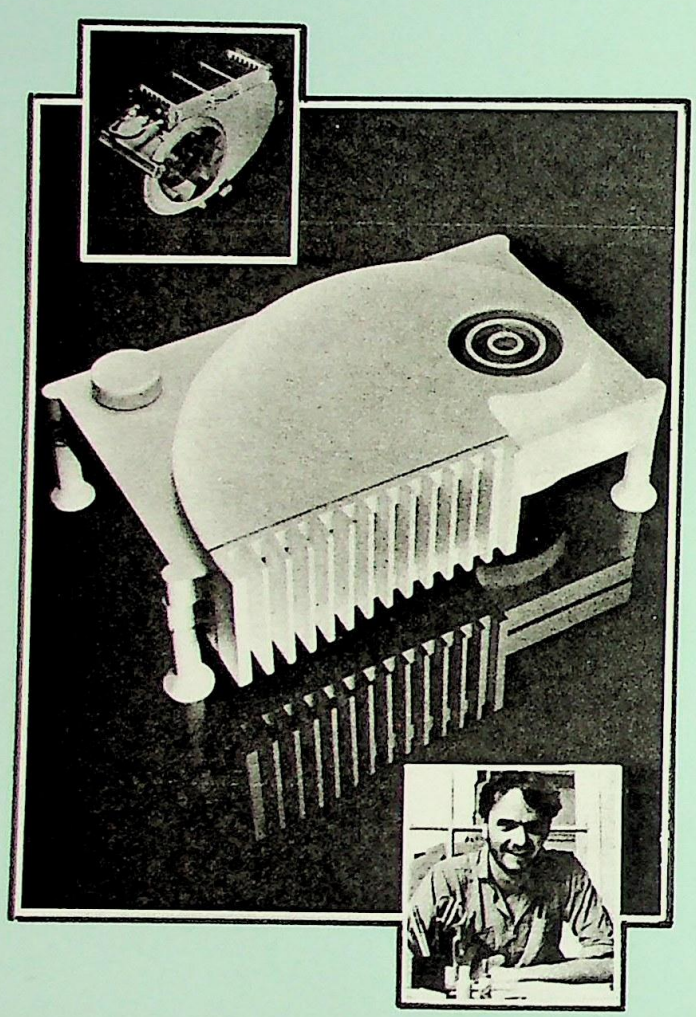


Figure 45

Mr Scheuer, on winning the prize stated :

"It means a lot to me. Industrial design still needs greater publicity so that manufacturers are more aware of the potential of design and new materials."

This statement reveals that designers are not being employed to the extent that they should be. There is still a reluctance on the part of the British manufacturer to employ and incorporate the industrial designer's skills into his products.

This form of heater would appeal to a very select market and would be seen by manufacturers as being self-indulgent design.

Philip Stanley, an industrial design student also at the R.C.A., took a new approach to the design fo a wall mounted electric fan heater illustration 46 where he converted mythology into a visual pun. He imagined the hot air blower as a dragon's head and the yellow knob switch as a pearl. When the knob was pulled, the attempted theft angered the dragon who responded by breathing hot air.

The knob was used to adjust the heat output and the fan speed by a pulling and twisting action. Stanley's novel and imaginative approach resulted in a heater which had a fun appeal and produced an interesting and distinctive form.

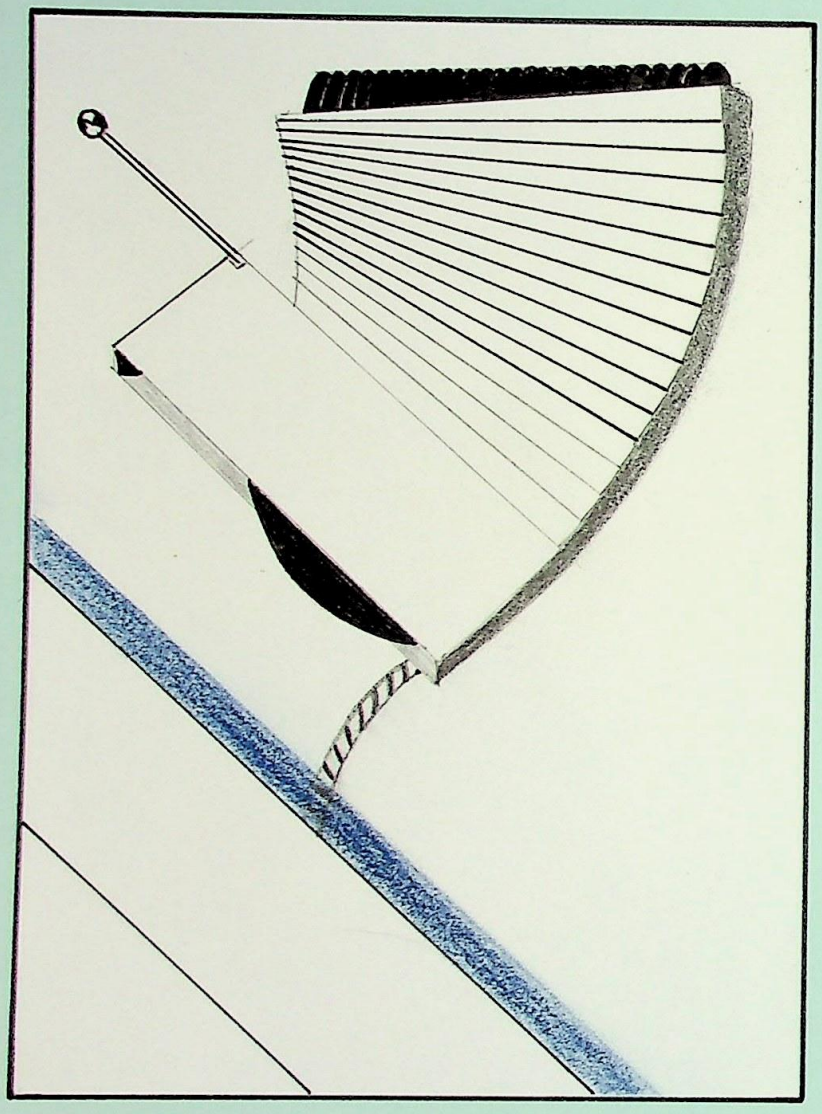


Illustration 46

CONCLUSION

Many heaters have no product identity. They compete in their respective markets on their efficiency, reliability and price. Yet they lack one of the most important elements, a distinctive form, which would make them stand out from the rest of the competition. There is no symbolism or imagery involved in the design of many of the heaters. What they require is a much needed injection of imagination, similar to the treatment given to the product by Bill Moggridge, Windried Scheuer and Philip Stanley.

At the beginning of the century, nobody writing about domestic heating could have failed to point to electricity as the "fuel" of the immediate future. The "Weir Report" which recommended the creation of the Central Electricity Board and the National Grid System was confidentially predicting cheap electricity at 1d or less per unit by 1940. This would make other fuels used in the home obsolete.

Electricity should have been the perfect "fuel" but it was always the monthly bill that provided the "shock". It was this expense which restricted its extensive use in the home. Even with the high hopes generated by atomic power, electricity still remained expensive. It was the high price of electricity that never gave the electric heater the opportunity to thrive.

The electric heater had to compete against two very important social considerations. Fistly, the delight of the open fire with its romantic connotations, and secondly, the fire being the focal point of

the room. If electric heaters were to become the primary source of heat in the home, this tradition and convention would have to be destroyed. However, fireplaces and fires appear to fill some ancestral need. It is going to take a very long time to dispose finally with the focal point of our homes. This perhaps explains the enormous success of the coal and log effect fires which still outsell many of the modern heaters.

The electric heater was demoted to a secondary source of heating with intermittant use when and where required. The heat of the main living room is still being provided by the solid fuel fire with electric heaters being chiefly used in bedrooms or to take the chill from the living room when there is a sudden drop in temperature.

Nevertheless the design of the electric heater still demands an aesthetic expression of its own, an element which has not often been satisfactorily resolved.

BIBLIOGRAPHY

"A History of Industrial Design"
Author : Smith, Edward Lucie,
Published : Oxford, 1983, Phaidon Press Ltd.

"Antique Household Gadgets and Appliances, 1860 to 1930"
Author : De Hann, David

"Architectural Review, Volume 78, 1935 : Toward a Rational Aesthetic"
Richards, J.M.

"Architectural Review : Design Review", May 1953

"Architectural Review", Number 726, 1957

"Architectural Review", July 1957

"Architectural Review : Design Review", May 1962

"Architectural Review : Design Review", November 1962

"Architectural Review : Desing Review", July 1968

"Architectural Review : Design Review", November 1968

"Architectural Review, 1975"
Author : Hanson, Brian

"Singing The Body Electric With Charles Holden"

"Art and Industry"
Author : Reed, Herbert
Published : London, 1934, Faber and Faber Limited.

"British Design Since 1880"
Author : M Carthy, Fiona
Published : London, 1982

"Central to Design, Central to Industry"
Author : Central School of Art and Design
Published : London, 1982

"Centenary of Service : A History of Electricity in the Home"
Author : Byers, Anthony
Published : London, 1981, The Electricity Council

"Design and Decoration in the Home"
Author : Carnington, Noel
Published : London, 1952

"Design", April 1981, Page 12

"Design", September 1985, Page 29

"Domus Magazine", December 1985

"Electrical Review", January 1959, January 1960, 27 January 1967, 12 September 1969, 3 October 1969, 31 October 1969, 5 December 1969, 19 December 1969, 9 January 1970, 30 January 1970, 5 June 1970, 21 January 1972, 28 January 1972, 10 March 1972, 10 February 1984

"Electrical Retailer", Numbers 9 - 11, 1974

"Electrical Times", 7 January 1984, 10 February 1984, 22 January 1982

"Forum Magazine", August 1983

"Home Fires Burning : The History of Domestic Heating and Cooking"
Author : Wright, Lawrence
Published : London, 1964, Ploutledge and Kegon Paul Ltd.

"Heating and Ventilation News", February 1983, August 1983

"In Good Shape : Style in Industrial Products 1900 to 1960"
Author : Bayley, Stephen
Published : London, 1979, Design Council

"Irish Heating and Ventilating News", June 1977, July 1977, October 1977

"Irish Plumbing and Heating Engineer", December 1964, July 1964, December 1966

"Italian Revolution : Design by Italian Society in the Eighties"
Author : Sartogo, Piero
Published : Milan, 1982

"Irish Electrical Industries Review", November 1971, September 1972, February 1973, October 1975

"Industrial Design"
Author : Heskett, John
Published : London, 1980, Thames and Hudson

"Keeping Warm"
Victorian and Albert Museum
Published : London, 1982

"Technology in the Home (Five Hundred Years)"
Author : Yarwood, Doreen
PUblished : London, 1983, B.T. Batsford Ltd.

"The Book of English Fireplaces"
Author : Alison, Kelly
Published : Middlesex, 1968, Hamlyn Publishing Group Limited

"The Canran Directory of Design"
Author : Bayley, Stephen
Published : London, 1985, Canran Octopus Ltd.

"The Industrial Designer and the Public"
Author : Woodham, Jonathan M
Published : London, 1983, Pembridge Press Ltd.

"The Rationalists Theory and Design in the Modern Movement"
Author : Sharp, Denis
Published : London, 1978, Architectural Press

"The Theory and Design of the First Machine Age"
Author : Banham, Reyner
Published : London, 1960, Architectural Press

"The World of Art Decoration"
Author : Hiller, Bevis

"Which Magazine : Radiant Convector Electric Heaters", March 1964