HISTORY OF THE 13 AMP PLUG AND THE RING CIRCUIT

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1 Introduction

1.1 This paper is based on papers, particularly Committee, Sub-Committee and Panel minutes, found in the IEE archives; there are references to working papers which would throw light on some of the discussions recorded but there are none to be found in the archives.

1.2 Articles which were published in the Electrical Review in the early 1940s and the subsequent correspondence have also been consulted at Amberley Working Museum. The archives of the Electrical Times and the Electrician have not been examined, it being believed that the substance of any article or correspondence would be much the same as that in the Electrical Review.

1.3 There appear to be no archives concerning BS1363 at BSI, at BEAMA or with such manufacturers as it has been possible to contact.

1.4 The following directorates, committees and sub-committees were formed and will be identified in the text by their reference.

Ministry of Works Directorate of Post –War Planning	DPWP[B]
Institution of Electrical Engineers Post War Planning Committee	PWPC
PWPC Sub-Committee 3	ESDIC
PWPC Sub-Committee 3 Panel E	Panel E
Directorate of Post-War Planning Electrical Installations (Study) Committee	EISC
EISC Study Panel No 2 Installations in Houses, Flats, Offices, Business Buildings and Hotels.	HFBBH
EISC Study Panel No 3 Installations in Schools, Hospitals, Institutions, Shops and Department Stores.	SHISDS
EISC Sub-Committee on Electrical Appliances	EASC
MOW Electrical Codes of Practice Committee	COP
COP General Considerations Sub-Committee	GCSC
Wiring Regulations Committee	WRC

1.5 In the discussion of each topic, the paragraph or section is headed by the initials of the committee whose discussions are being considered

2 Prehistory

2.1 Generators and wiring

2.1.1 Any history of modern accessories and installation must take us back to the origins of the electrical installation which may be said to have begun with ZT Gramme who, although not the originator of the ring armature, was the first large scale manufacturer of practical generators, with many machines being sold from 1870 onwards.
He was followed by subsequent manufacturers such as Siemens, and Crompton. Further improvements led to reliable, steam driven, small generators with satisfactory characteristics which enabled electric lighting by arc lamps to be provided.
Early wiremen were bell hangers who were used to running copper wire in capping and casing.

2.2 Early installations

2.2.1 A major change occurred in 1879 when Edison and Swan separately invented the carbon filament lamp; this allowed the "division of the electric light" which had been sought for so long. The provision of small relatively safe sources of electric light led to a considerable increase in the number of electrical installations. There were no agreed rules or standards; the various installation contractors, who usually were generator manufacturers, such as Crompton, had their own ways of carrying out installations, although the various insurance companies did impose their own requirements.

2.2.2 The foremost of these rules were those of the Phoenix Assurance Company, which were effectively a Code of Practice. In 1882, the Society of Telegraph Engineers, the forerunners of the Institution of Electrical Engineers and the Institution of Engineering and Technology issued their "Rules and regulations for the prevention of fire risks arising from electric lighting". These rules were a statement of principles rather than the more elaborate document they later became.

2.2.3 There was little understanding of the current ratings of conductors:-
"if the wires become perceptibly warmed by the ordinary current, it is a proof that they are too small for the work that they have to do and that they ought to be replaced with wires of a larger size"[1].
The need for fuse was recognised:-
"*there should be in connection with the main circuit a safety fuse constructed of easily fusible metal which would be melted if the current attain any undue magnitude and would thus cause the circuit to be broken".*[1]

2.2.4 There was little understanding, at a time when prospective short circuit currents were very low, of short circuit protection and we shall see that this was not

entirely understood in relation to installations in the early 1940s.

2.3 Early accessories

2.3.1 The only accessories which were originally needed were switches, which were relatively crude and mounted on wood.**;** they were made by the new electrical installation contractors who often put staff to their manufacture at times when installation business was slack.

2.3.2 The early plugs and sockets were used for table and standard lamps, although it is around about that time that the earliest domestic appliances began to appear in the form of electric irons and curling tongs.

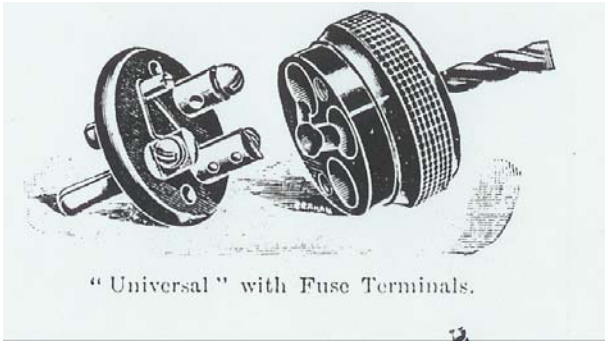
2.3.3 In 1883, TT Smith took out what appears to be the first patent for a plug and socket shortly followed by WB Sayers and G Hookham; these early designs had rectangular plugs with contact plates on either side. In 1885, two-pin plug designs appeared and in 1889 there were two-pin plugs and sockets in the GEC catalogue.

Figure 1 Early plug. *Amberley collection*

2.3.4 In 1893, Crompton designed the first socket which was shuttered for safety rather than for the exclusion of dirt.

2.3.5 In 1896, fused plugs were first mentioned in a patent taken out by FA Chapman. There were made by Lundbergs from 1900 until fuses in plugs were banned by the IEE in 1911, in the 6th Edition of the IEE "Wiring Rules". Fuses in plugs appear to have been banned because they were rewireable and the wooden plug top when was damaged when the fuse blew or possibly, looking at Figure 2, because of injury when the fuse blew.

Figure 2



Lundberg fused plug. *Amberley Archives*

The 7th Edition prohibited fuses in plugs and in socket but the 8th and 9th Editions, while continuing the above prohibition, allowed 5A fuses in adaptors so long as the circuit was protected in accordance with Regulations. The 10th continued to allow fused adaptors but also allowed fuses in plug, while continuing to prohibit them in sockets.

2.3.6 It was also common practice to put fuses in switches and ceiling roses and very often in sockets, which was inconvenient insofar that it was necessary for the socket to be dismantled in order to replace the fuse if it blew. Improvements were made by providing a porcelain, detachable fuse. The installation of fuses in sockets was still being discussed in 1944

2.3.7 WP Maycock in 1899 had been very clear that " although every socket in an installation should be individually fused, proper place for these fuses was not in the socket itself". [2]

2.3.8 In 1905, Diamond H introduced a socket in which the shutter was operated by a third pin, which was not an earth pin, but which only lifted the shutter.

2.3.9 In 1911, Higgins and Cattle produced a fused plug with Siemens Z type fuses. It was very large and intended only for industrial purposes but was significant in that it was the first attempt to use a cartridge fuse, thereby preventing damage to the plug top. The discussion in the Committees in the 1940's suggests that members were thinking of the industrial types of fuse when first considering the fused outlet

2.3.10 In 1899, Lundberg patented improvements in top entry plugs that is to say with the flex in the direction of the pins, but it was considered to be dangerous because of pulling the plug out by the flex and in 1908, the Memorandum to the 'Factories Act (Electricity) Special Regulations made it clear that compliance with Regulation 13 required that all plugs should be side entry, but these Regulations were not binding on domestic installations and side entry plugs did not come into regular use in domestic installations until after 1930. When they did they brought with them

the problem of over bending of the flex if the socket was mounted close to a surface.

2.3.11 Manufacturers chose their own dimensions both for the pin spacings and for the diameter of the pins, but very gradually the dimensions used by Tucker and by Lundberg were copied and most manufacturers worked to one or other of these.
Lundberg produced a small 2A 'Spot' plug, their 'Universal' 5A plug and a Magnum 15A plug; Tucker's produced a 'midget', 5A, 10A and 20A plugs.

The most commonly used size was 5A and the spacing of the pins was the same in both makes, but their diameters were different. The inconvenience produced by this was somewhat reduced by splitting the pins, which also made allowances for variations in manufacture. The British Mechanical Production Ltd 'Clix' plug offered this as a selling proposition. The matter was finally settled in 1927 when the Lundberg dimensions were incorporated into BSS 73.

Figure 3 Clix 10A plug. Amberley collection.

2.2.12 In the mean time the Multi-Kontakt firm (MK) had been set up by CL Arnold and CR Belling . Unlike other makes in which the pins had been split to accommodate differences in tube diameters, the MK plugs had solid pins and springy tubes and this principle was incorporated into BSS 73 although there were references in committee discussion to the difficulty of consistent manufacture, presumably over the range of manufacturers rather than MK themselves.

2.2.13 Shortly before BSS 73 was introduced, GH Scholes Ltd (Wylex) had introduced in 1926 a three-pin plug in three sizes, 5A, 10A and 15A, wit a very distinctive pin arrangement.

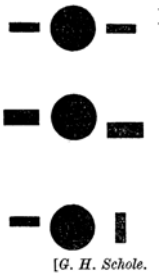


Figure 4 Wylex pin arrangement

The two smaller plugs were fused with cartridge fuses and could be inserted into the back of the 15A plug, as well as into the socket. The current carrying pins, as opposed to the round earth pins, were flat and of the same thickness for all three plugs, the difference lying in their widths. Three pin plugs were not then standardised and the Wylex plug was much used in the north-west

Figure 5 The Wylex 'piggy back' plug
Amberley collection

2.2.14 In 1934, the 10th Edition of what had then become the IEE's "Regulations for the Electrical Equipment of Buildings" introduced the concept of earthing and required all sockets to have an earth contact. To accommodate this requirement, BS 546 was introduced which standardised, as to pin diameters and spacings, a range of three plugs and sockets rated at 2A, 5A and 15A. In view of the later discussion which raged round the question of the 2kW fire and how to introduce a 10A plug, which at one time in the 1940's was seen a essential, it is surprising that a 10amp plug and socket was not introduced in BSS 546, although if it had been the 13Aplug and socket might not have been introduced

2.2.15 At this time electrical suppliers operated dual tariffs, that is to say they had one tariff for lighting and one tariff for power; these were separately metered so that if, within a house, there were both lighting and power socket outlets, there were effectively two installations. 2A sockets were apparently not much used, the most frequently used being 5A, (although later on there were claims that approximately the same number of 15A plugs had been sold); these were installed specifically for lighting by table lamps, though whether, in practice, they were always connected to the lighting meter is uncertain.

3 The situation in 1939

3.1 Wiring Regulations

3.1.1The 11th Edition of the IEE Regulations were published in 1939 and at Regulation 1312 required
'*every socket outlet to conform in all respects to an appropriate British Standard Specification*'

In spite of this, and perhaps because BSS546 was listed only in a Note, the manufacture and use of plugs and sockets which did not in all respects comply with

BS546, but which traditionally had been widely used in certain localities, continued (typically Wylex).

3.1.2 The number of socket outlets allowed by the 11th Edition to be connected to a circuit was covered by Regulations 202 C, D and E together with Schedule 23. Although the engineer who is used to the concept of diversity in socket circuits, consequent upon the adoption of the ring circuit, can see that that up to three 15A sockets may fed via a 7.036 (4.52 mm^2) cable two 15A sockets via a 7.029 (2.93mm^2) cable and up to six 5A sockets via a 7.029 (2.93mm^2) cable, almost all installations were arranged with each 15A socket on an individual circuit, fed through the power meter and up to three 5A sockets on a 7.029 (2.93mm^2) circuit fused at 15A fed via the lighting meter. A typical arrangement is shown in Figure 6

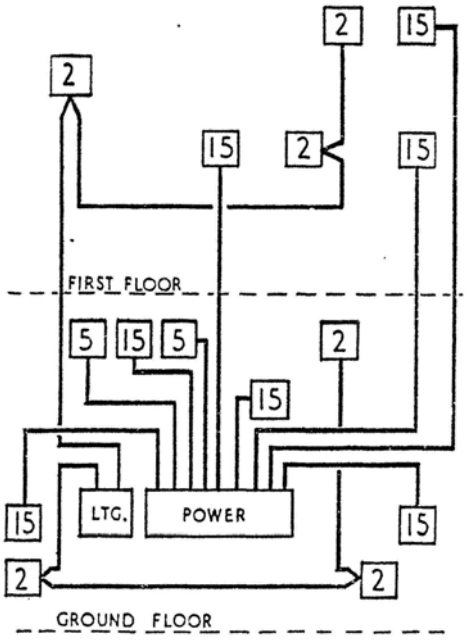


Figure 6 Ministry of Works Technical Note 4
© HM Stationery Office

3.1.3 The 11th Edition of the IEE Regulations, subject to certain relaxations to allow for more economical war-time use of materials, remained in force until 1950 although it was substantially amended in 1946 to accommodate the ring circuit.

4 Post-war planning

4.1 The Review Editorial

4.1.1 There the situation lay and there was no change in spite of an editorial in the Electrical Review on 18 November 1938 which called for *"new wiring methods"*. It was suggested that all branch circuits including lighting, apparently, should be taken from the same conductors "*with parallel connection*". It was suggested it would reduce the cost of the initial installation and would reduce the cost of additional sockets to "*as low as two pounds*"; note that the electricians hourly rate at this time was in the region of 1/6 (7.5p). The editorial pointed out that in order to have simplified wiring a single, if necessary two-part tariff, would be necessary.

4.1.2 The Editorial does not appear, as the Review later claimed it to have done, to propose the ring circuit. There is no record in the minutes of the Wiring Regulations Committee, nor of its sub-committees of the discussion of simplified wiring methods, let alone ring circuits until after it had been proposed in the Post War Study Committee, but this does not mean that informal discussions did not take place.

4.2 The Directorate

4.2.1 It might be thought that in 1941, at the darkest time of the Second World War, that government work and effort would not be put into considering what might happen after a war which at that time was far from certainly won. However, on 8th April of that year, Lord Reith, who was at that time the Minister of Works and Buildings, held a Press Conference on post-war planning, in which he announced that a Directorate of Post-War Planning and Building (DPWP) had been set up.

4.2.2 It is clear from the text of what was said at the Press Conference that this was mainly concerned with Town Planning. He had, he told the Conference, been appointed "Central Authority" although little is heard of this thereafter. It was announced at the Press Conference that the Ministry of Building and Works Consultation Panel on Reconstruction (with no direct reference to planning) had been set up. There were to be no technical institutions and it is clear that the thinking at that time concerned the architectural aspects of reconstruction and town planning.

4.2.3 In August 1941, an internal memo from within the Ministry of Town and Country Planning reported the setting up of a Directorate of Post-War Building (not Post-War Planning) whose object was to establish central Codes of Practice for post-war architecture and building; it would report to a National Advisory Council. (The number of Ministries and Directorates is confusing, particularly as their names seem to change over time). It is quite clear that the focus is still on architecture. Much later on in this paper, the setting up the Electrical Installation COP is referred to.

4.3 The IEE Committee on Post War Planning

4.3.1 In the summer of 1941 the IEE had set up its own Post War Planning Committee (PWPC) which is not to be confused with the Post-War Planning Directorate, (DPWP). This had a number of Sub-Committees , including the Electricity Supply, Distribution and Installation Sub-Committee (No 3) (ESDIC), which in its turn set up a number of Panels.

4.3.2 At the beginning of September 1941, a Joint Committee of the Electrical Lamp Manufacturers Association and the Royal Institution of British Architects, set up to ensure the lighting of buildings was

part of the post-war architectural function, organised a Conference, the purpose of which was to discuss with representatives of all interested bodies the advisability of co-ordinating thought and action on post-war problems and in particular those bearing on the subject of lighting.

4.3.3 The conference had been attended by the President of the IEE, JR Beard, who reported to a meeting of ESDIC (which met on 11th September 1941, over a month before its parent committee held its first meeting on 20th October) that he had drawn attention to the activities of the IEE Post-war Planning Committee (PWPC) and Lord Reith's apparent desire that the IEE should be prepared to give advice to the Ministry for the whole of the electrical engineering profession.

4.3.4 The President reported that resolutions at the Conference had been passed calling for the formation of a committee to represent the electrical industry and that the channel through which approaches should be make to the government by this committee should preferably be the IEE.

4.3.5 ESDIC were not happy about this and thought that, if the proposed industrial committee reported to the government through the IEE, then it was possible that this might be confused with other advice which the IEE might be giving. The Sub-Committee felt that it was preferable that the industrial committee should address specific subjects and that their findings should be passed to the IEE to be incorporated into any advice of its own which the IEE might give to the Government. The IEE would not be represented on the industrial committee.

4.3.6 After considering this report, ESDIC, whose terms of reference were to make recommendations to and to consider and report on post-war developments with regards to a number of subjects, then went on to set up six panels to study particular problems It was Panel E 'Desirable Standards of Equipment and Lighting', whose initial work under the chairmanship of Forbes Jackson, which would eventually lead to the ring circuit and the fused 13A plug.

The Scope of Panel E covered the whole field of utilisation; it was to look at:

1. The all-electric house.
2. A house with maximum possibilities, but not all electric.
3. A house providing for development, the degree of electrification being in accordance with the cost of the house.

Factories were not included.

4.3.7 Panel E prepared an Interim Report in which it recommended that consideration should be given to a 10A socket and that more than one socket per circuit should be permitted.

4.3.8 However, in the summer of 1942, the Ministry of Works Directorate of Post-War Planning convened a number of Post War Reconstruction Committees who would produce what came to be known as Post-War Building Studies on a number of subjects, eventually totalling thirty-three, of which number eleven was to be concerned with electrical installations; this would have duplicated or conflicted with the work of the IEE PWPC and ESDIC.

4.3.9 The IEE Post War Planning panels were informed of the setting up of the Study Committee and resolved through the ESDIC to transfer their work to the new MOW Post-War Planning Directorate's Electrical Installations Study Committee (EISC)

4.4 Post –War Reconstruction

4.4.1 The Post-War Reconstruction Sub-Committees set up by the Directorate of Post-War Planning were tasked, under the supervision of Policy Committees, with making recommendations as to how the one million houses which it was foreseen would needed to be built in the years immediately after the war might be built and equipped to the best possible standard, providing good quality houses with good facilities at a reasonable cost.

They were to report to the Minister, these reports becoming the Post War Reconstruction Studies. EISC was to be convened by the IEE. They were to produce an Interim Report which was to be submitted by October 1942, giving four months for its preparation. The draft was eventually approved for submission to DPWB and to the Council of the IEE on 11th November 1942

4.4.2 The EISC considered a wide range of matters outside the scope of this paper; they considered such things as supplies, tariffs, lighting, heating, ventilation, kitchen layouts, built-in appliances such as split level cookers, refrigerators and many others.

4.4.3 The EISC identified a number of 'problems' concerning electrical installations, amongst which were identified at their first meeting as :-

> 'Service outlets: -adequate provision for, and inter-changeability of, plugs and sockets
> Enunciation of principles governing the design of plugs'

It is these two problems with which this paper is concerned.

To address them the EISC set up a panel to deal with Installations in Houses, Flats, Offices, Business Buildings and Hotels (FHBBH) and, slightly later, a Sub Committee on Electrical Appliances (EASC). It is not clear why this was not a Panel; it was the driving force for the 'universal socket'

4.4.4 The DPWPB's priority was houses of 850 and 950 sq ft and there is no doubt in the minds of most if

not all of the EISC and panel members that they were making proposals for local authority housing or at least houses for the "working classes". The proposals for socket circuits were predicated on the idea that three kilowatt electrical fires were not supplied for such houses and that two kilowatt fires were adequate whether the house was all electric or was to be heated by coal; it was agreed that three kilowatt fires would be needed for larger houses but installations for such houses would be based on existing rules and equipment. It was only at the very end of the process that the idea of a plug and socket for universal use in all installations and capable of supplying a three kilowatt load was developed.

4.5 Circuits and Sockets

4.5.1 The discussions in the various committees and panels which are of interest very quickly divided into discussions of the circuits by means of which all the sockets in a small house might be supplied and the plugs and sockets necessary to feed a two kilowatt load when connected to a circuit which was fused at more than 15A.

4.5.2 The consumer unit to which we are now accustomed was developed during these discussions and one of the early considerations was how many fuseways should the consumer unit provide; a decision was made that a small house could be adequately fed by way of a three-way consumer unit, one circuit for lighting, one circuit for socket outlets and one circuit for the cooker. Cost and space were considerations

4.5.3 Most of the discussions in the committees etc centred on the question of the plug and socket. In order to have a clear picture of the development of the ring circuit as well as of the 13A plug and socket, the ring circuit will be considered first and then the development of the concepts of the plug and socket will be considered up to the point in 1944 at which the Housing Manual, (see 5.9) which incorporated those recommendations by the study committees which had been taken up by the Ministry of Housing was published.

5 Ring Circuits

5.1 Background

5.1.1 EISC and its panels were informed in 1942 that, although house plans had not yet been prepared, the DPWPB had recognised that the houses to be considered would be 650-1000ft^2.

5.1.2 Although ESDIC had been considering its Panel E's report and recommendation, namely that there should be a single 10A plug for smaller properties and more than one socket on the circuit and had concluded that such an arrangement would be needed and that fused plugs with cartridge fuses, for domestic purposes, would be necessary, there is no reference at this point to there being a ring circuit or the need for any circuit supplying multiple socket outlets to be protected by a fuse with a rating such as to require fuses at the outlet.

5.2 First references

The first reference to "ring mains" was in the minutes of the third meeting of FHBBH, held on 10 September 1942 at which the concept seemed to arise fully formed, with no indication of previous discussion in the Panel and none to be found in the minutes of the IEE Wiring Regulations Committee.

There must have been some discussion because the Panel is reported to have considered suggestions arising from estimates made by a Mr Marryat (ECA) and a Mr Walton (NECTA) of the cost of wiring "ring mains" in houses and flats; they did not see that there would be any appreciable difference in the cost between the use of a single ring main for the whole of a small house and several appropriately 'grouped ring mains'.

This latter idea appears to what was known later as the 'room ring'. The Panel discounted the idea of lighting being taken off the ring main. Nothing in these minutes suggests what the rating of the ring circuit fuse might be .

5.2.2 Two months later in November, there is a reference in the minutes of FHBBH to the connection of "the proposed .036(sic) cables" in special socket outlet ring circuits in which the cables would be run diametrically across each socket outlet without being cut ; not cutting the cables is matter which seemed to be important at this stage; it is referred to on a number of occasions.

5.3 30A rings

5.3.1 On the 1 March 1943 the EISC was back to considering 7.029(2.93mm^2) cables insofar that, at that meeting, they decided that such cables could be looped into a BSS 546 5A socket outlet, provided that (on the advise of BEAMA) the standardised minimum hole for the conductor was increased from 0.14" to 0.15". At a meeting of the EASC, a member representing the Electrical Development Association said that the necessity for fusing of the plugs arose because the proposed ring circuit would be fused at 30A; this is the first reference in the minutes to the proposed rating of the ring circuits. This member asked whether or not, instead of ring circuits, there could be room circuits, that is to say a circuit which later references clearly indicate was thought to be rated at 15A, supplying an unlimited number of 10A socket outlets, which would not need to be fused, in each room. (see Figure 8)

5.4 The IEE Paper

5.4.1 The discussions had up to this stage been held in Committee. On 30 January 1943, a paper on 'The future of the domestic wiring installation' was received by the IEE; this paper was eventually presented to the Installation Section of the Institution on 11 March 1943. It must be assumed, the authors being engaged in the various panels and with EISC itself, that this paper had official blessing and was intended to stimulate discussion within the installation industry. It is difficult to believe that the IEE would have allowed a paper to go forward in this way against the wishes of the Directorate of Post War Planning.

5.4.2 However, it should also be remembered that Forbes Jackson, as we shall later see, was a keen proponent of the ring circuit and the fused outlet and he almost certainly was using the paper to advance his views. Whether had by this time asked Dorman Smith and other manufacturers to produce fused plug in unknown but seems to be unlikely. Be that as it may, it was the first public reference to the ring circuit and is associated fused plug.

5.4.3 The paper was divided into two parts, part one 'Immediate Developments' and part two n 'The distant view'. The authors of the first part were Forbes Jackson, who was London County Council's electrical engineer and WJH Woods of the County of London Electricity Supply Company. The authors of the second part were G Smith of the Ministry of Works and Planning and E Jacobi, a Director of Messrs Troughton & Young Ltd, Electrical Contractors.

5.4.3 Forbes Jackson was not then on the IEE Wiring Regulations Committee although he was a member the EISDC and of the EISC Sub-Committee on Electrical Appliances. He was also the Chairman of EISC Study Panel 3 on Electrical Installations in Shops, Offices, Institutions etc, which does not seem to have met. The IEE paper is important insofar as it was the first presentation to the wider world of some of the thinking going on in the EISC and its panels. .

5.4.4 The first part of the paper, by Forbes Jackson and WJH Wood, describes how the authors would wire a small house of the municipal type with an area of six hundred to eight hundred ft^2. They thought that it was unlikely to be all-electric but the intention of the installation was to enable increasing advantage to be taken of the use of small appliances.
While at that time few houses were wired for lighting only, most having at least one general utility socket, the authors believed that, for reasonable advantage to be taken of the advantages of electricity, it was necessary to have several sockets, perhaps two to three, in most of the rooms.
They believed that 2kW electric heaters were adequate for the small rooms in the houses under consideration and that the occasional demand for heating at the beginning and end of the heating season would not be greater than the demand for heating an all electric house, which their proposed installation could meet.. They argued therefore that a general utility socket properly provided might be used for heating.

5.4 5 In a four roomed house or flat with three sockets in a room the number of sockets would be twelve. The authors say that they would have liked, before the war, to provide twelve sockets in the houses for which they were responsible for, but the Wiring Regulations, by requiring every 15A socket to be on a separate circuit [which was not true], made it expensive and needed a lot of room at the intake for a 13 way distribution board (15 way if there was a cooker and a water heater).

5.4.6 The authors believed a 10A socket to be adequate and that an unlimited number could be installed. They drew attention to the fact that twelve 10A sockets did not equate to a load of 120 amps which was the perception in the Wiring Regulations [again not true] but that with one 2kW fire in the living room and one 1kW fire in each bedroom, the heating load would not exceed 5kW. A 7.029(2.93mm^2) ring, feeding 15A both ways, could provide 7 to 8kW, which was more than adequate for the heating load and any additional appliances which might be used from time to time. They state that voltage drop on so short a circuit is not an issue [and it did not become an issue until the 1980s]. They suggest that the cost of installing twelve lights and twelve sockets would be some fifteen to twenty per cent (£2.00) higher than the cost of a pre-war installation of twelve lights and five sockets. Somewhat bizarrely they suggest that alterations could be made by means of a flat top plug and two to three feet of surface wiring, but their hope was that with a generous number of sockets this would not be necessary.

5.4.7 Jacobi and Smith, in discussing the Distant View, devote a great deal of time to the structure of the house in relation to the electrical installation and appliances, but also make an analysis of the problem of how to meet future electrical requirements. They declare the convenience of the user to be fundamental. The IEE Wiring Regulations were concerned with safety and provided rules for sockets circuits without considering for what the sockets were intended to be used.

5.4.8 They called on the installation industry to accept and develop the concept of the "actual load". At the present day, the concept would be 'connected load' and 'running load.' The actual load in any room is proportionate to the volume of the room and the lighting load to floor area. The authors propose that 1.5W per cubic foot would meet the socket load and 3W per square foot for lighting.
In order to meet the convenience of the user, there needed to be many more sockets provided to enable the use of the small appliances which they believed would be increasingly developed to ease the work involved in household tasks. However, the reference to a small motor driven buff for cleaning silver suggests they were not entirely in touch with what was going on at the time in a 600 square foot municipal house or flat.

5.4.9 The authors draw attention to the fact that existing sockets in use were rated at 2A, 5A, 10A and 15A with two or three pins and with flat pins or round pins. Added to the confusion was the lack of clear understanding of what was power and what was lighting. They state that people were asking at the time for three sockets in a room, one 15A socket and two 5A sockets, usually in the wrong place leading to the use of trailing flexes. They perceive the ideal as being one socket every three feet around the perimeter of a room. [This has never been generally achieved although it

should be noted that the requirement in the United States' National Electrical Code is one socket every six feet].

5.4.10 Such a proliferation of sockets was totally impracticable under the circuitry then imposed by the IEE Wiring Regulations for the same reasons as outlined by Forbes Jackson and WJH Wood.

5.4.11 The authors claim that a 5A BS546 socket will, if properly constructed, carry 12 to 15A and believe that a single 10A socket should be agreed and standardised, based on a 5A BS546 plug and socket, and its use should be mandated.
Having briefly discussed the voltage drop across the socket, which relates to heating, they then, somewhat strangely, moved away from the concept of the 30A ring outlined by Forbes Jackson and WJH Wood, to propose one ring per room, wired in 7.029 (2.93mm^2) with a 15A fuse which would allow for the protection [against short circuit]of a 23.0076 (0.65mm^2) flex (which would not be so protected by a 30A fuse). They do not distinguish between overload and short circuit protection.

5.4.12 They therefore proposed that at the intake there should be one 15A fuseway for each two thousand cubic feet of the house for sockets and, if the lighting is not to be taken from the ring, there should be for lighting one 15A fuseway for each six hundred and fifty square feet of floor area in the house but with a minimum of two, regardless of area. Fuseways for cookers and for water heating would also be required.

5.4.13 Note that Jacobi and Smith do not refer to the fused plug and propose a 15A room ring to address the problem of protecting the flex whereas Forbes Jackson and Wood are strongly in favour of the 30A ring feeding the whole house with a fuse in the plug. Note also that Forbes Jackson appears never to change his allegiance to the 30A ring and only briefly from the fused plug to the fused socket whilst Jacobi does so change. We will see later on in an article in the Electrical Review, he has slightly modified his views.

5.5 Meetings of EISC and its Panels

5.5.1 At a meeting of EISC, on 5 August 1943, consideration was given to estimates produced by EA Mills (Incorporated Municipal Electrical association, IMEA) who had prepared costs for the proposed post-war installation and the pre-war; he claimed that the ring circuit showed a thirty per cent reduction in cost.
On 14 October 1943, the EISC had a very extensive discussion on the question of supplying appliances from ring circuits and agreed, before moving on to considering plugs and sockets, that "the ring circuit is a desirably and acceptable development".

5.6 Amberton's article

5.6.1 In their issue of 29 October 1943, the Electrical Review published an article by R Amberton (a Director of Dorman Smith) which was one of, if not the first revelation to the technical public at large (as opposed to the IEE Installations Section) of the discussions which were going on in the committees.

5.6.2 The article said that, in order to keep down costs in a small house, there would be only three circuits which would include a ring, rated at 30As, for sockets. The articles goes on to argue for the fused plug with which this section is not concerned.
The publication of this article in the Electrical Review generated considerable correspondence, much of which re-iterated the arguments being heard in the various committees and panels.. On 19 November 1943, B Raynor wrote that the proposed ring and fused socket did not go far enough to meet the demand for a really comprehensive installation in "working class homes" and suggests, surprisingly a 3.036 (1.93mm^2) (10A) ring. This might be thought to be a misprint for 7.036(4.5mm^2) as later in the letter he proposes that it should be fused at 25A but short circuit only protection might have been envisaged. Why this should be thought to be better than a 30A 7.029 (2.93) ring is not clear, and is typical of muddled thinking by correspondents.

5.7 Jacobi's article

5.71 On 31 December 1943, E Jacobi, one of the authors of the IEE paper (see Section 5.4) wrote an article for the Electrical Review on the domestic ring main. The Electrical Review in an editorial claimed that they had called for a ring in 1938 [they did not; see Para 4.1.2] and applauds Jacobi for advocating the ring, for his 'Rule of thumb' methods of calculating the load on a ring and supporting the view that large loads should be supplied from independent circuits. The editorial declared that the ring allows flexibility and, importantly, that departures from existing practices are more likely to be accepted under wartime conditions.

5.7.2 In his article Jacobi says that the ring main had received considerable publicity. It is not entirely clear where this publicity was to be found, and it may be that rather than publicity in the form of publications etc, Jacobi means that the concept of the ring circuit had been discussed by committee members (in spite of confidentiality re-quirements), and discussions had taken place within such forums as the Electrical Contractors' Association.
Jacobi was quite clear that the ring circuit must not be developed in isolation from industry and the techniques to be used in the installation of ring circuits must be agreed. He acknowledges that a ring circuit is a departure from existing practice and goes on to discuss the question of diversity.

5.7.3 Diversity was allowed to be taken into account in the 11th Edition of the IEE Wiring Regulations, even if, as far socket outlets are concerned, the individual requirements prevent any real advantage being taken of it. Jacobi points out that there is diversity between room and room and between outlets in each room. The concept of diversity would be compromised if heavy loads such as cookers or water heaters were

permanently connected to rings [modern thinking, of course, takes account of the diversity provided by thermostatic control of water heaters and other appliances].

He points out that the 11th Edition of the Wiring Regulations was based on the concept of lighting socket outlets and of heating sockets outlets and that this concept was detrimental to the increased use of electricity because it was assumed that if there were four 15A sockets (for convenience) then these were treated as four 15A loads, but four 3kW fires in a single room is impracticable.

He describes how the new method relates the load on the circuit to the total heating load of the building and bases his calculations on one watt per cubic foot [a change from his IEE paper]. He stated that a 7.029 (2.93mm^2) ring loaded at 15A both ways can supply 6.9 kilowatts which, based on his one watt per cubic foot premise allows for a house of 6,900 cubic feet; with a nine foot ceiling, Jacobi calculates that this allows for 750 square feet. He then factors in the stairwell and calculates that one 30A ring will supply a 1,000ft^2 house. It is now clear where 1000ft^2 or 100 m^2 comes from.

5.7.4 This limit falls in well with a convenient size of cable, existing terminal sizes and capacity of fuses for convenience and safe protection. 7.036 (4.5mm^2) cable is too stiff and the terminals are not suited to it. 7.029 (2.93mm^2) cable is rated at 20A, (before the war it had been rated at 15As) which allows some spare capacity if the load is not balanced uniformly around the ring, which it clearly on occasion will not be.

5.7.5 Below is a diagram copied from his article which shows some of the ground floor sockets as spurs (which somewhat defeats the object); the rest are on a figure of eight circuit, which Jacobi says is quite acceptable. He says that spurs should not dominate and suggests that a spur might feed 250 ft^2 as part of the 1,000 ft$^{2;}$ this would equate in a 1000ft^2 house to two rooms .

This is thinking which was clearly lost somewhere along the way between Jacobi's article and the 1946 supplement to the 11th Edition of the Wiring Regulations.

5.7.6 He emphasises that there is no limit to the number of sockets. He discounts of possibility of feeding the lighting from the ring because of the danger of losing all light [somehow forgetting that with fused outlets this is unlikely]. Another objection to this which he raises is that some sort of fuse connecting device would be needed, the spur box at that point not having been invented. He gives a table of installation materials which he says indicates that the ring is cheaper.

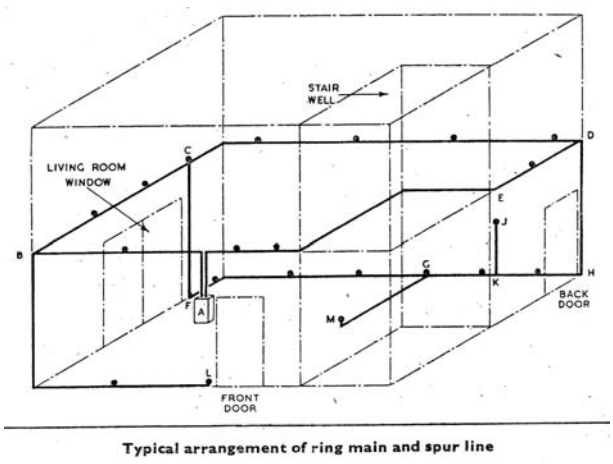


Figure 7 Jacobi's proposals for ring circuits
Electrical Review 31.12.43

5.8 EISC and Panel meetings

5.8.1 Shortly after the publication of this article, the EISC, in considering its draft report to the DPWP agreed to incorporate a paragraph prepared by the Chairman, JR Beard, on room circuits as an alternative to ring circuits, although the Panels and the EISC had seemed up to then to be solely in favour of the ring. It was reported that it was proposed to incorporate a room circuit into a demonstration house to be built. It was thought by EISC that the paragraph did not fully state the case for room circuits, but the paragraph was allowed to go forward.

5.8.2 Ten days after this decision a in a letter to the Electrical Review of 14 January 1944, AJ Heelis, a City Electrical Superintendent, demanded proof to show that a ring circuit is more economical and reliable; he proposed the room circuit with a 15A fuse feeding a number of sockets in each room; although in order to comply with the IEE Regulations, 23.0076(0.65mm2) flex would be needed to feed such things as table lamps. Heelis says that this was not usually done at the time but that there was no trouble with the 14.0076 (0.39mm^2) flex used [thereby demonstrating that, in practice, overload in appliance was not a problem]. His proposal was that adjustments should be made to the existing systems rather than going for a radically new system.

5.8.3 A week later Forbes Jackson, who was a strong proponent of the ring circuit and by now the fused plug wrote to the Electrical Review supporting Jacobi and saying that the present wiring system and plugs were not satisfactory and the interests of the consumer must be paramount. In the same issue, A Milne of Edinburgh agrees with Heelis that the first move should be an improvement of the present methods and suggests that poor workmanship would lead to be disaster with the ring circuit. He believed in individual 15A circuits and 5A outlets for lighting.

5.8.4 Correspondence in the Electrical Review rumbled on with those who wished to stay with existing methods being countered by Amberton and Jacobi who were strongly in favour of the ring circuit. Those in favour of existing methods claimed amongst other things that the ring main was easily tapped by an amateur (why a 15A circuit could not be interfered with by the amateur is not clear). Milne wanted the present standards to remain but, if somebody could think of a cheaper method to achieve the present standards with efficiency and safety then he would approve.

5.8.5 On September 1st 1944, the Electrical review published a letter from Newton Davey, who had demonstrated a fused socket to EASC in April 1994 although he is not listed as a BEAMA representative in the minutes.
In his letter he said that the question of interchangeability was obscuring the need for numbers; an interchangeable plug was no use if there were insufficient sockets; he then used this to advocate a room ring installation in which it seems to be suggested that if there are sufficient 2A,5A and 15A sockets a new interchangeable plug was not needed.

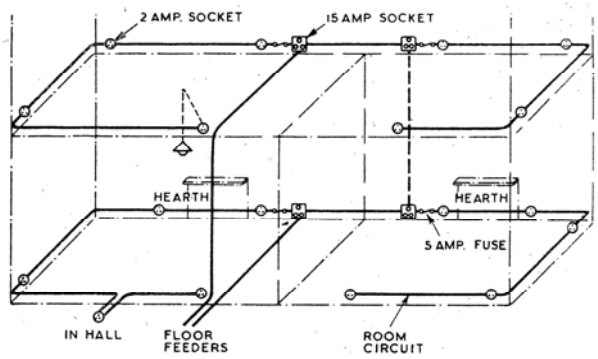


Figure 8 Newton Davey's proposal.
Electrical Review

He had a point worth considering but he was too late and it was not taken up.

There were some bizarre proposals including, in November 1944, that from E Williams in Cornwall proposing ring main wired in 7.064 (14.28mm^2) or equivalent MICC feeding a five-way distribution board in each room. The ring would be fused at sixty amps.

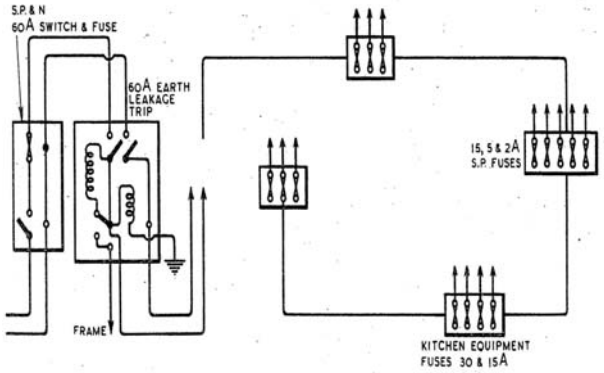


Figure 9 Scheme for post-war house Electrical Review

With this the correspondence in the Electrical Review dies.

5.9 The Housing Manual

5.9.1 On 2 February 1944, (before the EISCs Report had been sent to the Minister) the first draft of the Housing Manual was produced; this seems to be a joint publication with the Ministries of Housing and of Health, the Ministry of Health having previously had responsibility for housing. It is clearly based on the concept that the house would be heated by solid fuel but it refers to "rings" and room circuits, suggesting that a ring will provide different facilities such as radios, vacuum cleaners, standard lamps etc.

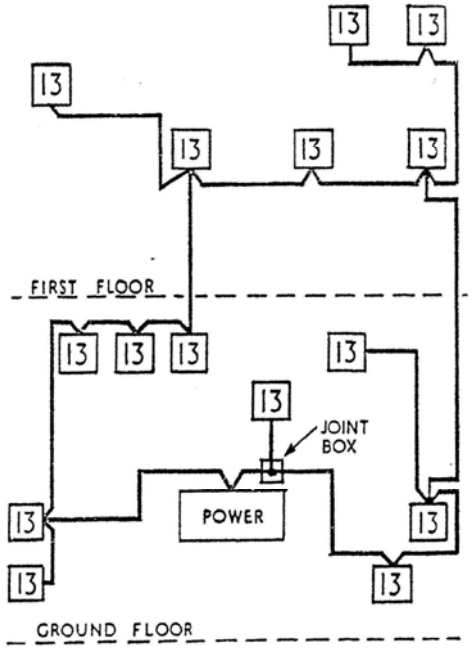
5.9.2 It says that recent developments, presumably a change in tariffs and the development of the concept of the fused outlet have made it possible to combine such lighter load facilities with facilities for room heating, this being achieved by the installation of ring circuits or room circuits.
In early drafts from March to May 1944, ten 10A sockets are recommended for a house of 760 –800 ft^2, variously disposed throughout the room ; none was listed as being in the bathroom , although they were allowed by the 11th Edition. By the time that the Manual was published in September 1944 references had changed to 13A outlets, with 12 in a house.

5.9.3 A draft specification in Appendix H in the Technical Appendices to the Housing Manual, published as a separate document in February 1945, refers to one lighting circuit, one 30A ring circuit feeding all the sockets in a house, or 15A room circuits feeding three sockets, the rating of which is not given.
The published version of the Appendix reads *"A B.S. is at present under consideration for a Standard all-purpose socket of 3kW rating for general use in all domestic installations. Until this socket outlet becomes available 5A and 15A sockets are to be used*", but it does not say whether this is with the old method or with a ring or room circuit. Room circuits fused at 15A would have been safe.
What is significant is that that the Appendix says that, as an alternative to a ring circuits serving all the sockets, *'room circuits feeding all the sockets in a room or in adjacent rooms, protected with a 15A fuse'*; bearing in mind it is effectively discussing one floor (of two) in a house of just under 1000ft^2 this is very close to what IEE Guidance has allowed since 1998, that is to say a 20A radial supplying unlimited sockets in 50m^2 (see 12.1 below)

5.9.4 When the manual was finally sent to the printer it read *"the IEE Regulations should be followed where possible but any variation in favour of room or ring main circuits would probably be accepted by the local supply authority who should be consulted."*

5.9.5 The Housing Manual was produced by the Ministry of Housing. The Ministry of works produced

in 1957 a Technical Note No 4, Ring Circuit; Electrical installations for housing.. Its theme is 'More sockets, less wiring' and it is a concise review of the advantages of the ring circuit, comparing it with pre-war practice and illustrating schematically how a ring circuit may be disposed round a house , with its spurs.
Its production some eleven years after the 1946 Supplement to thee Wiring Regulations may suggest that the ring circuit might not have been catching on as quickly as the MOW would have wished; this seems to be countered by the fact that by 1948 D&S alone had sold about a million of their 13A Plugs



Typical ring circuit
Figure 10 Ministry of Works Technical Note 4 © HM Stationery Office

5 10 EISC
5.10.1 The last reference in the minutes of the EISC, prior to the whole matter being handed over to the IEE for the preparation of amendments to the Wiring Regulations is of a meeting on 27 November 1944 where BEAMA had costings which suggested that what they called a ring room circuit, that is to say a 30A house ring with a 15A fused unit in each room with four 15A unfused sockets would be cheaper. The committee was willing to discuss room circuit proposals but seemed to feel that BEAMA was dragging its feet and asked where were the designs for the 3kW plug and socket.

Where, indeed, was the 3kW plug and socket?

6 The Plug and Socket

6.1 Uprating of the 5A BS 546 plug and socket

IEE Panel E
6.1.1 Panel E of EISDC was told on 28 August 1942 that their Preliminary Statement had been considered by the EISDC which had decided that the recommendation for a single 10amp socket outlet and plug should go forward; at the same meeting they considered the possibility of developing a plug incorporating a cartridge fuse. This is the first reference to a single, that is universal, socket outlet and plug and to the fused plug.

6.1.2 The panel agreed that their recommendation should go forward to EISC, which by then had been set up, and it was incorporated into the Draft of the Report (Post war Building Study11) from the EISC to the Directorate of Post War Planning. EISC had accepted the idea of a ring circuit but had not said that a fused outlet was essential but only recommended that fused plugs should be used.

FHBBH
6.1.3 The FHBBH Panel, on 3rd September 1942, recommended that the draft report should refer to flat pins as well as round, flat pins being very successful in the United States. They considered that the shape of the pins was immaterial to the consumer, the important thing being that the gauge should be universal throughout the country. They recommended that the question of 'closer standardisation of socket outlets and plugs' should be referred to BSI and/or to the Standardisation Committee of the Directorate of Post-War Planning

6.1.4 In December 1942 FHBBH demanded that the draft should be amplified to say that the use of a fuse or fused plugs was essential as the proposed ring circuit would be fused at least 30As. At this meeting two samples of 10A fused plugs using existing 10A standard pins and centres were presented by EA Mills of IMEA. It is not clear what standard this might be; the current three-pin standard BSS 546 did not include a 10A rating and it is also unclear what fuse was contemplated. It is possible that the pin diameter and the spacing of the live and neutral pins was based on the 10A BSS73 plug and that the fuse was BS646 which had a maximum rating of 5A. Beswick did not show his 10A fuse to EASC until April 1944. (See 6.1.36)

The Panel considered the plugs to be objectionably large and, in addition, the Secretary reported the comment from the SHISDS, of which Forbes Jackson was Chairman, that a fused plug was unacceptable because of the danger arising from the blowing of the fuse when it was inserted onto a fault, although there is no reference in the minutes to this comment. This suggests that at this stage, the SHISDS was considering a rewireable fuse in the plug.

6.1.5 FHBBH held a long discussion and concluded that small domestic installations would need plugs with replaceable fuses rated at 1A, 5A and 10A; however, concern was expressed that this was over-complicated and would defeat the objective of convenience and flexibility. The matter was referred back to the appliances sub-committee to obtain the views of the manufacturers as to how a compact and safe design might be achieved. (The puzzling thing here is that the

first meeting of the Appliances Sub-Committee was not held until 3 weeks after the meeting of FHBBH).

6.1.6 At the next meeting a fortnight later, the Secretary of FHBBH produced samples of fused plugs, There is no indication as to what these plugs might have been, but they may have been those produced by Mills.
After some discussion, the panel then decided that the Appliances Sub-Committee should consider the provision of 2A and 10A fuses (rather than the 1A, 5,A and 10amp previously agreed) and that these which would be non–interchangeable, that is to say that there would be 2A and 10A plugs. The Panel also agreed to recommend that appliances should be sold complete with the appropriately fused plugs, the rating of the fuse being marked on the plug. It took some fifty years for a requirement that appliances be sold with a plug attached to be introduced.

EISC Sub Committee on Appliances
6.1.7 The Sub-Committee on Appliances met for the first time at the end of December 1942 and considered the recommendations in the first draft of the Report and the minutes of the earlier meeting of FHBBH. They agreed to having two identical fused plugs, with the same pins and spacing, but with the fuses not to be interchangeable. It was decided to consult the manufacturers about this. They also agreed that appliances should be sold only with plugs attached.

6.1.8 They determined not be recommend the uprating of the 5A BS546 plug until it was sure that a reasonable small fused plug based on the BSS546 5A could be produced. Forbes Jackson was in no doubt that the BS546 5A socket outlet and plug would be capable of carrying 10A effectively; this was before he had asked DS and other manufacturers to produce a fused plug.
There was some doubt as to whether a 10A fuse could be accommodated within the plug without an unduly large cumbersome and unattractive article being the result. The BEAMA representative on the sub-committee, V Watlington, was asked to ascertain from the appropriate section of the BEAMA Accessories Section Committee:

1. Whether the committee were of the opinion that the standard 5A three pin plug could safely be used for normal current carrying capacity of 10A.
2. Whether such a 5A plug uprated to carry 10A could be make to accommodate in the head a 10A fuse (and as a alternative a non-interchangeable 2A fuse) without being too large, unwieldy or unsightly.

6.1.9 Forbes Jackson said that if the 2A fuse could be omitted and a 10A fuse used for all purposes, it would be much better to arrange for such a fuse to be accommodated in the socket outlet and not in the plug. Forbes Jackson later became a keen advocate of the D&S fused plug; it is not clear when he changed his mind and why.
JI Bernard of the Electrical Development Association (EDA) suggested that as the whole question of socket outlets and plugs was being considered *ab initio* that some consideration should be given to the desirability of standardising a flat pin plug instead of the then standard round pin plug.

6.1.10 By time of the meeting of the Electrical Appliances Sub-Committee held in February 1943, (Forbes Jackson in the chair), the replies from BEAMA had been obtained. In answer to the first question as to the uprating of the 5A plug, BEAMA replied that a 5A socket could not be uprated to 10A because of the characteristics of the switch. Forbes Jackson said that the EISC had realised this but as the use of switched sockets was not visualised in small domestic premises, in his opinion this had no bearing on the main question. The Sub-Committee sup-ported the view that shuttered un-switched socket outlets should be used in new post-war houses.

6.1.11 BEAMA then reported that, setting aside the question of the switch, a 5A socket could be safely uprated to 10A. As to the question as to whether an uprated 5A plug could accommodate a 10A fuse, the answer from BEAMA was that the 5A plug could certainly be made to accommodate a 5A fuse (presumably BS646) but could not be made to accommodate a 10A fuse having regard to safety and manufacturing considerations. What these considerations were was not recorded. The 10A fused plug was considered unsound and BEAMA strongly recommended it should not be adopted.; the Sub Committee concurred

6.1.12 The question of placing the 10A fuse in the socket outlet as an alternative was then considered. BEAMA were of the opinion that there would be a number of difficulties with such a system and the committee finally left the matter with a tentative agreement that the 5A plug would be uprated to 10A and would be produced in two varieties, one unfused to supply 2kW fires and the other containing a 5A fuse for smaller appliances.
The decision could only be finalised after tests had been made by the Electrical Research Association to confirm whether a 30A fuse was adequate for the protection of 70/0076(1.93mm^2) flexible cord and whether 23.0076(0.65mm2), 3A rating, and 40.0076 (1.10mm^2) 5A rating flexible cords could be protected by 10A fuses. Present day thinking can only be that ERA were testing for protection against short circuit, but it is clear that not all the Committees and Panels understood this

6.1.13 The Sub-Committee was somewhat puzzled by a paragraph in the BEAMA report which had been presented to them (not to hand); it seemed that the BEAMA Accessories Section Committee did not understand the actual function and form of the ring

circuit but, in the absence of the report, it impossible to say in what way.

6.1.14 As to the question of flat pins, BEAMA did not think that there was any useful purpose in re-opening the question and the Sub-Committee agreed.

EISC

6.1.15 The above answers were conveyed to the EISC at a meeting on 14 March 1943.

The IEE paper

6.1.16 The IEE paper of 11th March 1943 (see 5.4) did no more than refer to the desirability of standardising a 10A socket with the possibility of fusing.

However, discussion was provoked which affected much of what was said in correspondence in the Electrical Review. Some people liked the fuse in the plug but were thinking in terms of a rewireable fuse or were worrying about the dangers arising from the fuse's (even a cartridge fuse) blowing on insertion. Others were concerned that if there were a number of ratings of fuse, that the wrong one would be inserted and that, even if they were interchangeable, the wrong plug would be fitted. One contribution to the discussion, even went so far as to suggest that if putting a 10A fuse in a plug was unacceptable, then it would be possible to rely on a 30A fuse, saying that 70.0076(1.94mm^2) flexible, rated at 10As could safely carried 30As for four or five hours within exceeding 80^o Fahrenheit. This is undoubtedly true; in the 14th Edition of the IEE Wiring Regulations, was rated at 18A for a running temperature of 70 ^{o}C. Whether it was thought that this would happen only in the unlikely case of overload is not clear. No reference was made to short circuit conditions.

6.1.17 It is quite clear from the minutes of discussions in the Committee and elsewhere that even experienced engineers did not have a clear understanding of fuse protection of conductors, thinking in terms usually of overload and not of short circuit rating. Associated with this was a lack of understanding of breaking capacity and energy let through and indeed of prospective short circuit current.

Sometime in 1943, internal evidence suggesting that it might well have been in March of that year, Forbes Jackson had asked Dorman Smith whether they could design a domestic all-purpose fused plug.

As was later recorded by Richard Amberton, one of the Company's directors, "*at that time we did not know the recognised makers of plugs and sockets had already been approached for the same object but without practical results. As soon as it became known that we had succeeded in producing such an article, that it had great merit, we discovered that we had run into a hornets' nest*"[3]

Dorman Smith did not design the plug at the behest of Forbes Jackson. It had in fact been designed earlier. Patents were applied for in March 1943 for "*improvements to electrical connector plugs"* and in the following month "*for improvements and relating to high capacity cartridge fuses"*. These patents were related to the fused plug which had been conceived by the company's Chairman, Thomas Atherton, who was not an engineer. He carried out the first experiment on the cartridge fuse himself because the Company at that time could not afford to take on extra engineers.

When Forbes Jackson asked Dorman Smith, and as it transpired other companies, to design a fused plug, Dorman Smith had already done so. The novel feature of the plug was formed by a cartridge fuse, the body of which was made with the company's new high strength ceramic "Alorite".

This construction overcame many of the objections which were raised concerning the concept of the fused plug because the fuse could only be changed when the plug was withdrawn and therefore isolated and because there was no risk of danger if the plug were inserted onto a short circuit because the fuse was high-rupturing capacity, being able to break a prospective short circuit current of thirty thousand amps d.c.

Figure11 The Dorman Smith plug

Amberley collection

EASC

6.1.18 The Electrical Appliances Sub Committee remained unable to make up its mind. At its third meeting in May 1943, it considered a test which had been done by Forbes Jackson who had overloaded flexes by four times their rating and concluded that a rewireable fuse would blow before the flex caught fire. It should be remembered that these were rubber flexes, in which the problem is the general deterioration of the rubber rather than the de-centralisation of the conductor or even melting of PVC insulation.

Forbes Jackson put to the Committee the question as to whether all plugs should be fused or only the (now) 5A fused plug, the problem being space for the fuse which probably could be overcome by making one of the pins a fuse which, of course, was what was done in the Dorman Smith plug . It will be recalled that Forbes Jackson had advocated the fused socket in December

1942, but by now DS had produced their socket and Forbes Jackson showed the Committee a model of the Dorman Smith plug.

He became a keen exponent of it, but does not seem to have declared his interest in the DS plug and socket. The fate of the DS fused plug is discussed in the section on the development of BS 1363.

6.1.19 Forbes Jackson had tested 70.0076(1.93mm2) 10amp flexible cords which appeared to carry 30As indefinitely without serious deterioration and the Committee now reverted to a previous proposal to have an unfused plug with 70.0076(1.94mm2) flexible cord for supplying a 2kW fire fed from a ring circuit having a 30A fuse and a 2A fused plug for appliances fed through 23.0076(0.65mm2) flexible cord.

6.1.20 Forbes Jackson reopened the discussion by revealing that the Incorporated Municipal Electrical Association had expressed an opinion in favour of a completely new 10A plug as an alternative to uprating the present 5A plug. While this would mean going back on the Sub-Committee's previous decision, he thought that this could not be disregarded and received support from other members of the Committee who stressed that the most important factor in the decision to the taken on the point of the plug was the convenience to the user.

6.1.21 JI Bernard took the Committee right back to the beginning again by questioning whether there were any advantages in the ring circuit as opposed to the then normal system of one socket outlet circuit for each room. He agreed with the desirability of having a single standard socket outlet but disagreed that the plug should be fused on the grounds that when spare plugs (sic) were not available then users would attempt to re-establish the supply by connecting the fuse clips together or, if he had an unfused plug of the same gauge, or if he had an old plug available, he would use that.

With this in mind Bernard made a proposal that the fuse should be in the socket, but replaceable without taking of the cover plate, the 5amp plug should be uprated to 10A and under no circumstances should the fuse be in the plug.

The Appliance Sub-Committee agreed to ask for BEAMA's views on this, in addition asking for the fuse to be arranged for insertion in a socket without the removal of the front plate and to be incorporated in a Bakelite holder which could be screwed into the socket outlet. In that case, the 5A standard three-pin plug would be uprated to 10A and fuses would not be accommodated in plugs under any circumstances. Forbes Jackson seems not to have spoken against this, although in May he had been advocating the DS plug.

6.1.22 At the next meeting in July 1943, Forbes Jackson presented a document which he had prepared (not to hand) in which he showed in tabular form all the proposals that had been made previously. Following discussion, the Committee decided to reiterate their decision that a 10A fuse should be accommodated in the socket outlet and not in the plug, and that the only plug in use would be the present 5A BS546 uprated to 10A They slightly amended their decision in so far as it was agreed to ask BEAMA for their views on the design and manufacturing questions involved, but leaving it up to the manufacturers to consider accommodating the fuse in the socket outlet in such a way that the front plate would not need to be removed to change the fuse. The Committee recognised that such a socket outlet would be more expensive. They also agreed to advise the EISC that they could see no objections to the use of an adapter for the fused socket outlet which would enable a two-pin BS plugs to be inserted for standard lamps etc, this at a time when two pin plugs were not allowed by the IEE Wiring Regulations; it may be that the Sub-Committee had in mind the large number of two pin plugs in use.

EISC

6.1.23 On July 27th 1943 the discussion transferred back to the EISC which noted the recommendation for fused socket outlets. They also noted that IMEA now took the view that flat pin fused plugs should be adopted, these being in existence with a fuse, (thought to be the Wylex plug) but were not reminded that the Appliances Sub-Committee had agreed in February that the flat pin did not need to be considered further and that they had accepted this view. The EISC were at this time being pressed very strongly by the Directorate of Post-War Planning to submit their final report and were meeting at weekly intervals.

6.1.24 Forbes Jackson said that a fuse capable of clearing thirty thousand amps at 250 volts d.c. had been developed (possibly by DS) and that this could be incorporated in a fuse plug with no danger or inconvenience to the consumer.

He was of the view that the Committee would be unwise to recommend the adoption of a fused socket without having an example of what might be produced. It should be remembered that Forbes Jackson, apparently unbeknownst to the EISC, had asked Dorman Smith and other manufacturers to produce models of a fused plug and that he had shown EASC a model DS plug; he did not refer to this at this meeting of EISC.

The BEAMA representative took the view that, from the point of view of the consumer, any change from the present standard would be most undesirable.

6.1.25 The Committee was being pressed for its Final Report and therefore determined not to make any recommendation as to socket outlets and to report that the matter was receiving consideration and that they would submit a Supplementary Report, which they later did.

At the next meeting (four days later), the Committee considered a short memorandum which summarised the methods before the Committee. These were:-

> "A. Two standard plug tops for the up rated 10-ampere B.S..S. three-pin socket, one accommodating a 5 ampere cartridge fuse and,

the other without a fuse for loads between 5 and 10 amperes.
It is proposed to regard the circuit fuse as sufficient protection for the latter

"B A redesigned 10-ampere plug, possibly of the flat pin type, containing a 10-ampere cartridge fuse. There would be only one plug for all apparatus consuming l0-axnperes or less.

"C The retention of the B.S.S. 5-ampere three-pin plug (up rated to l0-ampe:res) without change and the redesign. of the socket-outlet to accommodate a 10-.ampere cartridge fuse."

The Committee decided that no further consideration need be given to Method A, but that they would consider the relevant merits of B & C when a satisfactory design for the fused socket had been produced, which was thought to be shortly available.
.

6.1.26 At a further meeting of the EISC on 28 September, it was reported that, the previous day, the EASC had examined the fused socket and had disagreed. This disagreement was eventually included in the draft Report:-

"A substantial majority of us…recommend that the British Standards Institution should be requested to undertake the preparation of a new standard specification for a 10 ampere fused, shuttered socket- outlet and plug with round pins of spacing and dimensions conforming to B.S.S. 546 and incorporating the other design requirements to which reference has been made.

We had hoped that it would have been possible to make this recommendation unanimously, but a minority of us wish to postpone a decision until alternative designs and models of the proposed up-rated 5 ampere socket -outlet and of new 10 ampere socket outlets and plugs can be made available This minority attach less importance to the principle of the adaptation of an existing standards and feel that a better design both technically and economically might be produced if present standards were ignored."
.

It was agreed that a future meeting of the EISC which was hoped to be fully representative would discuss this report with the view taking a final decision.

6.1.27 This meeting took place on 14th October 1943. It was a long meeting. The EISC agreed that they had got as far as this:-

a) That the ring circuit is a desirable and acceptable development.
b) Standardised 10A shuttered socket outlets and plugs should be provided on the ring circuit.
c) A cartridge type fuse rated at 10As should be provided at each outlet position for local protection.

The question was would this be in the socket or in the plug?
The Committee commenced by considering flexible cords and recollected that they had agreed that flexible cords smaller in size than 23.0076(0.65mm^2) should not be used but that a 10A fuse would protect a 23.0076(0.65mm^2). The Committee then agreed that the recommendation regarding the minimum size of flexible cord for domestic use should be referred to the IEE Wiring Regulations Committee, with a proposal that it should be incorporated in the proposed Basic Safety Regulations (See 11.2).
They went on to discuss the standardised 10A shuttered socket outlet and plug ((b) above). They agreed that the 5A socket outlet BS546 could be safely uprated to 10A.
The BEAMA representative was of the opinion that because about one million dwellings have at least part of an installation equipped with 5A socket outlets to BS546, the interests of consumers could best be served by the proposed uprating; and that the Report of the EISC might have a permissive clause requiring that existing non-standard plugs might still have to be used in areas where their use had been established.
The incorporated Municipal Electrical Association representative pressed for a British Standard for flat pin plugs to suit the requirements of certain areas where they were in general use, (probably Wylex) referring to the questionnaire circulated by the Lancashire Electrical Power Company in which seven out of thirteen undertakings had expressed a preference for flat pin plugs which he said was now supported by the Electrical Development Association. From the way in which the Minutes are written it would seem that this received a cool reception as it would being based on one manufacturer's product.

The EISC decided that because so many new installations would to be required in the post-war period, the retention of any existing standard was not justifiable on the grounds of interchangeability of old plugs in new sockets and they agreed that they were free to recommend an entirely new standard. The alternatives were summarised as:

i. A 10A shuttered socket outlet and plug with round pins in accordance with BS 546 uprated to 10A.
ii. An entirely new standard 10A shuttered socket outlet and plug with round solid pins.
iii. An entirely new standard 10A shuttered socket outlet and plug with flat pins.

It was agreed that earthed metal (i.e. overload was not a problem) would require a fuse at the outlet but the Committee were still divided as to whether it should be in the socket or the plug. As an answer to point (ii) above, Forbes Jackson placed before the Committee a new design of fused round pin plug, quite clearly the Dorman Smith plug. (Why he had previously produced it to EASC and only now to EISC is not clear).

This was thought to be an attractive possibility as there were fewer contact points than with a fuse in a with-drawable carrier. The Committee agreed that a plug on the same principle but with flat pins might be devised to meet (iii) above and that a clip-in fuse might be provide for either (ii) and (iii). The idea of selling fused and unfused plugs was rejected. It was decided that the Chairman and the Secretary would produce draft paragraphs for inclusion in the report.

6.1.28 At the next meeting held a fortnight later, the paragraphs were considered and agreed. These were of a holding nature and the Committee decided that their final recommendation should be made in a supplementary report at a later date. They also asked the EASC to prepare a draft for the supplementary report, and to consider the designs and models of various alternative socket outlets and plug arrangements. Two manufacturers were to be invited to the next meeting of EASC

Amberton's paper

6.1.29 At this time R Amberton, a Director of Dorman Smith, wrote an article published in the Electrical Review at the end of October 1943, advocating a new plug and socket, countering the argument that the new tooling would be expensive by saying that modifications to the existing tooling would be no less expensive. He was of course putting forward the Dorman Smith plug with the screw-in fuse.

The flavour of the comments on tooling suggested that manufacturers of plugs and sockets to existing standards were reluctant to adopt a new design; whether or not Amberton is right that it would be no more expensive is never determined but his contention seems reasonable.

Correspondence about Amberton's article

6.1.30 The article by Amberton generated enormous correspondence; there was clearly a great deal of interest in the industry about what was happening.

Many of the arguments raised in the Committee and Sub-Committee were raised in the correspondence. There were however, one or two other interesting points raised. Firstly, FE Ryder pointed out that you cannot protect every small-current device with a fuse, you can protect only the flex against short circuit and a 10A fuse would protect a $23.0076(0.65mm^2)$ if of a suitable design.

E Crisp proposed a separate fuse component between the socket and the plug, only one or two of these being needed per house; it should be noted that he proposed double-pole fusing.

B Raynor raised the point that if an amateur was likely to insert the wrong fuse, then they were quite likely to connect an appliance to the wrong plug. B Raynor also raised the question of whether the fused would pin break off and be left in the socket.

FB Phillips believed that going from 10A from 15A was a retrograde step and also pointed out that two kilowatts would be inadequate and a 10A plug would restrict development of larger appliances; he was later vindicated.

EISC

6.1.31 At the next meeting on 5th November 1943, the paragraphs arranged to be produced were before the Committee and were agreed to represent the views at the previous meeting. However, the Chairman had seen fit to produce a draft for inclusion which concluded that a 10A BSS564 plug in a fused socket should be adopted as a new standard.

Members were to consider both proposals and submit postal votes, two-thirds to approve, after they had discussed the proposals with their organisations. There is no record of any discussion in the IEE.

6.1.32 The Committee met again on 17th November 1943. The draft paragraphs had once again been amended, the alternatives being to defer the final recommendation or to recommend a 10A BSS564 fused socket. There is a flavour of the Chairman or the Secretary being in favour of the fused socket.

It was reported that the second alternative had received 12 votes as against 6 for the first.. Forbes Jackson protested vigorously and said that he would submit a Minority Report if a fused socket were to be recommended, saying that, because not all members of the Committee had voted, the vote was not representative.

In his opinion, the whole matter might be left to the Codes of Practice Committee (which had held its first meeting a week earlier). It was reported that a large majority of manufactures favoured the fused socket. There was a long discussion and it was decide to recommend a 10A BSS546 fused socket, the recommendation drawing attention to the Minority Report. In the event there was no Minority Report, the views of the majority and of the minority being reported in the main report. A supplementary report was submitted in June 1944 in which the 13A plug was proposed.

6.1.33 A meeting was held early in January 1944, to sign off the Report to the Minister. The Committee did not meet again until June 1944. But at January 1944, it was all decided: it was going to be a fused socket.

Forbes Jackson Article

6.1.34 The Electrical Review published an article by Forbes Jackson in their issue of 21st January 1944. He reiterated all the arguments raised in committee, making it plain that the argument in favour of the fused socket was driven by the agreed fact that a 10A fuse could not be accommodated in a 5A BSS546 plug although, he said, it was agreed that it would be better if the fuse was in the plug. He agreed with TC Gilbert who had proposed in earlier correspondence that the three plug flat pin solution was attractive but that a fused pin was necessarily round. He does not openly advocate the DS plug, but the thrust of the article is in that direction.

EASC

6.1.35 The EASC had not met since September 1943 when they had reported the division of views between

recommending a fused socket and waiting for work on uprating of the 5A plug to be completed.. (See 6.1.26).
They met on 2nd February 1944 at the request of EISC to give further consideration to this report. ERA had reported that the 5A BSS546 plug could be uprated to 10A but the heat from a fuse in the socket might affect the results to minor degree. It was noted that, with the submission to the Minister of the EISC's Report, the majority recommendation (for a fused socket) would go forward, eventually, to BSI. It was agreed therefore to review requirements on which manufacturers would welcome guidance.
The Committee examined two model fused sockets and agreed that a one hole solution was desirable. In spite of the ECA's strong opinion that the new plug should not be interchangeable with any existing, it was agreed that a BS546 10A pin spacing of the pins would be satisfactory and that if a 2kW appliance was connected to an existing 5A circuit (which would be fused at 15A), there would be no problem; based on the arguments for the ring they were probably correct.
Burnt out 5A switched sockets could be replaced with a new un-switched socket. It was agreed that the cartridge fuse must blow without danger to a consumer and that it must discriminate with the 30A fuse and the cut-out fuse.

6.1.36 EASC met again in April with five representatives from BEAMA attending. They considered a letter from the ECA who were adamant that the new plug must not be interchangeable with the old, on the grounds that large numbers would be in use and that the plug was likely to be universal and so should not be an old design uprated to the limit; it should not be possible to plug a two-kilowatt fire into an existing 5A socket.
BEAMA continued to press for the uprating of the 5A socket saying that more such sockets were in use than was generally appreciated, the pin dimensions having being established in 1928. Further consideration was deferred.
The Sub-Committee were shown, by K Beswick, a 10A glass tube cartridge fuse, which the Sub-Committee agreed was could be used in a fused socket.
Discussion then took place with and between BEAMA representatives on the best way for the fuse to be inserted in the socket. It was said that the cost of a fused socket would be two shillings and six pence ($12^1/_2$p) more than an unfused socket; this should again be compared with an electrician's wages of 1/6 (7.5p) per hour.
SJ Pearce of Scholes (Wylex) argued against circular pins and the triangular pin formation and said that the best solution was flat pin 10A socket to take a 10A fused plug and also a 2A fused plug, which would fit in a standard conduit box. He stressed that this was a simple and economical design which had been proved in practice.
R Amberton was at the meeting and circulated a memorandum concerning the DS fused plug and said that this one plug would accommodate a 5A cartridge fuse for small appliances or a 13A cartridge fuse for three kilowatt fires, the 5A and 13A fuses being of a different colour. This socket also would also fit in a conduit box.
This was the first time that there has been any mention of a 13A plug. It is not clear why Amberton had raised the question of a 13A rating when everybody else was still talking about 10A but 13A became a major factor in the discussions. In answer to questions concerning the breaking of the pin, Amberton demonstrated the strength of the pin on a small impact testing machine.

6.1.37 At the next meeting, on 1st May 1944, the representative from IMEA said that they considered that if there was to be a new design, then it should be a flat pin in a 'T' formation and provided a sample; it is not know what it looked like.
Miss Haslett of the Electrical Association for Women said that what was needed was interchangeable plug throughout the house and, if there was to be a completely new design, it was now or never.
The view was expressed that if the vote taken in the EISC on 1 November 1943 was taken now, it would be reversed in the light of the evidence that 5A fused sockets would add substantially to the cost of a domestic installation and that they could not be uprated to 13A.
There was no discussion of this point; a new design of plug must be developed.
Apart from agreeing that an uprated 10A plug and socket would not supply a 3kW load and, taking into account the views of the Electrical Contractors' Association, The Electrical Association for Women and BEAMA, the Committee now decided that a new socket with a fused plug should be considered, of 3kW rating with 5A or 13A fuses; they were not concerned about the section for the pins or the combination of sections, they were not concerned whether the fuse was in one pin or in the body of the plug, they only required that the contacts of the fuse should be inaccessible while the plug was inserted.
However, before taking a final decision, views of consumers and users should be ascertained. A questionnaire was to be prepared and sent to Electricity Suppliers via EDA and other organisations, although in fact it was sent only to EDA.

13A plugs
6.1.38 There is no clear reason why the emphasis had turned to 13A plug, but it several months had passed since the EISC Report had been submitted. What discussions had taken place and when the information that 3kW fires and wash boilers were used in small houses in the north of England and in Scotland had been received is not recorded, but it was probably generated by the publication of the Housing Manual (see 5.9)
Correspondence in the Electrical Review indicated that the Dorman Smith 13A plug was being used in a number of London Boroughs and it was clear that the fused pin was seen to have the advantage that nothing could be used in substitution. Some correspondents were objecting to any change from what was done at the time, some to the introduction of a new gauge, some to

the size and rating of the fuses and the flexes thus needed.
Only one correspondent pointed out that the fuse was there to protect against short circuit or earth fault, and the problem was not the load but the fault level throughout the domestic installation.

EASC

6.1.38 By July 1944, the replies to the questionnaire (6.1.37) had been received and the EASC considered that they concurred with the electricity suppliers that the present situation was unsatisfactory and that a standard all-purpose plug should be developed; the BEAMA representatives did not agree, and said that while the present set-up was not satisfactory, the use of existing 5A and 15A plugs could be extended to provide "an acceptable and effective solution".
The Committee rejected arguments that a new standard would produce "climax of confusion in the period eight to twenty years hence'. Various figures for the number of BS546 sockets in use were produced varying from 2.5 million to 7.5 million 5A with 7.4 million 15A in eight million dwellings.
On the other hand, if a new standard were produced, in ten years there would be forty million of the new sockets in use.
Forbes Jackson outlined to the Committee the reasons for the proposal to adopt 13 amps as standard and cited the ratings of existing wash boilers and radiators now in use in larger dwellings, it apparently being forgotten that the origin of the argument was that the new sockets should go only into small houses.
The whole Committee, including the BEAMA representatives, agreed that the fuse should be in the plug; although this would increase the size and cost of the plug that would be borne by the consumer and not by the authorities building the houses. Miss Haslet was silent on this.
The Committee noted that there was no clear majority for either round or flat pins and left the matter to the manufacturers. It was also noted that flat pins might not need shuttering and that flat pins seemed to have stronger technical arguments in favour; what these might have been is not said.. The Committee did not discount the prospect of a fused pin.

EISC

6.1.39 On the 21 July, the EISC appeared finally to have agreed, after some discussion involving all the previous arguments, that a completely new three-kilowatt socket outlet and fused plug should be adopted for all post-war housing. They agreed that BEAMA should be asked to submit the problems of manufacturers, noting that there might be a need for a joint discussion with the manufacturers. A supplementary report was agreed to be sent to the Minister.

6.1.40 On 27 November 1944 the twenty-fourth and final meeting of the EISC took place. BEAMA representatives had met the Chairman of the Appliances Sub-Committee and the letter from BEAMA concerning the discussion was circulated to the committee.
In effect, the majority of the BEAMA accessories section were not willing to accept the unanimous conclusion reached by EISC that "a completely new type of three kilowatt (230V) socket outlet and fused plug should be adopted as the all-purpose domestic standard.' They were worried that unless the new plug and socket became the standard for post-war housing, the Committee's recommendation would result in 'yet another standard amongst others'.
A letter from Sir Hugh Beaver of either Ministry of Health or Works, gave a reasonable assurance that the Ministry would specify where possible and foster and encourage generally, the use of the proposed new standard.
This had been confirmed with a recommendation of the "all-purpose three kilowatt socket outlets" contained in the Housing Manual 1944 which had since been published.
It was also noted that the Electrical Industry Committee of BSI had voted by thirteen votes to five in favour of a new standard as proposed (see 7.8). The Committee agreed that to reopen the whole discussion was now scarcely practicable.
The Committee noted that only BEAMA dissented from the idea of a new standard and that not all manufacturers held this view. It is thought that the minority were GH Scholes Ltd (Wylex), Dorman Smith Ltd and British Mechanical Productions Ltd who probably hoped that their design of plug would be adopted.
Emphasising that the convenience of the user was the criterion and that the views expressed by BEAMA were not strictly relevant insofar that no new facts had been produced which would justify reopening the matter, the Committee confirmed their decision unanimously.

6.1.41 Because the request had been sent to BEAMA for a design to be prepared for a new standard, additional representatives of BEAMA had been invited to the meeting and they entered the discussion. They were told that the decision to have a three-kilowatt standard fused plug was confirmed and were asked for their views.
The point was made by them that the EISC had changed its position between the issue of the main and supplementary reports (i.e. from 10A to 13A) and they believed that this was as a result of further evidence and they further believed that the possibility of further evidence might cause the Committee to change back..
There does not appear to have been any new evidence merely a reiteration of old evidence, although the BEAMA representatives declared that the room ring circuit using 15A plugs and sockets would be more economical.
There was considerable discussion and the Committee expressed their willingness to examine the ring room circuit but asked where the design for the new standard all-purpose three-kilowatt plug and socket was.
BEAMA representatives said a considerable amount of work had been done but labour restrictions had retarded

progress, but the BEAMA representatives undertook to produce alternative designs and to give full consideration to the use of flat plugs.

6.1.42 There were no further meetings of EISC; the matter passed to other bodies.

7 Codes of Practice, Wiring Regulations and Standards

7.1 It should be noted that the work of the COP and its Sub-Committee was being carried on while the EISC and it Panels and sub-committees were still meeting to prepare their Report; COP had accepted the decisions of EISC and sought to implement them, not to amend them.

COP

7.2 In November 1943, in anticipation of receiving the EISC's report (Building Study 11), the Codes of Practice Committee (COP) for the Electrical Equipment in Buildings was set up by the Ministry of Works. The main Committee was to have a number of Sub-Committees would be convened by the relevant Institution and would prepare Codes of Practice which would eventually be published by British Standards Institution.

The Codes of Practice were to define what was good practice in building and the IEE Regulations were to be Code of Basic Safety (perhaps like the present Part1) to which statutory authority would be given. It was clear that a distinction was seen between the safety requirements laid down by the Wiring Regulations and the Codes of Practice.

This would seem to be the reason that the COP General Considerations Committee (GCSC) proposed alterations to the Wiring Regulations; the Wiring Regulations Amendments Sub –committee did not meet until after the COP had finished it work.

7.3 COP had a number of Sub-Committees which included No 2 Wiring Systems and No 3 Utilisation. Neither of these appear to have met, being replaced by the General Considerations Sub Committee. GCSC

7.4 COP met again on 15 June 1944 noting that the EISC report (Building Study No 11) would be published before the end of July; the issuing of the questionnaire (6.1.37) was reported to the Committee.

GCSC

7.5 GCSC noted the contents of Building Study No 11, the acceptance of whose findings was not compulsory, but which seemed largely to have been accepted.

They considered the IEE Regulations 201 A to E making slight amendments to take account of the ring circuit and the fused plug, adding to 202 A the provision "*that b) the current rating of the fuse protected a ring circuit shall not be more than double the current rating of the cable comprising of ring and b) that the flexible cords are of sufficient cross-sectional area to be protected by the smallest fuse in the circuit to which they belong"*

In 1944 when the rating of 7.029 (2.93mm^2) was 20A this was implied the use of 7.029 (2.93mm^2) cable ; later Editions specified the use of 7.029(2.93mm^2). It was in the 14th Edition that the $^2/_3$ requirements for installations in high ambients was introduced; otherwise the 14th Edition required 7.029(2.93mm^2) to be used. In 202 B), GCSC introduced the requirement that "*where a plug and its flexible cord was protected by a 10A fuse*, the cord should be not less that 70.0076(1.94mm^2) and with a 3A fuse, the cord should be not less than 23.0076(0.65mm^2)"*

* The 13A fuse had not at that time reared its head

Meeting of Chairmen.

7.6 A meeting of COP Sub-Committee and Panel Chairmen met on 4th April 1944 to determine certain issues which included the GCSC recommendation concerning flexes and rather fudged the issue by deciding that a 10A fuse could protect 23.0076(0.65mm^2) but good practice called for 3A; they were struggling with the difference between short circuit and overload. The concept that an appliance will not cause an overload was not yet articulated, though the meeting's decision certainly reflected this.

GCSC and COP

7.7 At the sixth meeting of GCSC on 21 February, 1944 they agreed to delete the Wiring Regulations requirement that the fuse should not be in the socket because (at that time) it was envisaged that a fused socket would be an important part of an installation. The meetings between February 1944 and January 1945 did not discuss ring circuits or plugs and sockets; the only relevant discussion involved flexes which was re-considered by COP on 15th June 1944 when they confirmed that a 23.0076(0.65mm^{2}p) flex should be protected by a 3A fuse. Forbes Jackson had reported his experiments which showed that flexes could carry many time their rated current for some hours without catching fire but the committee accepted the view that, from the fire risk point of view, short circuit was more important.

BSI

7.8 On 20 December 1944, the Electrical Industry Committee of the BSI passed a resolution "*that an all-purpose socket outlet and plug rated at three kilowatts, 13A be standardised, the plug being fused and the socket outlet and plug being non-interchangeable with any existing standard for plugs and sockets or with the existing flat-pin plugs and sockets in use"*.

This resolution was noted and endorsed by the Wiring Regulations Committee and the Codes of Practice Committee.

GCSC

7.8 In January 1945, GCSC amended the existing Regulation regarding fusing of sub-circuits so as to allow spurs to be taken from a ring circuit, without a fuse provided that the spur cables were not of a smaller

cross-sectional area that those on the ring and that not more than two sockets should be connected to each spur.
We can see how the requirements for ring circuits are being developed. The committee also accepted that in a small house having a floor area not exceeding one thousand square feet, the number of socket outlets which may be connected to the ring circuit should not be restricted; for larger houses with a floor area exceeding one thousand square feet, the number of socket outlets connected to a ring circuit should not exceed twelve and where more socket outlets are required, a second circuit should be installed.
They laid down that fixed apparatus such as tubular heaters, water heaters and cookers should not be connected to the ring circuit, except when a corresponding reduction is made in the number of sockets on the ring circuit concerned, without laying down what that reduction was to be.

BEAMA continues to object

7.9 Although it might be thought that with the publication of the Supplementary Report and the Housing Manual the whole thing had been settled, BEAMA continued to fight against the introduction of a new Standard. On 8 March 1945, the COP noted that a memorandum had been prepared by the Chairman of EISC, the Chairman of the Appliances Sub-Committee and the Secretary of the Code of Practice Committee setting the principal considerations being put forward in the various discussions.
It noted a statement that the Codes of Practice Committee should be the body to reach the final decision and that Electrical Accessories section of BEAMA had agreed to abide by this decision. The Chairman of the Appliances Sub-Committee confirmed that this correctly expressed his recollections of discussions but Mr Watlington of BEAMA was unable to concur.
Forbes Jackson considered that the broad principles should be addressed and that the EISC who had been unanimous in recommending the publication of a supplementary report was fully representative. They had been supported by a large proportion of the supply industry and also by the Electrical Industry Committee of BSI. Furthermore, the new all-purpose standard socket outlet had been endorsed in the Housing Manual 1944. He proposed the Codes of Practice Committee should accept the EISC's proposal.

7.10 However, Mr Jones of the Electric Lamp Manufacturers Association, said that while the supplementary report of the EISC said that their conclusions were unanimous, his support had been contingent of the use of the standard all-purpose plug being made mandatory. The Committee learned that the Electrical Industry Committee of BSI were prepared to re-discuss the matter in the light of any new findings by the COP Committee. It was noted that the Post-War Building Studies No 11 was not necessarily binding on the Code of Practice Committee and acknowledged that their findings should be regarded at the starting point for any further discussions, particularly in the light of any new information.
It was considered that the ring room circuit arrangements proposed by the Electrical Accessories section of BEAMA constituted such new information (despite the fact that this meeting was taking place in March 1945, the ring room circuit having been discussed back in January 1944).
During the discussion it was stated that thirty out of the thirty two members of the Electrical Accessories section of BEAMA were not prepared to agree the EISC conclusions as being in the best interest of the consumer
The Electrical Contractors' Association took the view that a completely new type of socket outlet and plug should be adopted [the 13A plug which had already been agreed by BSI to be Standardised] and that although the room circuit deserved consideration, it was not the ultimate factor in considering the all-purpose socket outlet and plug which should be suitable for use on a variety of circuits.
Cost depended on the plan of the building under examination and the socket outlet should always give as much freedom as possible to the choice of the most appropriate type of circuit in each instance.
It was suggested by BEAMA that of the three possibilities:-

The fuse at the socket outlet.
A fuse in the plug.
A fuse serving several socket outlets.

the last must be more economical because the first two would progressively necessitate a large number of fuses (it is not clear exactly why this should be so, since the cost of the fuses would be infinitesimal compared with the cost of the installation).

7.11 AH Young then took the Committee back to the proposal to uprate the 5A BS546 plug to 10A and that this should be adopted as the standard, with the IEE Wiring Regulations and the Codes of Practice modified to enable advantage to be taken of the diversity factor.
The Committee also noted, surprisingly, that some members of the Committee were unfamiliar with the very detailed pros and cons of the motion so the meeting was adjourned and reconvened on the 23 March 1945 when members of the Appliances Sub-Committee joined the meeting.

Joint meeting COP and EASC

7.12 The adjourned meeting re-opened with the correction of the minutes, BSI saying, not that they were willing to re-discuss the matter, but they could no doubt be invited to re-discuss the matter.
Turning to socket outlets and plugs, the Chairman expressed the hope that a broad approach directed towards a reasonable solution from the consumers' point of view should be borne in mind and while the question of the universal plug and socket had been driven in the main by the needs of post-war housing, the "all-purpose" socket outlet and plug would be adopted for general use in all classes of building.

7.13 In considering a number of questions which had been put forward from the previous meeting, the Committee decided that fusing at outlets was necessary for the protection of flexibles of 23/.0076 or smaller, whether or not there was a 30A ring circuit or a 15A room circuit.
Discussing whether there should be fuses at some socket outlets or all socket outlets and whether the fuse should be in the socket or the plug, the Committee noted that if fused plugs were adopted, unfused plugs would undoubtedly be sold, but that the most that could be hoped for was to provide for good practice; enforcement would be not more practicable in the case of plugs than good practice in the protection of flexible cords.
It was agreed eventually that a 3A fuse should be in the plug and that no additional fuse between the fused plug and the main circuit fuse was necessary.

7.14 The Committee agreed that there ought to be a fuse of a size intermediate between 3A and 30A and the Committee narrowly agreed to locate it in the plug.
The Committee decided after a great deal of discussion, which once again raised all the points which had been raised in the EISC, the EASC and the FHBBH, that the proposal to uprate the BS546 socket outlet and plug to the all-purpose Standard should be abandoned. A proposal that the existing 15A BS546 socket outlet and plug should be adopted as the all-purpose Standard was also narrowly defeated.
Reviewing all the discussion, it was concluded that the new all-purpose socket outlet should have a rating of 13A The question as to whether the pins should be round or flat was left by the Committee, (who could not agree) to BSI noting that flat pins precluded the use of a fused pin.

BSI rescinds its decision
7.15 BEAMA still did not give up. At the next meeting of COP on 15 May 1945, the Director General of BEAMA, C Rogers, said that having received the minutes of the last meeting, Watlington had written to the Chairman to express the view that having regard to the closeness of the voting, the proposed action was not justifiable and he regarded the whole question as still being open.
At further meeting of COP in August 1945 it was reported that the Committee's findings on socket outlets and plugs had been considered by the Electrical Industry Committee of BSI which had passed by twenty-five votes to three a resolution which rescinded their decision to accept standardisation of a new three kilowatt socket outlet and fused plug non-interchangeable with an existing standard (see 7.8) and that the majority recommendation in the report of the EASC should be endorsed except that the 5A BS546 plug and socket should be uprated to 13A instead of 10A. Clearly there had been lobbying. While it was agreed that a well made 5A plug would carry 10A, it is not clear whether the tests carried out by ERA on the BSS546 5A plug had indicated that they would be satisfactory carrying 13A; the report had said that it could be uprated to 10A which was the question that ERA had been asked. Whether ERA had pursued the uprating further is not known.
The Committee noted this decision and awaited a full account of the discussion. The IEE archives are silent as to what happened.

BSI Re -rescinds it decision
7.16 However, on 11 January 1946, the Electrical Review published an editorial reporting that BSI had re-rescinded the decision of the Electrical Industry Committee to uprate the 5A BSS546 plug to 13A and had now reverted to the recommendations of EISC (subject to endorsement by the IEE Wiring Regulations Committee) that a completely new type of three kilowatt 230V socket outlet and fused plug should be adopted.
The Wiring Regulations Committee had in fact endorsed this decision as requested after the usual discussion involving the location of the fuse and interchangeability, current rating of the fuse and a decision to recommend that the fuses should be 3A and 13A.

11 What happened then
Standardisation
8.1 There is nothing to be found in the IEE archives concerning the standardisation process; BSI do not have any archives on the matter; BEAMA do not have any archives on the matter, MK do not have any archives. In the end the Committees had left to the manufacturers all decisions about the gauge of the plug, the question of flat pins or round pins, and whether the 13A and 3A fuses should be interchangeable as long as the two sizes (sic) of plug could be used in the same socket; manufacturers were free to put forward designs.
The possibility of two sizes of plugs and different ratings was of course related to the Wylex system which would require flat pins. All we know is that 1947, BS1363 was issued.
Some small indications may be gleaned from the History of Dorman Smith[2] where Richard Amberton is reported as having written, in referring to the development of the Dorman Smith plug, "*at that time we did not know the recognised makers of plugs and sockets had already been approached with the same object but without practical results. As soon as it became known that we had succeeded in producing such an article, and that it had great merit, we discovered we had run into a hornets' nest.*"[3]
The history also says "*there are no technical reasons why rectangular pins are any better than round pins but many other manufacturers are only too anxious that Dorman Smith should not sweep the field with their new plug*"[3]. Dorman Smith were reluctant to licence the manufacture of the plug to other manufacturers feeling that they would have forfeited their reward for the invention if the had allowed their plug to be standardised but by not doing so they faced "*the combined opposition of virtually the whole industry*"[3].
DS thought they might at first succeed in face of the opposition because Forbes Jackson had specified the DS plug in council housing and other authorities followed

suit, but eventually it succumbed to the rectangular pin plug.

5A DS Tucker13A

Figure 12 The three plugs

Amberley collection

Wiring Regulations

8.2

The IEE had agreed to develop the Wiring Regulations as a Basic Safety Document (see 7.2) but this did not happen and on 17th January 1946 the Council resolved that 'until the Basic Safety Document is made mandatory the Wiring Regulations will remain in their present form'; on 1st March 1946 the 1946 Supplement to the 11th Edition was published, laying down the requirements for ring circuits.

In developing the Wiring Regulations, the Wiring Regulations Committee followed the discussions and proposals by the Electrical Installations Code of Practice Committee, many of whose members were on the Wiring Regulations Committee and the Amendments sub Committee

Code of Practice on Electrical Installations

8.3 The Code was not published (as BS COP 321 in 1948 does little more than re-iterate in a 'should' mode the requirements of the 11th Edition of the Wiring Regulations, sections beginning with statements which would have been included in the IEE Basic Safety Requirements, had it been prepared and published. For instance

> ***301. General.*** *(a) All apparatus and conductors should be sufficient in size for the work which they are called upon to do. Details as to ratings of cables are. given in Appendix 802.*[4]

It is not the 'how to do it' document which a Code of Practice, such as the IEE's On-Site Guide, should be.

When the Code was eventually published because the Wiring Regulations remained in their original form, and the 11th Edition had precede it by 2 years, the COP was not much referred to, was never revised and fell into desuetude.

12 Conclusion

12.1 In spite of its difficult birth, the ring circuit and the universal plug succeeded beyond the hopes of their progenitors and the fears of their detractors. Other than countries which have traditionally used the IEE Wiring Regulations, no other country has adopted the ring circuit, although Germany, which uses the room circuit tentatively considered it in the 1990s. Since the introduction of the 15th Edition, the 2.5mm^2 ring circuit has a deemed to comply status and the area served etc has become guidance. But so successful has been the ring circuits that electricians studiously ignore the change in the guidance referring radial circuits under which a 20A 2.5mm^2 radial may serve an unlimited number of sockets in 50m^2. But they know what the guidance is and do not need to read anything new.

References

1 IEE Rules for the prevention of fire 1st Edition

2 WP Maycock Electric wiring, fittings, switches

3 Lee & Stubbs The History of Dorman Smith

4 British Code of Practice CO321 (1948) Electrical Installations. BSI London

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REQUIREMENTS OR PROPOSALS FOR RING CICUITS

ITEM	JACOBI SMITH IEE PAPER	JACOBI ARTICLE	11th Edition 1946 SUPP	12th Edition	13th Edition	14th Edition	METRICATION	14th Edition		15th Edition	On-site Guide June 1998
Ring, 7.029 15A fuse	Unlimited 5A plug uprated 12-15A							2.5mm^2			
Ring, 7.029 30A fuse		Unlimited 1 ring/ 1000ft^2	Houses.1000ft^2-10 Houses<1000ft^2 Unlimited	Houses.1000ft^2-10 Houses<1000ft^2 Unlimited	Unlimited on ring not > 1000ft^2 Reasonably distributed	Unlimited on ring not > 1000ft^2 Reasonably distributed		2.5mm^2	Unlimited on ring not > 1000ft^2 Reasonably distributed	Unlimited on ring not > 1000ft^2 Reasonably distributed Comply with Reg 553-9	Unlimited on ring not > 1000ft^2 Reasonably distributed
Spur 7.029 unfused		Unlimited 250ft^2, part of the 1000ft^2	Each spur 2 Ring and spurs not to exceed limit for	Each spur 2 Ring and spurs not to exceed limit for	Each spur 2 Not more than $^1/_2$	Each spur 2 or 1 twin Number not to exceed total of		2.5mm^2	Each spur 2 or 1 twin Number not to exceed total of		
Fused spur fuse not>13A Cable to suit fuse						Total demand per spur ? 13A Numner unlimited			Total demand per spur ? 13A Number unlimited	Not to exceed number of sockts and fixed equipment	Not to exceed number of sockets and fixed equipment
Radial 7.029 20A fuse All outlets in 1 room area limited					3 200 ft^2	6 300ft^2 not kitchen no fixed water heaters		2.5mm^2	6 30M^{22}not ktchen no fixed water heaters		
Radial 7.029 20A fuse			2	2	2	2 rooms other than above		2.5mm^2	2 rooms other than above	Unlimited 20M^2	Unlimited 50M2
Radial 7.036 30A fuse			4	6	6	6 rooms other than above		4mm^2	6 rooms other than above	Unlimited 50M^{2}Cartridge fuse or CB	Unlimited 75M^2
Industrial 7.029 Ring 30A Fuse					10	Max demand not to exceed fuse rating		2.5mm^2	Max demand not to exceed fuse rating	Max demand not to exceed fuse rating	Max demand not to exceed fuse rating