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* Oct. 23, 24.

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* Apr. 24.

WESTERN ELECTRIC COMPANY, }
INCORPORATED, AND NORTHERN } APPELLANTS;
ELECTRIC COMPANY (PLAINTIFFS) }

AND

BALDWIN INTERNATIONAL RADIO }
OF CANADA (DEFENDANT) } RESPONDENT.

ON APPEAL FROM THE EXCHEQUER COURT OF CANADA

Patent law—Infringement—Specification—What it should disclose—Construction of—Within province of court, and not of jury or experts—Also question of law—Matters on which experts may give evidence—Devices for amplifying electric signal waves—Audions.

In an action for infringement of a patent, not only is the construction of the specification exclusively within the province of the Court, and not within that of the jury or expert witnesses, but it is also for the Court a question of law. To quote the words of Lindley, L.J. in *Brooks v. Steele* (14 R.P.C. 9), "the judge may, and indeed generally must, be assisted by expert evidence to explain technical terms, to show the practical working of machinery described or drawn, and to point out what is old and what is new in the specification. Expert evidence is also admissible, and is often required, to show the particulars in which an alleged invention has been used by an alleged infringer, and the real importance of whatever differences there may be between the plaintiff's invention and whatever is done by the defendant. But, after all, the nature of the invention for which a patent is granted must be ascertained from the specification, and has to be determined by the judge and not by a jury, nor by any expert or other witness."

On the merits of the appellant's action for infringement of letters patent relating to devices for amplifying electric signal waves, upon the evidence adduced in the case, the trial judge was right in holding that the language of the claims must be construed by reference to the disclosure of the nature of the invention in the body of the specification and that, so construed, the thing done by the respondent did not constitute an infringement.

APPEAL from the judgment of the president of the Exchequer Court of Canada, Maclean J., dismissing the

* PRESENT:—Duff C.J. and Rinfret, Smith, Cannon and Crocket JJ.

appellants' action for infringement of letters patent relating to devices for amplifying electric signal waves.

O. M. Biggar K.C., R. S. Smart K.C. and M. B. Gordon for the appellants.

E. G. Gowling and D. K. MacTavish for the respondents.

The judgment of the Court (Smith J. taking no part) was delivered by

DUFF C.J.—First, as to the Arnold patent. The action, in so far as concerns this patent, is founded upon allegations that the respondents have infringed the monopoly limited by claim no. 2, which is in these words:

2. The combination with a plurality of thermionic repeaters connected in tandem, the first repeater of the series having a high-voltage output and the last repeater of the series having a high-current output.

It will be convenient, at the outset, before stating the precise considerations which seem to me to dictate the construction of this claim, to mention some long established and well understood principles of patent law.

The first I shall mention could hardly be better stated than in the language of the treatise in Lord Halsbury's collection, of which Lord Halsbury himself was the author:

In order that the public may have sufficient and certain information respecting what they are prohibited from doing whilst the privilege continues, the patentee must particularly describe and ascertain the nature of his invention. In order that, after the privilege is expired, the public may be able to do what the patentee has invented, he must particularly describe and ascertain the manner in which the same is to be performed; (22 Hals. 161; Art. 338).

In *Tubes, Ltd. v. Perfecta Seamless* (1), Lord Halsbury explained the purpose and meaning of a specification in these words:

* * * if one has to look at first principles and see what the meaning of a specification is * * * why is a specification necessary? It is a bargain between the State and the inventor: the State says, "If you will tell what your invention is and if you will publish that invention in such a form and in such a way as to enable the public to get the benefit of it, you shall have a monopoly of that invention for a period of fourteen years." That is the bargain. The meaning which I think, in my view of the patent law, has always been placed on the object and purpose of a specification, is that it is to enable, not anybody, but a reasonably well informed artisan dealing with a subject-matter with which he is familiar, to make the thing, so as to make it available for the public at the end of the protected period.

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The question here is whether that has been done. Now it appears to me that the mode in which one ought to face that question is to look—and I should say so not only of the specification of a patent, but of every instrument—at the whole of the instrument to see what it means—not to take one isolated passage out of it and make that inconsistent with the general invention, but to see substantially what the inventor really means, and when you arrive at that, then see whether the language is within the test that I have suggested as the proper test to apply to such a specification and is such as will enable a typical workman to give the public the benefit of the invention.

In *Clark v. Adie* (1), Lord Cairns said:

* * * it must be made plain to ordinary apprehension upon the ordinary rules of construction, that the patentee has had in his mind, and has intended to claim, protection * * *

for the things which the infringer is alleged to have taken or done contrary to the prohibition of the patent.

In *Dudgeon v. Thomson* (2), Lord Cairns expressed it in this way,

* * * that which is protected is that which is specified, and that which is held to be an infringement must be an infringement of that which is specified.

You ascertain what is specified by considering the specification as a whole. Lindley, L.J., in *Needham v. Johnson* (3), after quoting the language of the plaintiff's second claim, used these words:

Now the first thing is to ascertain what that means; and with a view to ascertain what the whole sentence means, it is necessary to understand exactly what is meant by the expression "conduit". The expression "conduit" requires explanation, and one must look for it, and see what it does mean. Of course it does mean that which the patentees have said it means. You are not to look into the dictionary to see what "conduit" means, but you are to look at the specification in order to see the sense in which the patentees have used it.

I should add also that not only is the construction of the specification exclusively within the province of the court—but also it is for the court a question of law. In *British Thomson-Houston Co. v. Charlesworth, Peebles & Co.* (4), Lord Buckmaster said,

My lords, what did the specification of 1906 disclose and what did the patent of 1909 protect? These are the questions that arise for determination on this appeal, and their resolution depends upon the construction of two documents; such construction is the exclusive duty of the court, and this duty can neither be delegated nor usurped. As however in ordinary cases the existing circumstances in which documents were prepared, the relationship of the parties and the interpretation of terms of art are the proper subject-matter of evidence, so in specification of patents the state of knowledge in the craft, art or science to which the specification is directed and the explanation of technical terms, words and phrases are

(1) (1877) 2 A.C. 315, at 321.

(3) (1884) 1 R.P.C. 49, at 58.

(2) (1877) 3 A.C. 34, at 44, 45.

(4) (1925) 42 R.P.C. 180, at 208.

the proper subject-matter of testimony to aid interpretation; but beyond this, evidence affecting construction should not be allowed to stray. Finally, the document must be regarded as addressed to craftsmen in the particular branch of industry to which the alleged invention relates.

And Lindley, L.J., in *Brooks v. Steele and Currie* (1), expressed himself thus:

The judge may, and indeed generally must, be assisted by expert evidence to explain technical terms, to show the practical working of machinery described or drawn, and to point out what is old and what is new in the specification. Expert evidence is also admissible, and is often required, to show the particulars in which an alleged invention has been used by an alleged infringer, and the real importance of whatever differences there may be between the plaintiff's invention and whatever is done by the defendant. But after all, the nature of the invention for which a patent is granted must be ascertained from the specification, and has to be determined by the judge and not by a jury, nor by any expert or other witness. This is familiar law, although apparently often disregarded when witnesses are being examined.

This is a case in which the specification, read as a whole, sheds a peculiarly revealing light upon the meaning of this claim. Moreover, we have the assistance of another document—a contemporary document—which, in view of the manner in which it was dealt with in the court below may properly be looked at for some purposes which will appear as I proceed.

It is necessary, however, I think, perhaps, to speak a word of caution with regard to such evidence. The duty of the inventor to disclose with certainty the nature of the invention for which he claims protection is a duty owing to the public, as Lord Halsbury observes, and that duty arises out of important public considerations. The protection afforded him by the grant is strictly limited to the invention disclosed and specified. He cannot enlarge his monopoly beyond that which he has specified, or that for which he has claimed protection (in such a manner as to make it clear to those to whom the document is addressed) by reference to supposed intention gathered from some contemporary document which is not part of the specification and has never been made known to the public. Such a document may establish or support a contention that the true nature of the invention has not been disclosed, or that the best manner known to the inventor of performing it has not been made known; and such matters may redound to the disadvantage of the patentee because it is a double condition of his right to a grant that

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(1) (1896) 14 R.P.C. 46, at 73.

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he has invented a new manufacture and that he has disclosed completely his invention. But the rule limiting his monopoly right to what is clearly disclosed by the specification is a rule of substantive law, which it is the duty of the court, in the public interest, to enforce, and the application of it is quite independent of any question as to the admissibility in evidence of any particular document for some other purpose.

All this is, no doubt, applied with some qualification where the issue concerns the validity of a patent or the validity of a claim; where the claim is attacked, for example, on the ground that it is so broadly expressed as to embrace matters not included in the invention, or to embrace matters in respect of which it is alleged that there was no novelty at the date of the patent; or on other cognate grounds. In passing upon such an issue, the courts, as in the case of other documents, have, where they have been satisfied that there was a meritorious invention, resorted to the maxim *ut res magis valeat quam pereat*. And, where the language of the specification, upon a reasonable view of it, can be so read as to afford the inventor protection for that which he has actually in good faith invented, the court, as a rule, will endeavour to give effect to that construction.

But, I am now dealing with the construction of the specification from another point of view; for the purpose of ascertaining the limits of the monopoly acquired by the appellants and determining whether or not what the respondents do is something which the appellants' patent prohibits. In relation to such a question, the principles indicated above have full play.

The document I have just mentioned, which is a memorandum produced by Arnold for the information of his superior officer, Colpitts, thus discloses the subject matter of his investigations which led to the invention: the memorandum is headed "Audion amplifiers without transformers," and the first sentence is as follows:

This relates to the use of audions as amplifiers in circuits from which it is advisable to exclude transformers.

That is the subject matter of the memorandum. The subject matter of the specification is defined in very much the same way in these words:

This invention relates to the use of repeaters generally, and of vacuum discharge repeaters more particularly, as amplifiers without transformers. Still more particularly, it relates to the use of thermionic repeaters for securing amplification of current in circuits of low impedance.

In his memorandum, Arnold outlines the nature of the difficulties and disadvantages attending the use of audions then "on the market" as amplifiers. Before doing that, he explains that in certain very important fields for use of audions as amplifiers, it is advisable to exclude transformers. These include telegraph circuits of all kinds, land, submarine and wireless. He emphasizes cable telegraph circuits and also the reproduction of speech and music where undistorted amplification must be secured over a wide range of frequency. He explains that, in this last case especially, the inherent selectivity of a transformer is undesirable. Then he states that with the audion then "on the market" it is necessary to use transformers in order "to secure appreciable amplification". He adds that this is especially true where the circuit in which amplification is desired is of low impedance. This is due, he points out, to the "characteristics of the audion itself." If there is a circuit of low impedance, say 1,000 ohms, and it is desired to secure amplification in that circuit, you cannot obtain more than 10% of the possible current amplification without the use of a transformer, because, with the audions then in current use, the impedance of the input side, when the audion is operating efficiently, is greater than 100,000 ohms, and it did not appear that any structural change would be likely to reduce it.

Then, with the same type of "commercial audion structure," if you were to attempt, without transformers, to operate into a line of like impedance there must always be a considerable loss of "possible amplification," on account of the magnitude of the impedance on the output side. So that if you desired to take a current from a line of low impedance and deliver that current, after amplification, to a line of like impedance, you could not get more than 10% of the possible current amplification, unless you made use of transformers,—transformers at the point of reception from the incoming low impedance line and at the point of delivery to the outgoing low impedance line.

The problem before him was to design "circuit arrangements" which would escape these difficulties and disadvantages; and he says, at the end of his memorandum,

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We have designed circuit arrangements such that a combination of audions can operate without the use of transformers, and, even between circuits of low impedance, can give an output current in excess of 50 times the arriving current for all frequencies from those suitable to wireless signalling down to the lowest frequencies used in cable telegraphy.

It is this circuit arrangement, involving this combination, which is the subject matter of the patent. In the specification he states,

It has been discovered that a combination of one or more of the aforementioned high-voltage output type of audions working into one of the high-current output type, will operate, without transformers, from a line of low impedance, for example, 250 ohms, into a like line with a resultant current much greater, fifty or more times greater, than would flow in the second circuit if it were directly connected to the first circuit. The present invention is directed to such combination of two different types of repeaters, preferably audions.

It is well to point out, perhaps, that the invention which the respondents are alleged to have infringed is not that involved in the discovery and construction of the special types of audion themselves made use of in this circuit arrangement. The patentee explains in his specification that in respect of the audions themselves, applications have been made for patents, which, it appears, were afterwards granted, and, further, he explains that an application was made for a patent for another somewhat analagous combination but involving the use of only one of the new types of audion.

The combination, however, to which he declares in the specification that "the present invention is directed," and which in his memorandum he describes in the passage just quoted, seems to be very clearly defined. For the moment, the feature of it with which I am concerned is this: it is a circuit arrangement in which a combination of audions "will operate without transformers, from a line of low impedance" into a line of like impedance.

It is not necessary to consider, for the purposes of this appeal, whether or not the patentee has conformed to the conditions of patent law which would be necessary to enable him validly to claim protection for a combination of repeaters other than audions. The infringement, if there has been one, is an infringement by the use of audions in a manner in which the appellants allege to be precluded by their monopoly under the patent, and we are concerned with audions alone.

I now proceed to consider, first, the particular point of controversy as to transformers: whether, that is to say, the absence of transformers is a characteristic and essential feature of the invention disclosed by the specification.

Now, Arnold, in his memorandum, follows up the passages already cited with this:

It has been found possible to construct audions with any desired output impedance, but no modification of this kind has produced a single audion-structure which will operate to advantage in low impedance circuits from which transformers are excluded.

Obviously an attempt might be made to use several audions, the one operating into the next, etc., in the hope that by such a succession of devices the output and input losses noted above might be so far overcome as to render the complete operation of value. Various attempts at so-called "cascade" operation have been made by DeForest and others, but never, so far as I am informed, in circuits from which transformers are excluded.

This appears to indicate that at least one of the desiderata which he is aiming to meet is the exclusion of transformers from such circuits.

Then he proceeds to tell what he and his associates have accomplished:

In the course of our experiments we have discovered that certain forms of audion structure are especially adapted to this end.

Then he describes these "forms of audion structure" which are "especially adapted to this end." They are of two types. The first type provides

without the use of transformers * * * the possibility of stepping up the input voltage in one step to as much as 30 times its original value, or in two successive steps to as much as 500 times its original value.

Audions of the second type "step down the input voltage to one-third its original value." He does not say in so many words that this audion is operated without a transformer but he makes it quite plain, by implication, because he says,

It is not because of this property that this latter type is of value, however, but rather because its output impedance can be made as low as 500 ohms, and hence it can be worked efficiently into a line of like impedance.

One surmises from the context that the figure 500 is a slip of the pen and ought to be 250.

Then he proceeds to explain the nature of the combination that has been discovered, which is a combination of the two types of audion he has invented; each of which being (by a definition) operated without the use of transformers, as already explained; and he sums up the results obtained at the end of the memorandum by a description

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of the circuit arrangement involving this combination, in terms already quoted in which it is made perfectly clear that one fundamental characteristic of the invention is that, through these circuit arrangements, a combination of the two types of audions so described can operate "without the use of transformers," and can, without the use of transformers, take a current from a circuit of low impedance and deliver it amplified by at least fifty times into a circuit of like impedance.

To revert to the definition of the combination to which, as the specification says, "the invention is directed," it would be difficult to find any construction, consistent with the grammatical sense of the words, that would exclude the absence of transformers from the essential features of the combination in respect of which protection is claimed. First of all, he defines the "high-voltage output audion"; and an element of that definition is that "without the use of transformers" it will perform certain operations on the input current.

Then, there is a definition of the "high-current output audion," which does not explicitly make the absence of transformers an essential element, but which, as already indicated, appears very clearly to do so when it is read with the specification as a whole properly construed.

Then, after mentioning that the patentee has applied for patents in respect of these types of audions, he proceeds to describe the combination, and the combination, which is the invention for which he desires protection, is of one or more of the aforementioned high-voltage output type of audions (a type which, by definition, is of such a construction that it performs the function assigned to it in this circuit arrangement without the use of transformers) with one of the high-current output type.

This combination, he says in explicit terms will "operate without transformers"; and it is "such a combination" to which, he says, the "present invention is directed."

This conception of the absence of transformers as characteristic and essential in the invention, essential, that is to say, for the purpose of efficiently securing the desiderata at which the inventor is aiming, indeed, pervades the whole specification as well as the whole memorandum addressed to Colpitts.

The specification is illustrated by figures and there is not in any one of these figures a suggestion of a transformer.

In finally summing up the advantages of his invention, he emphasizes the various fields, indicated in the memorandum and in the beginning of the specification, in which the invention is hoped to prove of the greatest service. All these fields are fields in which, he declares, more than once, it is desirable to exclude transformers; and, I think the fair conclusion from his memorandum is that by that he means it is necessary in these fields to exclude them in order to secure efficient, if not, indeed, "appreciable" amplification.

My conclusion is that the learned trial judge was right in holding that it is an essential feature of the invention, for which the specification claims protection, that it should be capable of efficient operation for the purpose of amplification in currents of low impedance and in the fields to which he draws special attention, without the use of transformers. Indeed, the inventor has not left us in doubt as to his own view of the relation between the absence of transformers and the efficiency of the circuit arrangements which he has designed. After describing the two types of audion and describing the discovery of the combination of the two types and its happy effects in amplification between lines of low impedance, and emphasizing the transcendent importance of this discovery for submarine cable circuits, he proceeds to say,

An essential part of the system of amplification is the circuit whereby the several elements are interconnected without the use of transformers. The significance of this statement is brought into relief by the fact that, so far as I have been able to observe, this paragraph and the preceding paragraph in his memorandum are the only places where he makes any explicit statement as to what he regards as the essential parts of his system. In the preceding part of this paragraph he says,

It must be admitted that the "B" type is not an essential to this scheme of operation but it is, however, necessary that audions of the "A" type must be used at the input.

And then follows the sentence I have just quoted in which he declares that the exclusion of transformers is an essential part of the system.

I now turn to the construction of the specification in another aspect. To revert to the language of claim no. 2:

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2. The combination with a plurality of thermionic repeaters connected in tandem, the first repeater of the series having a high-voltage output and the last repeater of the series having a high-current output.

The learned President has held, in addition to his holding as to the use of transformers, that the language of this claim must be construed by reference to the disclosure of the nature of the invention in the body of the specification, and that, so construed, the thing done by the respondents does not constitute an infringement. I agree with him in both these conclusions.

First of all, as to the construction of the claim, we need not concern ourselves with the phrase "plurality of thermionic repeaters connected in tandem". The controversy really concerns the meaning of the phrase "the first repeater of the series having a high-voltage output and the last repeater of the series having a high-current output."

As already observed, this is especially one of those cases in which it is the document itself which affords the most valuable assistance possible for ascertaining the scope and signification of the phrases employed to limit the claim. That will fully appear as I proceed.

"High-voltage output" and "high-current output" as applied to audions or thermionic repeaters do not appear, so far as the evidence discloses, to have been terms of art prior to Arnold's invention. No witness says they were, and Arnold's memorandum rather suggests that they were not, as we have seen.

He describes two types of audion which he and his associates have succeeded in designing, one of which steps up the input voltage (type "A") to as much as thirty times its original value, and the other of which steps down the input voltage by as much as two-thirds of its original value; the first being denominated type "A" and the second, type "B."

In the first paragraph of his summing up, at the conclusion of his memorandum, he refers to this particular matter in this way,

We have discovered the fundamental factors and their relative importance in audion structure to such an extent that we are able to make one particular type of structure which provides a large amplification of input voltage, and another type of structure which provides large amplification of current with considerable diminution of voltage.

The memorandum seems to show very clearly that both types of audion are new,—the inventions of himself and

his associates. In the specification, where the description in the memorandum is virtually repeated, the denominations are changed. Type "A" becomes the "high-voltage output audion" and type "B" the "high-current output audion".

The specification seems to indicate that, as regards the high-voltage output audion, what Arnold has done is to give "audions of the usual type" a form of construction which provides certain effects that are essential to the operation of his circuit arrangements; while, as to the "high-current output audion," he speaks of it in the specification as a "new type of audion". As already mentioned, it apparently was patented in January, 1915.

In the specification, he says, referring to the "high-voltage output audion",

This type of audion will, for convenience, be hereinafter referred to as the high-voltage output audion.

Referring to the high-current output type, he says,

This new type of audion will, for convenience, hereinafter be referred to as the high-current output audion.

The natural conclusion from all this is, that Arnold conceives himself to be assigning a denomination to a new type of audion designed by him for certain purposes, and a denomination to a special construction of the usual type of audion designed by him for specific purposes; and that these denominations are assigned for the purposes of the exposition of his invention in the specification. The particular type is to be "hereinafter referred to" under its appropriate denomination.

As we proceed through the specification, at the very outset, we are met with a sentence in which he defines the combination to which, he says, the "invention is directed", as

one or more of the aforementioned type of audions working into one of the high-current output type."

As to the significance of these phrases, I shall come to that later. In the meantime it is sufficient to point to the perfectly definite way in which the specification tells the people to whom it is addressed: Here is a type of audion which has been devised and which has certain definite features; and that type of audion will hereinafter be referred to under its appropriate denomination. Then he proceeds immediately, in defining the combination, in re-

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spect of which the invention is claimed, to speak of a combination of the "aforementioned types".

One might multiply references:

Fig. 1. is * * * an audion of the high-voltage output type;

Fig. 2. * * * an audion of the high-current output type;

Fig. 7. * * * audions of the high-voltage type in tandem working into * * * audions of the high-current output type * * *

Fig. 8. * * * a circuit arrangement embodying the invention in which the two different types of audions are combined in one bulb.

In the drawings, the audions 1 are of the high-voltage output type and the audions 2 are of the high-current output type.

In the high-current output type of audion, the input electrode * * * may be at any side of the filament * * *. As hereinbefore stated, the high-voltage output type of audion gives an amplification with low current and high voltage in its output circuit; whereas the high-current output type gives amplification with high current and low voltage, and hence low impedance, in its output circuit.

Fig. 7 shows a plurality of the high-voltage output audions in tandem working into a plurality of the high-current output audions.

Fig. 8 shows * * * an audion of the high-voltage output type (which) works into an audion of the high-current output type * * *

I do not believe that any member of the class of people to whom this specification is addressed could have much doubt that the specification is employing these phrases in the sense defined by the specification itself. As I have already said, there is no evidence that they were terms of art having a generally understood signification in the art at the date of the patent, and, even if there had been such evidence, I should have regarded it as quite immaterial, because the inventor has made it plain that he is not using these phrases in any sense caught from the air, or from some general usage, but with a precise signification which he has defined in his specification.

It ought to be mentioned that Mr. Arnold admittedly is a distinguished scientist, and it seems not an unreasonable assumption that he would express himself in a manner likely to be understood by practitioners in his own art. Such persons, I think, could not fail, in perusing this document, to read the phrase "high-current output type" and "high-current output audion" as phrases denoting the "new type" which the specification has already defined and which it declares will be "hereinafter referred to under the denomination high-current output audion". Nor do I think this exposition is calculated to convey to an intelligent reader any other impression than the impression that the phrases "high-current output" and "high-voltage output" are employed to denote what is described

in the paragraph defining "high-voltage output audion" and "high-current output audion" respectively.

Moreover, I find it impossible to separate claim no. 2 from the final summing up of the invention beginning,

It has been discovered that a combination of one or more of the aforementioned high-voltage output type of audions working into one of the high-current output type, will operate, without transformers, from a line of low impedance, for example, 250 ohms, into a like line * * * The present invention is directed to such combination of two different types of repeaters, preferably, audions.

I have no doubt whatever that, on a proper construction of the specification as a whole, the combination mentioned in the second claim is the combination described in the passage just quoted; or that the "thermionic" repeaters mentioned in the claim must be taken to be thermionic repeaters having the characteristics ascribed by definition to those with which the inventor has succeeded in securing the results which he says are secured by his invention. As a matter of construction, the point does not really appear to me to be open to serious argument.

Then, what are the essential features of the combination? The combination, I repeat, is defined in the passage quoted, and it is

a combination of one or more of the aforementioned high-voltage output type of audions working into one of the high-current output type.

I do not think there is much controversy as to the essentials of the high-voltage output audion, but there is a controversy as to the high-current output audion. Grammatically, there could be no possible question about the construction of the language which is used in defining the high-current output audion. In the first sentence it is stated that

It has been discovered that audions may be constructed which will step down the output voltage to, for instance, one-third its original value. Then follows the sentence, "This last mentioned type of audion has a high current and low voltage output." "Last mentioned type of audion" means, grammatically, the type of audion mentioned in the first sentence; and the only typical thing about the audion mentioned in the first sentence is that it "will step down the input voltage, for instance, to one-third its original value." Then follows the sentence, "Because of its low output impedance * * * such type of audion" (which means this "last mentioned type of audion" of the next preceding sentence, that is to

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say, the type of audion which steps down the input voltage) "can be worked efficiently into a line of like impedance." Then, the final sentence, "This new type of audion," (which, of course, is the type of audion with which alone the paragraph is concerned, the type of audion "mentioned" in the first sentence, "will, for convenience, hereinafter be referred to as the high-current output audion.")

Then, in the description of the combination just cited, the definition of the two types of audion is imported by this phraseology.

* * * a combination of one or more of the aforementioned high-voltage output type of audions working into one of the high-current output type
 * * * The present invention is directed to such combination of two different types of repeaters, preferably audions.

Grammatically, therefore, the type of audion which is denominated the "high-current output audion" or the "high-current output type," and in the description of the combination is the last of the series of audions, and in the claim is referred to as "the * * * repeater * * * having a high-current output" is, for our present purposes, since we are here not concerned with repeaters other than audions, a type of audion which is defined by the possession of the property that it "will step down the input voltage to one-third its original input value." That is the result of reading the words in their ordinary grammatical sense, and there is not in the specification, or in Arnold's memorandum, anything I can discover which would justify a departure from the grammatical sense. On the other hand, there is much in these documents, apart from the paragraph cited, which goes to show that the property of stepping down the voltage is a property of essential importance. In the definition of high-current output audion, there is this which is not without significance:

Because of its low output impedance * * * such type of audion can be worked efficiently into a line of like impedance.

That is to say, "such type of audion" (the type which "will step down the input voltage") possesses, as such, a low output impedance which can be worked into a line of low impedance. Elsewhere in the specification, and in Arnold's memorandum, this relation between the reduction of input voltage below its original value and low output impedance is recognized in unequivocal terms.

In a passage already quoted from the specification it is stated,

The high-current output type gives amplification with high current and low voltage and hence low impedance in its output circuit.

It is the low output impedance, which is characteristic of the high current output audion that, by definition, steps down the input voltage, that makes it possible to have an audion, so defined, work efficiently into a line of like low impedance. That is one, at all events, of the cardinal virtues of this type of audion.

The capital purpose of the inventor, no doubt, is to secure a high amplification of current flowing into a line of low impedance.

The audion 2, says the specification, acts as an amplifier in which the current is increased and the voltage lowered in its output circuit. Because of the fact that the impedance * * * is lowered, it can be worked efficiently into a line of similarly low impedance.

In his memorandum, Arnold describes the high current output type in this way,

We have also succeeded in making audions which step down the input voltage to one-third its original output.

He goes on to explain that this property, that is, the property of stepping down the input voltage is not, *per se*, the thing which gives this type its value; but that such value directly results from the property by which the output impedance can be made low, by reason of the fact, as the specification explains, that the voltage has been lowered, making it suitable therefore, for direct connection to a low impedance outgoing line.

Again, at the conclusion of his memorandum, in describing this type of audion, the properties mentioned are that it provides a large amplification of current with considerable diminution of voltage.

It is quite clear, I think, that one of the essential characteristics of this type, for the purposes of the invention in question, is that it should be capable of diminishing, and does diminish, the input voltage below its original value.

I do not propose to enter upon a scientific discussion touching the relations between voltage, impedance and current in thermionic repeaters of the kind with which Arnold is dealing in their bearing upon this device of Arnold's in which the input voltage is reduced below its original value, and by the use of which he produces such

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results in magnitude of current and minimization of impedance in the output circuit as to enable the inventor to arrive at that at which he says he has arrived, viz., to obtain a current amplification of fifty-five times between circuits of 250 ohms impedance with sufficient energy capacity to deliver at least one-tenth of an ampere at the terminals. There was no satisfactory scientific discussion of these matters at the trial and, although I have read the evidence many times, I have not discovered any evidence (and our attention has not been called to any) which would enable me to go into scientific matters of which I do not think I can take judicial notice without a much more complete instruction upon them than this record presents.

It is sufficient that Arnold himself says he obtained these results with a series of tubes consisting of one or more of the high-voltage type and one of the new type known as the high-current type, the primary characteristic of which is (by definition) that it steps down the input voltage below its original value, and that he was able to do so because this tube, in which the input voltage is lowered as low, for example, as one-third its original value, is a tube in which the impedance of the outgoing circuit can be reduced as low as 250 ohms or 500 ohms which makes it possible to work it into a line of like impedance,—the normal impedance, as one of the witnesses says, for low impedance circuits.

I now come to the matter of infringement. The issue is, to adopt the language of Lord Cairns in *Clark v. Adie* (1). “Whether” (the alleged infringer has) “adopted the substance of the instrument patented”, or, to vary the phrase, whether he has “taken in substance the pith and marrow of the invention”.

Infringement is a mixed question of law and fact. First of all, it involves the construction of the specification and, if there is any dispute about that, the issue, let me repeat, is an issue of law for the court.

There is further an issue of fact whether the invention, as disclosed by the specification as construed by the court, has been in substance taken by the defendant. This issue is, to adopt again the language of Lord Cairns in *Clark v. Adie* (2), “either for a jury or for any tribunal judging

(1) (1877) 2 A.C. 315, at 320.

(2) (1887) 2 A.C. 315.

of the facts of the case". It is for the appellants to establish by reasonable evidence to the satisfaction of the court, as judge of the facts, that the respondents have really taken and adopted the substance of the invention which Arnold specified in his specification.

The contention of the appellants is that the thing which the respondents do is prohibited by claim no. 2.

The description of Baldwin's system, given by the witness Cornwell in the course of his examination, may, I think, for all relevant purposes be accepted as accurate. It is as follows:

117. Q. Do that briefly?

A. The first tube of this amplifier is a type 224 vacuum tube and it is a potentially operated tube, in other words, its function depends on nothing but voltage which is applied to the terminals connected by the input. It has a very high impedance circuit in design and when connected there is a resistance of 200,000 ohms. This tube is a screen grid tube, a development of late years, where in a high rate of amplification is realized over what was had in the days of Colpitts and Arnold; by virtue of the introduction of this screen grid this tube steps up the voltage that is applied to its grid and in addition increases the current at the same time; in other words, it is an energy amplifier which is the standard and common action of all conventional radio tubes. If I might give a value that perhaps would make it more clear. We can apply at the input $\frac{3}{10}$ of one volt, a very small fraction, and by virtue of its amplifying power it will step up that voltage to 50 volts; that is, we could get off the plate of that tube 50 volts if $\frac{3}{10}$ of a volt was applied to its grid. In so much as it is a pulsating or alternating current of 50 volts it will travel to the grid of the tube labelled (B) and it travels directly to this grid through a copper conduction, there being introduced in that circuit nothing in the way of condensers, inductors or batteries, giving the conductivity the value of the lowest possible resistance, which assures more efficiency than is disclosed in patents in the prior art. This tube receives this 50 volts and steps it up still higher. Relatively speaking, the 224 tube is rather a low voltage tube as regards the value of its output in comparison with the voltage of the output of tube (B) which has a value of about 3.8; in other words, it multiplies the voltage 3.8 times. However, we do not realize exactly that full value but actually realize a gain of three times, which means that off the plate of this second tube we obtain 150 volts and a small increase in current as well. This plate, the output or plate of this tube also contributes voltage to the grid of tube (C), the third tube. The voltage is conveyed to tube (C) through another resistance and those resistances are R10, R9 and R8 and they maintain a fixed value of ratio nearer that grid and tube (C) will receive 50 volts when the grid of tube (B) is receiving 50 volts by reason of the gain to tube (B) from the amplification power and tube (C) steps it up to 150 volts, and those two plates as mentioned above are working in a series relation to each other, so that they gain double that voltage, making it 300 volts which is, of course, a very high value. The relationship of the tubes (B) and (C) to each other, in so far as performance is concerned, can be explained as follows:

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If tube (B) is removed from the circuit and tubes (C) and (A) are retained, then the whole instrument ceases to function. If tube (B) is replaced and tube (C) is withdrawn, the circuit will function but unsatisfactorily, due to the fact that its power is reduced to less than half and it is distorted due to unbalanced potentials and change of impedance in what we call the inductance T. The two tubes are essentially then to give operation that is acceptable for general commercial standards of quality. The two terminals, labelled output, upon being measured, possess the value of approximately 8,000 ohms impedance, which is a high value. With the impedance of 8,000 ohms, roughly figuring upon driving the whole amplifier with this $\frac{3}{10}$ of a volt, is computing it at 300 volts, and with the imposed values of that impedance of 8,000 ohms, we get power, which is energy, the product of current and voltage, of 11 watts. In consideration of 300 volts being embraced the current would be, very roughly figuring, about $\frac{37}{1000}$ of one ampere, which is, of course, quite low. That is, the output would not work when connected to a cable line or telephone line of the conventional values of 250 ohms impedance or that of 500, as far as efficiency or quality is concerned, first, because of the values in the circuit the amplifier is not able to reproduce the low frequencies that go down to as low as 30, 20 or 10 cycles and no efficiency could be realized at 2 cycles with it and if you desire to apply it to a telephone line, if you want to obtain any efficiency or quality at all, as well as vitality of wave form, it is essential that a transformer be connected to that output, that is, to reduce the voltage and to also, of course, reduce the impedance down to a value that is comparable to the impedance value of your line, and naturally, when you reduce that voltage but retain that power, your current then will increase, but it can only be done by the insertion of a transformer; the tubes do not do it, but the transformer does it in such a case. I believe that covers the circuit.

* * *

126. Q. Is there any device or such a thing as a cable telephone or microphone which you could attach to the input of the defendant's circuit and have it match the impedance of the circuit generally?

A. Microphones and telephones of general type are low impedance instruments, telephone lines are also low impedance circuits usually. If any of them were connected to the input of the defendant's amplifier natural impedance matching would not be realized; it naturally suffers in efficiency and does not amplify as much as it might or should do if they matched.

127. Would you say whether it was practical to use the defendant's circuit without transformers, input and output, in public address systems?

A. No, sir.

Subject to what the defendants' witnesses say in regard to the use of transformers, the physical characteristics of the Baldwin system are briefly summed up in a passage from the appellants' factum which I quote in full:

20. Specific figures were given with respect to the defendant's system. The input upon which the calculations at the trial were based was $\frac{3}{10}$ of a volt and the input amperage fifteen ten-millionths of an ampere. In the first tube (A) the voltage is amplified 166 times, and the current only 55-66 times. In each of the tubes of the pair (B and C) on the other hand, the current is amplified 370-444 times and the voltage only 1.8-3.8 times, the variance in the figures depending upon the particular method

of calculation adopted. By reason of the last repeater consisting of a pair of tubes the resulting voltage output of the system is double what it would have been if there had been only one. In the final result the system's output of power is just short of 25,000,000 times the input, a result which by the use of ordinary tubes in cascade would require five stages instead of two, and about 80 tubes of the kind until lately used.

Now, comparing broadly Baldwin's device with Arnold's invention, and postponing for a moment the matter of transformers, you have these contrasted features:

Arnold's specification contemplates his amplifying system as one which, without the use of transformers, could be efficiently worked from and into it a line of low impedance, 250 to 500 ohms, for example. He refers thus to some of the fields in which he thinks his invention can be most usefully applied:

As applied to submarine cable work for amplifying the feeble current at the receiving end the invention is of special importance. And, he adds, the invention is particularly adapted for use in circuits where especially pure, loud reproduction of speech or music is desired. In general in the art of submarine, land and wireless telegraphy, the invention is of importance with reference to recording, high-speed working and direct repetition from one type of system to another type of system.

As to the Baldwin system, the impedance of the first repeater reaches the high magnitude of 200,000 ohms, and, as a result of the evidence as a whole, I have no hesitation whatever in saying that, without the use of transformers, a repeater having such an order of input impedance could not be efficiently operated from lines with such impedance as would be encountered in those fields which Arnold has specially in view. Cornwell's evidence is perfectly clear on that point. Cornwell's evidence is quite explicit that the use of this system is not practicable for the transmission of speech and music without transformers at both ends of the circuit, that is to say, at the input of the first repeater, as well as at the output of the last repeater.

It is admitted, it is true, that in some cases where the incoming line connected with the input of the first repeater has an impedance ranging from 5,000 to 8,000 ohms the system can be put to some practical purpose; though this is emphatically denied by the appellants' expert witness. The point I am concerned with at the moment is that by reason of the very high impedance of the first repeater, Baldwin's system cannot be usefully employed without the use of a transformer in the wide and important fields

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specially mentioned by Arnold. That, coupled with the fact already mentioned that in his disclosure of his combination he contemplates working from a line of low impedance, say 250, ohms, into a line of like impedance without transformers, is a not unimportant circumstance when considering whether or not the pith and substance, the spirit of Arnold's invention, has been taken by Baldwin.

Then, there is another feature which is not without its importance in Baldwin's first repeater. Arnold contemplates no appreciable increase of current in his first repeater. Baldwin's first tube is vastly different. It amplifies the current over 60 times. This is of significance when it is remembered that Arnold only contemplates a total amplification of current by his whole system of 55 times.

Now, coming to the second repeater consisting of a pair of tubes (B and C) in series. The distinction is marked. It is an essential feature of Arnold's invention, that the second type of repeater, according to the intention of the inventor, and by express definition in the specification as well as in the memorandum, reduces the output voltage of the first repeater below its original value; Baldwin does not lower the output voltage from the first repeater. On the contrary, the second repeater, involving two audions, amplifies that voltage by six times. I shall have to return to this in discussing one of the arguments addressed to us, but, in the meantime, I pass on to the output impedance of the system.

One of Arnold's capital aims is to reduce the output impedance of the system, which he was eminently successful in accomplishing, to 250 or 300 ohms. The difference in figures alone is striking but the practical consequences are of still greater importance. Arnold's object, let me repeat to the point of weariness, in reducing impedance to 250 or 500 ohms was to enable him to work his output circuit of his last repeater into a line of low impedance directly, without the use of transformers, and this to enable him to employ his system in the fields already mentioned with all the advantages arising, as he considered, from the absence of transformers.

In Baldwin, the output impedance reaches at least 4,000 ohms and in the most efficient operation it reaches 8,000 ohms. It is not seriously disputed that Baldwin's output

circuit, working through such impedance, could not be efficiently connected with an outgoing line, for any of the purposes for which his devices are employed, without the use of transformers.

A word upon the subject of transformers. The learned trial judge rightly found as a fact that for practical purposes the Baldwin system is not used without transformers connected with the output circuit; that for all except some very exceptional purposes for which such systems are used, a transformer is employed and is necessarily employed between the incoming line and the input circuit of the first repeater.

To sum up, Baldwin employs an initial repeater having 200,000 ohms in his output circuit, which, if it can be worked directly at all with an incoming line of low impedance, cannot be efficiently worked with an incoming line of impedance less than 5,000 ohms.

Arnold's invention contemplates a system which, after amplification of current by 50 times can be worked directly, without the use of transformers, into a line of low impedance and ordinarily will be so worked.

Baldwin employs a repeater of outgoing impedance of from 4,000 to 8,000 ohms which cannot be efficiently, and is not in practice, worked, into an outgoing line without the use of transformers.

Arnold employs as his first repeater a repeater which does not amplify the current. Baldwin employs a repeater which amplifies the current of the incoming circuit between 55 and 66 times.

Arnold's invention involves a final repeater of such characteristics that it diminishes the voltage of the input circuit by a factor of two-thirds. Baldwin employs a repeater consisting of two audions which increases the output voltage of his first repeater by a factor of six, and these differences are not mere differences in figures. They have most important results in relation to the respective objects aimed at.

As I have already said, I entirely agree with the conclusion of the learned trial judge, and on the issue of fact whether or not Baldwin's arrangement in substance infringes Arnold's patent, I agree with his finding.

I also agree with the view expressed by him upon what is also a mixed question of fact and law, as I have already

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intimated, that neither the individual audions which constitute Baldwin's second repeater, nor the repeater as a whole, can be brought within the definition derived from Arnold's specification of high-current output audion.

This brings me to one or two points argued on behalf of the appellants to which I think it is necessary to refer. In order to be sure that I am doing no injustice to the argument, I quote from the appellant's factum:

28. The patent specification refers to audions of the kind adapted for use as the first repeater as being of the "high voltage output type", and to audions of the kind adapted for use as the second repeater as being of the "high current output type". It describes the construction of each type. They differ in the size and spacing of their electrodes, which are to be larger or smaller and more or less far apart according to the result desired. This result is, in the case of the first type, a high output impedance, which leads to a high voltage amplification and inhibits the ready flow of current in the output circuit; in the case of the second type it is a low output impedance which permits a large increase in current but is inconsistent with a corresponding voltage amplification. In a passage twice quoted in the judgment Arnold says that he has discovered that audions of the second type can be made with so low an output impedance as even to "step down the voltage, for example to one-third of its original value". From this the learned trial judge infers that such a stepping down of the voltage in the second repeater was an essential feature of Arnold's idea, and accordingly holds that although each of the audions constituting the defendant's second repeater amplifies the current 370-444 times and the voltage only 1.8 to 3.8 times, these audions are not of the high current output type contemplated by the patent. Not only is the learned trial judge's inference directly contrary to the intention really entertained by Arnold and expressed in the preliminary memorandum, but it is also contrary to the oral evidence. The plaintiffs' witness Waterman categorically states that the second repeater in the defendant's system is a "high-current output tube", and the definition which the defendant's witness gives of the expressions "high-voltage output" and "high-current output" supports this statement. The point is one upon which, in the plaintiffs' submission, a judicial conclusion contrary to the express evidence cannot be supported. The plaintiffs further submit that Arnold's object is accurately expressed in his patent. He proposes to obtain a high undistorted amplification of signal energy by using audions in tandem, the first so constructed as to secure the amplification primarily of voltage and the second primarily of current. It is such a system which Arnold's claim defines and the defendant uses. There is no excuse for attributing to Arnold an intention to restrict his invention, or for interpreting his claim as being confined, to a system in which either of the audions used is the most extreme possible example of its type.

The essential fallacy of the argument seems to lie in the assumption that the phrase "high-current output audion" is to be construed by witnesses, and that the tribunal charged with interpreting the specification is bound to

accept the opinions of witnesses as to the effect of these words.

I have already fully discussed this point of construction and I will now repeat that the question of the meaning of these terms in the specification, and the construction of the claim with reference to these terms, is a matter exclusively within the province of the court; and the learned trial judge would have fallen into grave error if he had accepted, as binding upon him, the evidence of witnesses with reference to that matter, as the appellants contend he ought to have done.

I repeat that the witnesses relied upon in the factum did not profess to say that these terms had, before the publication of Arnold's patent, derived any commonly known meaning from usage in the art; that the specification itself provides the dictionary by which the scope and effect of these terms is to be ascertained; and, moreover, that it is clear that Arnold did not intend them to be read in any sense imposed by general usage, but solely in the sense in which he himself defines them.

I may add, moreover, that if I were at liberty to treat the construction of these phrases as a question of fact, that is to say, if I were at liberty to treat as a question of fact, to be determined upon the testimony of witnesses along with the other facts in evidence, whether the meaning ascribed by the appellants to the phrase "high-current output" corresponds with the sense in which Arnold intended to use it, or intended it to be understood, I should have no hesitation in coming to the conclusion that the oral evidence relied upon by the appellants, whatever be the effect of it, is entirely overborne by the internal evidence of documents before us.

Then, the argument includes this statement:

Not only is the learned trial judge's inference directly contrary to the intention really entertained by Arnold and expressed in the preliminary memorandum, * * *

I have already discussed the memorandum sufficiently to show that in my judgment the evidence is diametrically in contradiction to this argument, but I must notice for a moment the reference by which that statement is supported. The first of these is a paragraph in these words:

It has been found possible to construct audions with any desired output impedance, but no modification of this kind has produced a single

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audion-structure which will operate to advantage in low impedance circuits from which transformers are excluded.

In several respects, this passage is not entirely clear. I am not sure that Arnold is speaking of some invention of his own. The context, especially the two following paragraphs, seem to indicate that he is not. However, the point of his observation seems to be this: The single audion-structure, whatever its impedance, it has not been found possible to devise in such a way as to make it possible to operate efficiently without transformers. I do not think that lends much force to (indeed, I am afraid I think it tells neither way) the contention the appellants are advancing.

The next reference is to another paragraph which is in these words:

It must be admitted that the "B" type audion is not an essential to this scheme of operation. We may replace one of the "B" type by from 10 to 100 of the "A" type in parallel, and secure comparable results. It is obvious, however, that the use of one audion of the "B" type is to be preferred. It is, however, necessary that audions of the "A" type be used at the input end, since only this type has the property of voltage step-up transformation.

I must admit that here again I cannot ascribe any weight to this paragraph either for or against the appellants. The point under discussion is the validity of the learned judge's conclusion as to the nature and properties of a "high-current output tube" as that phrase is used in Arnold's specification. The paragraph quoted points out that Arnold's "scheme of operation" as conceived by him, does not necessarily involves the use of an audion of the "high-current output type" which may be replaced by a series of from 10 to 100 audions of the high-voltage output type arranged in parallel.

We are only concerned with Arnold's specification. There is no suggestion that the claim sued upon (which relates to a combination of two different types of thermionic repeaters) or the invention as described in the specification, embraces this alternative method; and, indeed, it is stated in the specification that, for a method which, from its description, I take to be this alternative method, Arnold has applied for a separate patent. I am unable to see what bearing all this has upon the scope and significance of the phrase "high-current output audion" in Arnold's specification.

On the other hand, I must point out that these are the only two passages from Arnold's memorandum that are referred to in support of the proposition that the learned trial judge's conclusion in respect of the nature and properties of that type of audion is "directly contrary to the intention really entertained by Arnold and expressed in the preliminary memorandum." These references, as I have said, in my opinion have no weight either way. There are many other passages in the memorandum, however, to which reference might be made which at least point to the conclusion that this comment upon the learned President's judgment rests upon a misconception of the essential effect of the memorandum.

For example,

We have discovered the fundamental factors and their relative importance in audion structure to such an extent that we are able to make one particular type of structure which provides a large amplification of input voltage, and another type of structure which provides large amplification of current with considerable diminution of voltage.

The expert witness called by the appellant insists that in the high-current output type of audion the high-voltage delivered from the first type is accepted and passed on "without material alteration." It will be plain from what has already been said that this description is a quite inadequate substitution for the definition given in Arnold's memorandum and his specification of this electrical device.

There is one general observation which, I think, ought not to be omitted. Fortunately, in this case we have, in the memorandum of Arnold, an exposition in language chosen by the inventor himself (who is a distinguished scientist and admittedly an entirely competent expert in this particular field of science) of the characters and circumstances of his inventions. The character of the devices, of the combination and of the circuit arrangements is explained by Arnold for the information of his superior officer in the memorandum before us, and we may assume that he would not use language of which the grammatical sense, as well as the sense imposed by the context, is the very opposite of what he intended to convey. A like remark would apply to the specification.

I cannot yield my adherence to the process of replacing the plain language selected by Arnold himself to express his

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ideas of the properties of his inventions and substituting therefor paraphrases, possibly ingenious, but far from faithful.

With reference to Colpitt's case, it does not seem necessary to add anything to the observations of the learned trial judge. I entirely agree with his conclusions.

The appeal should be dismissed with costs.

Appeal dismissed with costs.

Solicitors for the appellants: *Smart & Biggar.*

Solicitors for the respondent: *Henderson, Herridge & Gowing.*
