BL O/313/17
07 July 2017

Intellectual Property Office

PATENTS ACT 1977

APPLICANT	Woodward MPC Inc.
ISSUE	Whether patent application GB1312256.9 complies with section 1(1)(b)
HEARING OFFICER	H Jones

DECISION

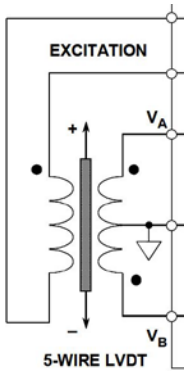
Introduction

1 International patent application PCT/US2012/020512, entitled “Method and apparatus for a half-bridge variable differential transformer position sensing system”, was filed in the name of Woodward MPC Inc. on 6 January 2012 and afterwards entered the UK national phase as application number GB1312256.9.

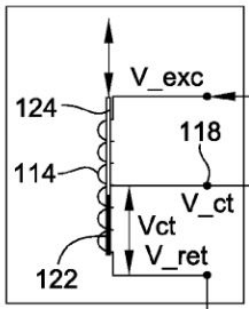
2 Following amendment of the claims and several rounds of correspondence, the examiner maintained that all of the claims lack an inventive step over the prior art. The applicant disagreed and requested a hearing to decide the matter. The hearing took place via telephone on 8 June 2017 where the applicant was represented by Peter Smith of Serjeants.

The invention

3 The application relates to a variable differential transformer position sensing device, which are commonly produced in linear (LVDT) and rotary (RVDT) formats. Position sensing devices such as these are used in large numbers in aerospace applications. Conventional LVDT and RVDT sensors typically use five wires at the electrical interface for the transducer (two wires for excitation of a primary coil, two wires for outputs from secondary coils and one wire from a central tap between the secondary coils) to sense the position of a movable core from the voltages induced in the secondary coils (see example below):



4 The invention provides a variable differential transformer position sensing system (see below) having an inductive coil 114 and no more than three electrical wires providing an electronic interface for the transducer (e.g. a first wire to supply the excitation signal (V_exc) to the coil 114, a second wire to ground (V_ret) and a third wire to carry an output signal (V_ct) from a centre tap):



5 Furthermore, the invention provides correction for variations in the voltage of the output signal due to temperature of the transducer and due to non-linearity of the output signal with respect to the position of the moving core. The specification states that a reduction in the number of electrical wires provided as an electronic interface for the sensing device results in reduced weight and a simplified system of wiring.

6 The latest set of claims was filed on 30 August 2016 and includes independent claims 1 and 20, reproduced below:

> *1. A half-bridge variable differential transformer position sensing system comprising:*
>
> *a transducer having a stator with an inductive coil having a center tap configured to provide an output signal, the transducer having an armature with a magnetically permeable core configured to move within the inductive coil, wherein such movement causes a change in the output signal;*
>
> *a first circuit configured to provide an excitation signal at one terminal of the inductive coil; and*
>
> *a microcontroller configured to calculate the degree of change in the position of the magnetically permeable core based on a comparison of a voltage of the output signal and a voltage of the excitation signal, the microcontroller being further configured to correct for variations in the voltage of the output signal due to the temperature of the transducer and due to non-linear effects on the output signal caused by movement of the magnetically permeable core;*
>
> *wherein no more than three electrical wires are provided as an electronic interface for the transducer of the half-bridge variable differential transformer position sensing system.*
>
> *20. A non-contact method of sensing position using a variable differential transformer position sensing system, comprising:*
>
> *providing a transducer having an inductive coil in a center tap configuration*

which supplies a transducer output signal;

attaching a part, whose position is to be sensed, to a magnetically permeable core located within the inductive coil;

generating an excitation voltage to be applied to the inductive coil;

measuring variation in transducer output signal voltage resulting from a movement of the magnetically permeable core;

correcting for effects of temperature and non-linearity when determining a degree of movement of the magnetically permeable core; and

providing no more than three wires as an electrical interface for the transducer of the variable differential transformer position sensing system.

7 In addition to the independent claims outlined above, the wording of dependent claim 3 was briefly discussed at the hearing as it could be read in a way that casts doubt on the scope of claim 1. Although not discussed at the hearing, dependent claim 26 could similarly cast doubt on the scope of claim 20. These claims suggest that the transducer may have two inductive coils, as follows:

3. The half-bridge variable differential transformer position sensing system of claim 1, wherein the stator has first and second inductive coils wound on a bobbin, the first and second coils connected in series with the center tap coupled between the first and second coils, the stator being housed in a protective casing with a bore configured to accommodate the magnetically permeable core.

26. The method of claim 20, wherein providing a transducer having an inductive coil comprises providing a transducer with a stator having a pair of inductive coils wound on a bobbin, the pair of coils connected in series with a center tap located between the pair of coils.

The law

8 The relevant provisions in relation to inventive step are sections 1(1)(b) and section 3, which state:

1(1) A patent may be granted only for an invention in respect of which the following conditions are satisfied, that is to say -

(a) …
(b) it involves an inventive step;
(c) …

3 An invention shall be taken to involve an inventive step if it is not obvious to a person skilled in the art, having regard to any matter which forms part of the state of the art by virtue only of section 2(2) above (and disregarding section 2(3) above).

9 "Matter which forms part of the state of the art by virtue only of section 2(2)" is everything that was made available to the public before the priority date of the application in question.

10 In the case of *Windsurfing*[1], the Court of Appeal formulated a four-step approach for assessing whether an invention involves an inventive step. This approach was restated and elaborated upon by that Court in *Pozzoli*[2], as follows:

> *(1)(a) Identify the notional "person skilled in the art";*
> *(1)(b) Identify the relevant common general knowledge of that person;*
> *(2) Identify the inventive concept of the claim in question or if that cannot readily be done, construe it;*
> *(3) Identify what, if any, differences exist between the matter cited as forming part of the "state of the art" and the inventive concept of the claim or the claim as construed;*
> *(4) Viewed without any knowledge of the alleged invention as claimed, do those differences constitute steps which would have been obvious to the person skilled in the art or do they require any degree of invention?*

Arguments and analysis

11 At no point during the exchange of correspondence between the examiner and the applicant has the identity of the "person skilled in the art" and the relevant common general knowledge of that person been disputed. In the specification, the applicant identifies the field of the invention as "position sensors suitable for aerospace applications". Such position sensors would need to be lightweight and able to "perform under harsh environmental conditions with high reliability and accuracy". In his examination reports, the examiner identifies the field of "electromagnetic position sensing" as that of the skilled person.

12 There also appears to be agreement as to the inventive concept, namely a variable differential transformer position sensing system comprising a transducer having an inductive coil in a centre tap configuration to provide an output signal and no more than three electrical wires providing an electronic interface for the transducer. The system also corrects for effects of temperature and non-linearity when determining a degree of movement of the magnetically permeable core of the transducer.

13 The area of disagreement has involved the matter cited as forming part of the "state of the art" and the differences that exist between that matter and the inventive concept of the claims.

14 The examiner has maintained that the invention defined in the claims does not involve an inventive step when considered in the light of certain prior art. His position was set out most recently in his pre-hearing report of 8 May 2017. The applicant's arguments are contained in their responses of 30 August 2016, 23 February 2017 and 10 April 2017, with further arguments being set out at the hearing.

15 The examiner has identified the following documents as the closest prior art:

D1: US 2004/090227 A1 (HIRAMATSU)

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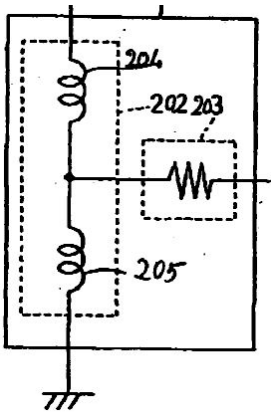
[1] Windsurfing International Inc. v Tabur Marine (Great Britain) Ltd, [1985] RPC 49
[2] Pozzoli SPA v BDMO SA [2007] EWCA Civ 588

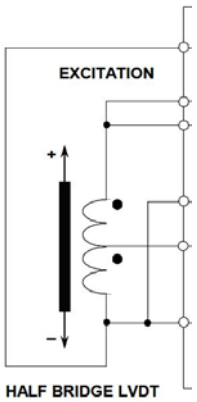
D2: Linear Circuit Design Handbook by Hank Zumbahlen (ZUMBAHLEN)

Both of these documents were published before the priority date of the application and so form part of the state of the art by virtue of section 2(2). Both also disclose half-bridge differential transformer position sensors.

16 HIRAMATSU discloses two coils 204, 205 connected in series with output signals taken from a junction point at the centre of the two coils (see below). The examiner has argued that this arrangement falls within the scope of the transducer defined in claim 1, particularly in the light of claim 3 that defines the same two coil configuration. Additionally, the examiner argues that the interface to the coils comprises only three wires.



17 ZUMBAHLEN discloses a half-bridge LVDT (or RVDT) in a centre tap configuration (see below). The examiner has contended that the electrical interface to the transducer comprises only three wires, i.e. only those in direct communication with the coils.



18 Therefore, the examiner has asserted that the difference between the prior art of both HIRAMATSU and ZUMBAHLEN and the inventive concept of claims 1 and 20 is the correction for the effects of temperature and non-linearity.

19 The examiner identified further patent documents that demonstrate the correction of the output of inductive position sensors for both non-linearity (US6097183 and US5245869) and temperature (US5245869 and US5332966). Hence, in the light of

these additional disclosures, the examiner concluded that claims 1 and 20 lack an inventive step. In fact, the examiner was of the opinion that each of the dependent claims lacked inventive step over the prior art and that the application does not contain any patentable subject matter.

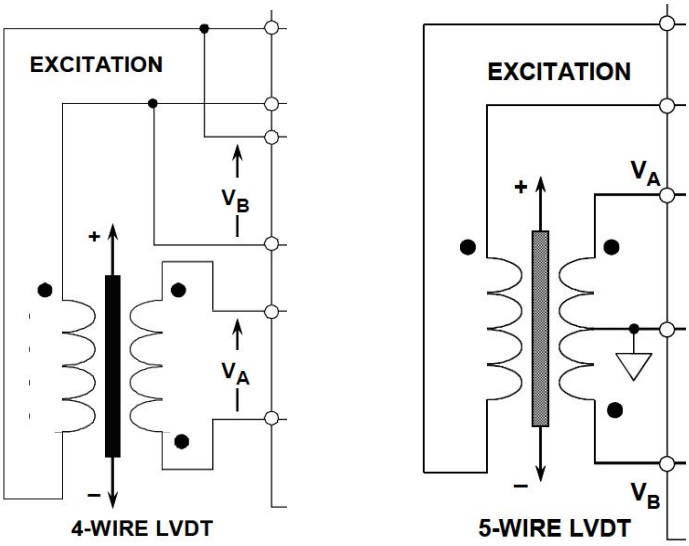
20 In their letter dated 10 April 2017, and reiterated by Mr Smith at the hearing, the applicant argued that, whilst schematically the relationship between the induction coils appears similar to that defined in the claims, the actual physical arrangement of HIRAMATSU is different. In considering the document as a whole, the physical configuration disclosed in HIRAMATSU, particularly illustrated in figures 8 and 9 and described in paragraph [0094], comprises two coils separated by a partition so that there can be no linkage between the coils within the differential transformer and no centre tap configuration. Furthermore, Mr Smith pointed to the discussion of the physical arrangement of the differential transformer in paragraph [0094] that describes both a "coil line" and "first, second and third terminal pins" indicating that there are more than three wires forming an electrical interface for the differential transformer.

21 At the hearing, Mr Smith also highlighted passages of HIRAMATSU, such as paragraphs [0071] and [0075], where the physical arrangement of the differential transformer makes it easier to regulate the temperature characteristics of the components so that there is no need to additionally provide any circuits for temperature compensation. Hence, HIRAMATSU points away from the need for correction for the effects of temperature as required in the claims.

22 Mr Smith's arguments are persuasive and I cannot see how the skilled person would be able to arrive at the claimed invention using HIRAMATSU as the starting-point without making an inventive step. HIRAMATSU makes no explicit reference to the number of wires forming an interface with the differential transformer, but there is certainly enough to suggest that the physical implementation of the interface would require more than three wires. Furthermore, it is unlikely that the skilled person would consider the teachings of HIRAMATSU together with the other patent documents that disclose correction for temperature. In fact, HIRAMATSU clearly discourages such a consideration by stating that this correction is not required.

23 Turning to ZUMBAHLEN, Mr Smith again contended that the half-bridge LVDT arrangement illustrated is schematic and not a representation of a physical arrangement. Additionally, the applicant has argued that the electronics interface with the transformer is represented in the schematic diagram by the six terminals (indicated by open circles on the diagram) rather than the wires in direct communication with the coils.

24 In his report dated 1 November 2016, the examiner has responded to these arguments by highlighting that, as well as illustrating the half-bridge LVDT arrangement, ZUMBAHLEN also illustrates a four-wire LVDT and a five-wire LVDT (see below):



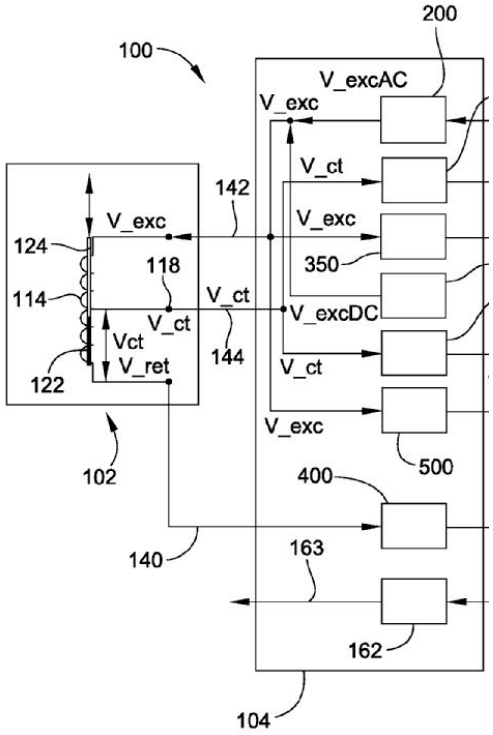
25 Significantly, the examiner noted that the schematic diagram of the 4-wire LVDT also shows six terminals (indicated by open circles on the diagram), but that the actual interface is characterised by the four wires in direct communication with the coils. In the same manner, the interface of the half-bridge LVDT should also be characterised by the wires in direct communication with the coils, i.e. three wires.

26 At the hearing, Mr Smith countered that the four-wire interface for the 4-wire LVDT discounts the two branch wires that provide voltage V_B to an amplifier of the signal conditioning circuit (not shown on diagram above) and so, by the same approach, the interface for the half-bridge LVDT should discount the two branch wires to the same amplifier of the signal conditioning circuit (not shown on diagram above but connected to the third and fourth terminals on the right-hand side of the diagram), which would still leave a four-wire interface.

27 It seems necessary for me to determine exactly what a skilled person would understand by the "electronic interface for the transducer" in order to determine whether the interface for the half-bridge LVDT of ZUMBAHLEN is provided by "no more than three electrical wires". I believe that the invention as defined in claim 1 can provide some guidance here since the "transducer" is defined as having "a stator with an inductive coil having a center tap... [and] an armature with a magnetically permeable core". Given that the "armature with a magnetically permeable core" has no physical connections to the electronics of the position sensing system, the "electronic interface for the transducer" would comprise the points of connection or interaction to the "stator with an inductive coil having a center tap". Considering the half-bridge LVDT of ZUMBAHLEN, these points of connection or interaction are at either end of the coil (i.e. two wires) and at the centre-tap (i.e. one wire). Hence, I am in agreement with the examiner's assessment of ZUMBAHLEN, namely that the electronic interface for the half-bridge LVDT is provided by three wires.

28 I am of the opinion that a skilled person would not consider any of the additional branch wires illustrated in the diagram of ZUMBAHLEN's half-bridge LVDT (i.e. the connections between the filled circles and open circles in the diagram) to constitute part of the "electronic interface for the transducer" in the same way that the additional branch wires illustrated in the diagram of ZUMBAHLEN's 4-wire LVDT would not be considered to constitute part of the (four-wire) interface for that transducer. I note that

the applicant's own figure 1 similarly shows a number of branch wires that they do not consider to be part of the "electronic interface" for their transducer 102, but rather part of the signal conditioning subsystem 104 of their invention (see below):



29 It remains for me to consider whether the difference between the prior art of ZUMBAHLEN and the inventive concept of claims 1 and 20, namely the correction for the effects of temperature and non-linearity, would have been obvious to the person skilled in the art.

30 In their letter dated 30 August 2016, the applicant has argued that US6097183 teaches away from the use of LVDTs and so a skilled person would not look to this patent for ways of improving the device of ZUMBAHLEN. However, the applicant has not so argued against the disclosures of US5245869 or US5332966 (their only comments made regarding US'869 related to the three-wire limitation of their claims that, I have concluded, is already disclosed in ZUMBAHLEN). In fact, at the hearing Mr Smith conceded that a skilled person may consider this other prior art as an obvious way to compensate the output of ZUMBAHLEN for the effects of temperature and non-linearity if such compensation were needed.

31 In their discussion of the background of the invention, on the first page of their application, the applicant acknowledges, "when employing these sensors (i.e. LVDT and RVDT sensors), the user must consider the best means for correcting variation in output data due to variations in temperature... [and the] user must also consider the best means for correcting variation in output data due to the nonlinearity." Hence, these considerations are presented, not as inventive insights, but as state of the art concerns of which the skilled person would be keenly aware. Therefore, upon reading ZUMBAHLEN, which does not specify any compensation or regulation for temperature or non-linearity (unlike HIRAMATSU), the skilled person could reasonably be expected to consider other solutions for temperature and/or non-linearity compensation, such as disclosed in US5245869 or US5332966.

32 Hence, I am of the opinion that the invention as defined in claims 1 and 20 lacks an inventive step. However, I am not convinced that the application is devoid of any patentable subject matter; for example, it appears from the agent's letter dated 30 August 2016 that the applicant considers the features of claims 14 and 15 to be inventive and, in paragraph 15 of his Examination Report dated 1 November 2016, the examiner has deferred further investigation of the features of these claims. These claims were not considered at the hearing for this very reason. The examiner's arguments relating to claims 2-13, 16-19, 21-27 and 29-30 as adding either known or routine modifications to the invention of claims 1 and 20 appear on their face to be well founded, but again these arguments were not explored fully at the hearing.

Conclusion

33 I have concluded that the invention as defined by claims 1 and 20 lacks an inventive step as required by section 1(1)(b). If the claims remain in their current form then the application will be refused under section 18(3).

34 However, I consider that the examiner's objections against claims 14, 15 and 28 cannot be supported without further investigation, therefore I will allow the applicant an opportunity to amend the claims and have the matter referred back to the examiner for further examination. I note that the applicant has already filed a further request to extend the compliance period for placing the application in order to allow for further amendment to be made and for examination to be carried out. This further request was made under rule 108(3) and is at the discretion of the comptroller, and I indicated at the hearing that I would exercise discretion in the applicant's favour.

35 The applicant should file amended claims within two weeks of the date of this decision.

Appeal

36 Any appeal must be lodged within 28 days after the date of this decision.

H JONES
Deputy Director, acting for the Comptroller