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An electric power transfer system

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(58) Field of search
H1T

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Fig.1.

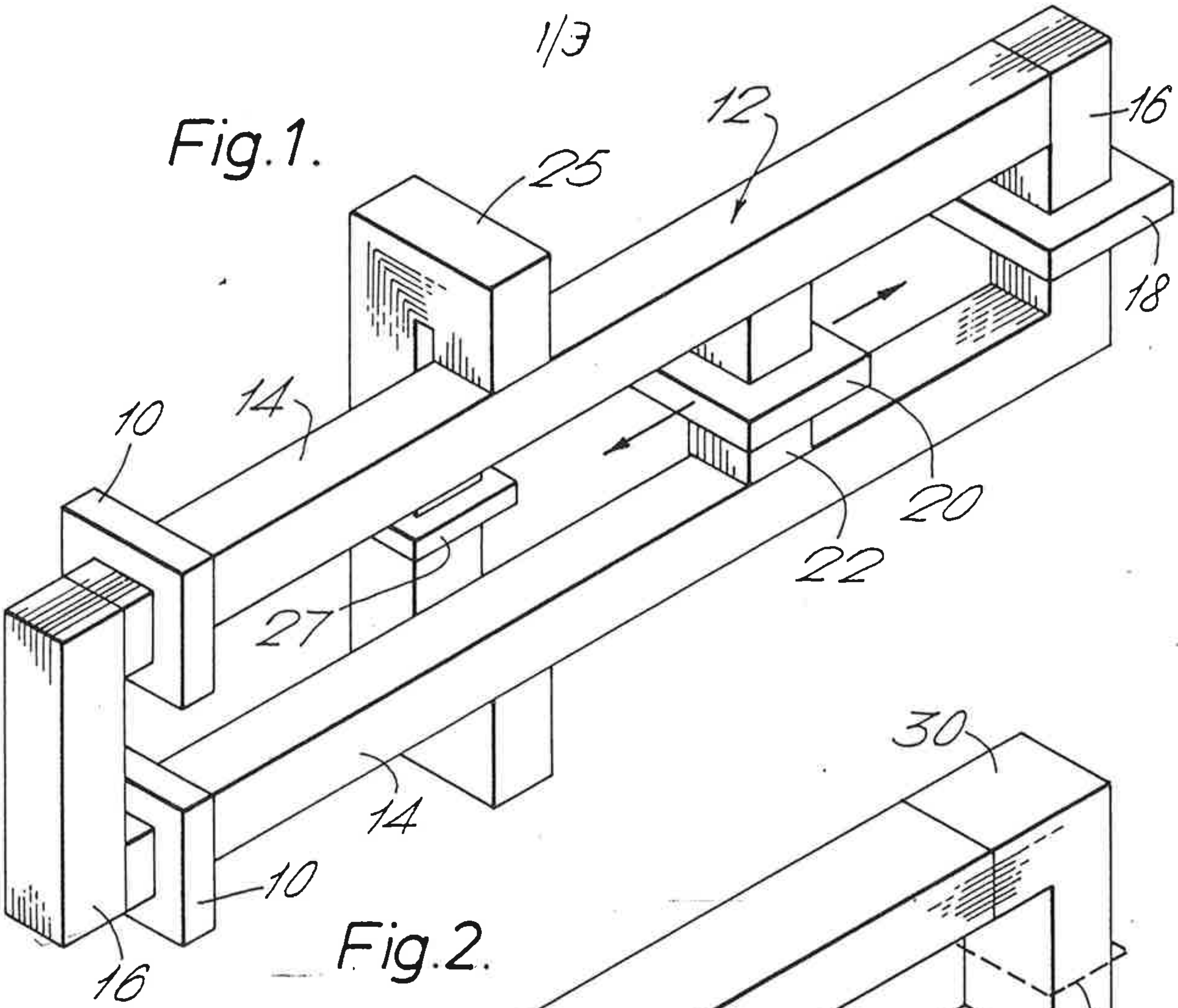
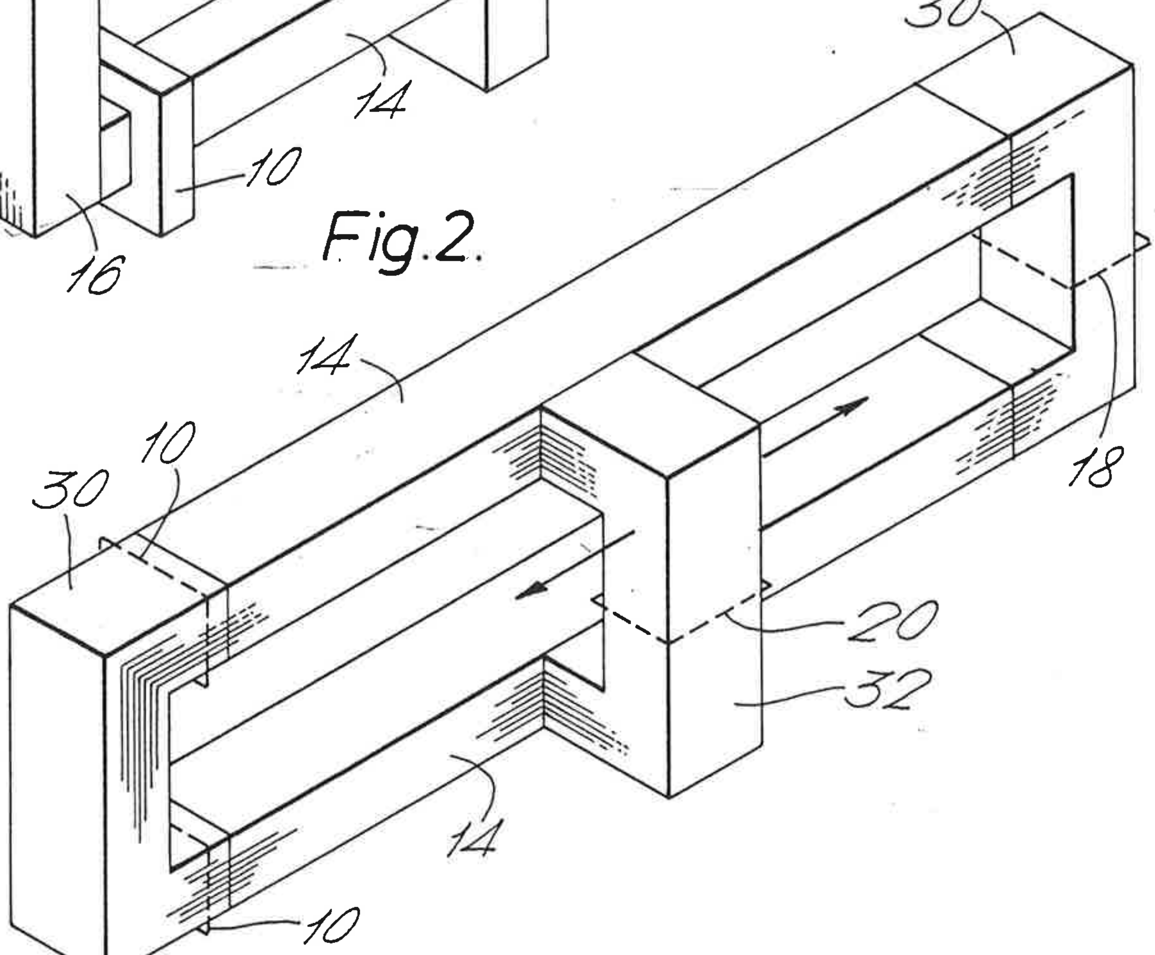


Fig.2.



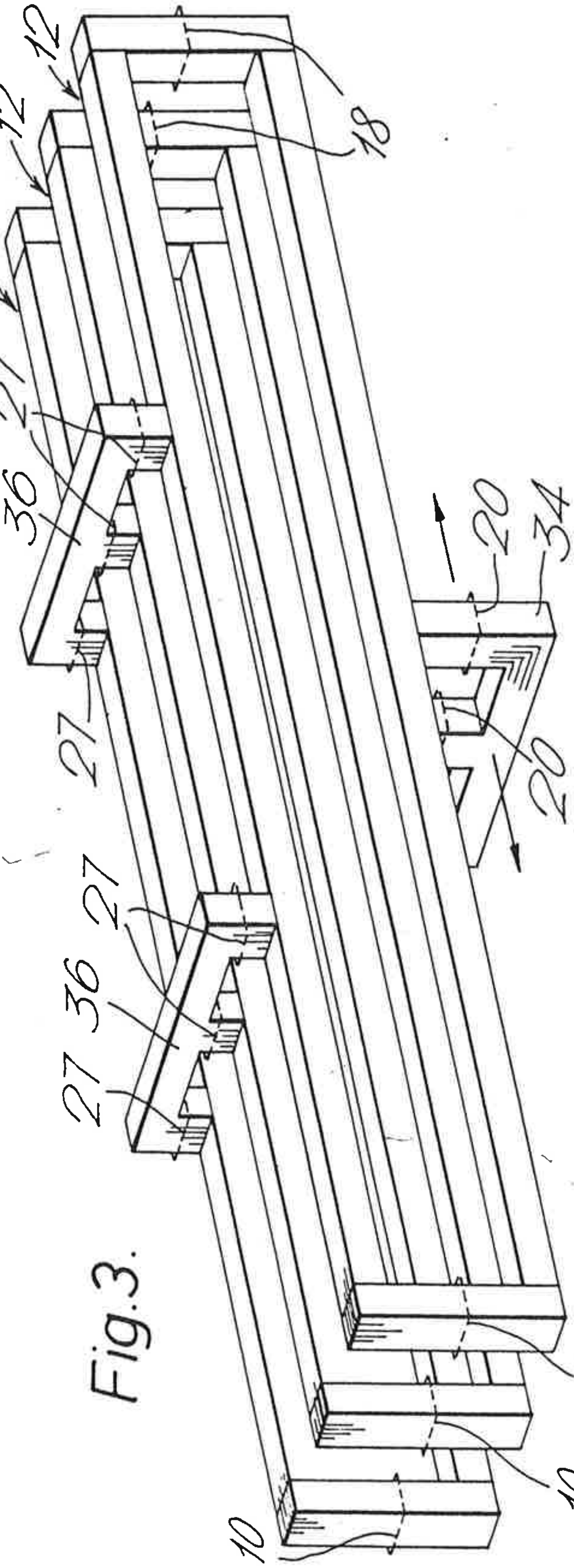

12
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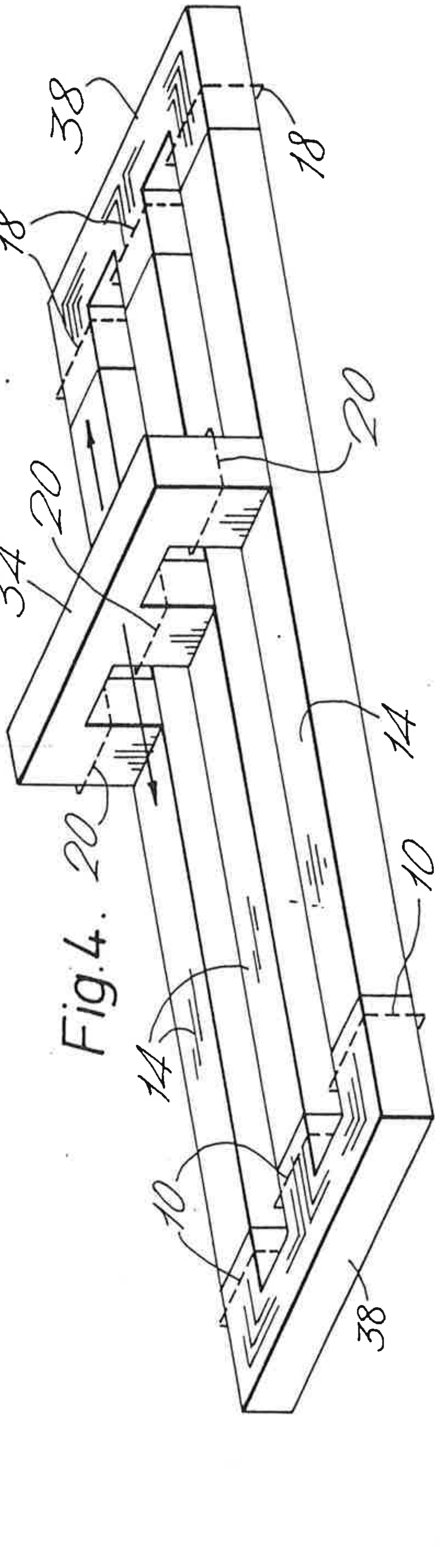
Fig.3.


38
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14
14
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38

Fig.4.

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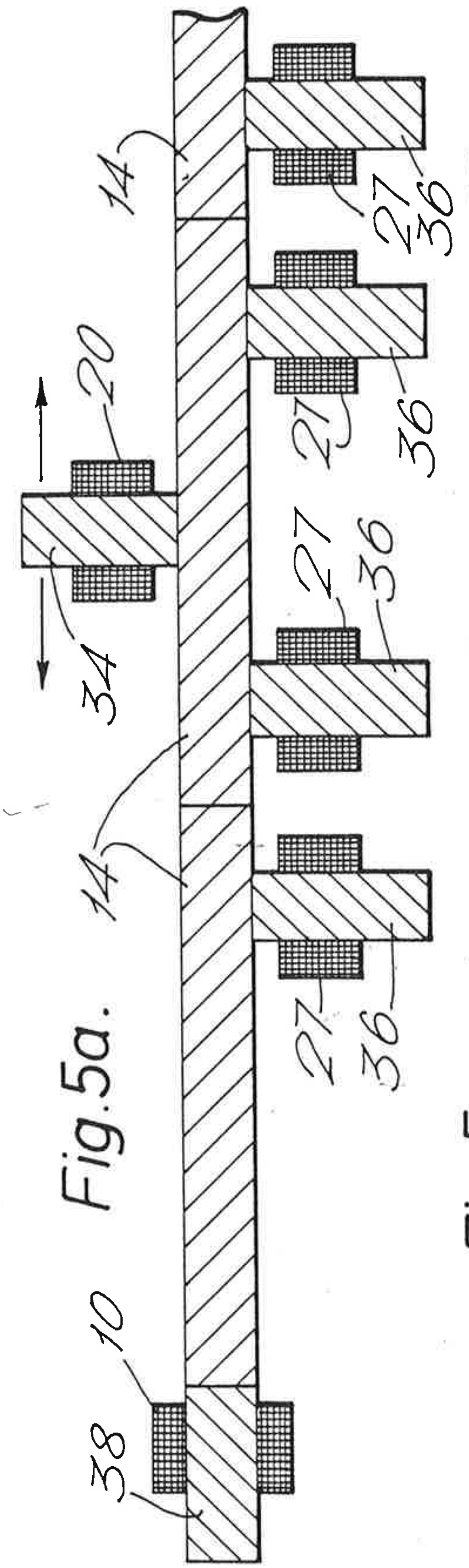

Fig.5a.

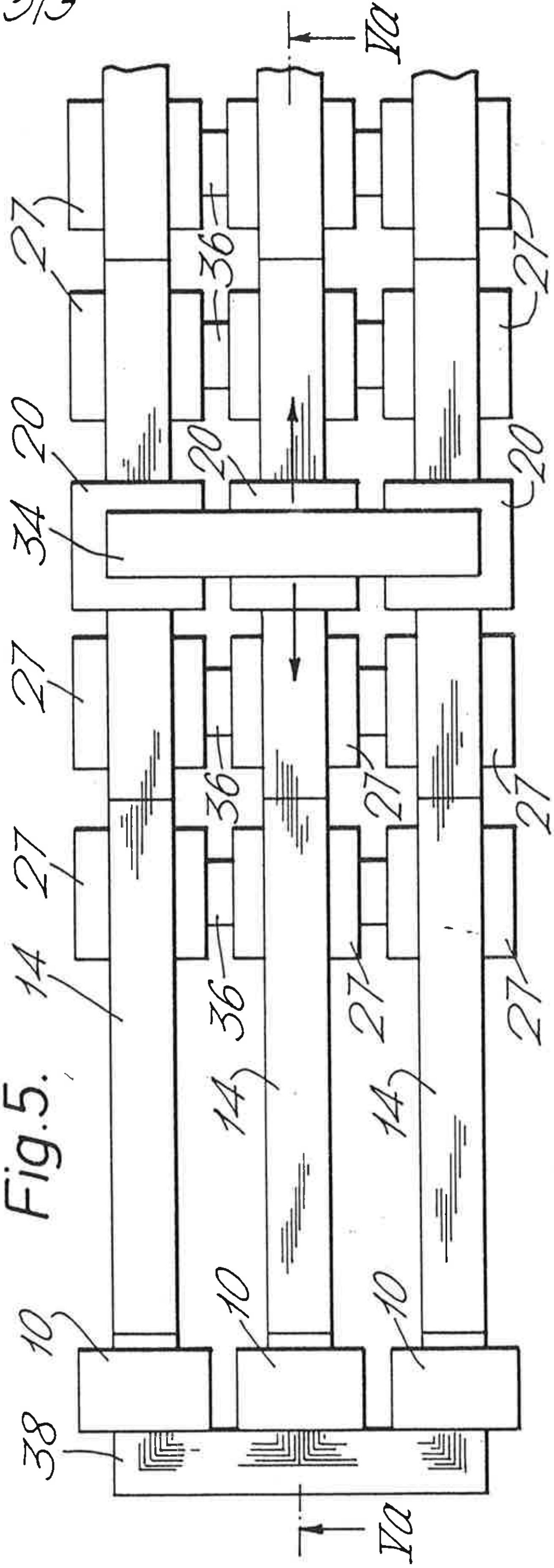

Fig.5.

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An Electric Power Transfer System

This invention relates to a system for transferring electric power from an electric source to an electrical device which is movable relative to the source.

Two known techniques for transferring electric power from a stationary source to a movable electric device, involve either the use of flexible cable links, or the use of brushes making contact with conductor rails. Cables may suffer fatigue due to repeated flexing, or encounter obstructions in use, and brushes may cause sparking and become contaminated with particulate material, thus making reliable electrical contact difficult.

According to the present invention, a power transfer system comprises transformer means comprising: a first magnetic core portion defining at least two spaced-apart regions thereof which extend in a direction along which power supply is to be provided; a first winding wound around the first core portion; a second magnetic core portion of limited extent in the said direction, providing a low reluctance flux path between the spaced-apart regions of the first core portion so as to complete a magnetic flux circuit therewith, and being movable relative to the first core portion along the said direction; and a second winding wound around the second core portion; wherein an auxiliary primary winding is wound around the first core portion remote from the first winding.

The regions which extend in the direction along which power is to be supplied might extend in a straight line, or in a curved or circular manner. The system may be adapted for polyphase operation.

The invention will now be further described by way of example only with reference to the accompanying drawings in which:-

Figures 1 and 2 show perspective representations of single phase electric power transfer systems;

Figures 3 and 4 show perspective representations of three-phase electric power transfer systems;

Figure 5 shows a plan view of a modification of the system of Figure 4; and

Figure 5*a* shows a sectional view along the line V*a* - V*a* of Figure 5.

In the above Figures, like parts have like numerals.

Referring now to Figure 1, a single phase power transfer system comprises primary windings 10 wound onto a magnetic core portion 12 formed from straight, elongate laminated iron bars 14 extending parallel to and adjacent to each other and linked at each end by short laminated iron bars 16. (Note: Short lines drawn on the bars 14 and 16 represent the direction of the laminations). An auxiliary primary winding 18 is provided at the end of the core portion 12 furthest from the primary windings 10 and a secondary winding 20 is wound onto a laminated iron member 22 which extends between the bars 14 and is movable in a direction parallel to the bars 14 as shown by the arrows, the member 22 providing a low reluctance magnetic path between the regions of the magnetic core portion 12 defined by the bars 14.

When the primary windings 10 are connected to a source (not shown) of alternating current with a frequency of for example 50 Hz, an alternating magnetic flux passes through the magnetic core portion 12 and also through the low reluctance magnetic path provided by the member 22. An alternating electromotive force (e.m.f.) will therefore be induced in the secondary windings 20, and may be used to provide electric power to an electrical device (not shown). Some magnetic flux leakage from the bars 14 can be expected. Hence if the member 22 is far from the primary windings 10, it may be necessary to augment the flux from the primary windings 10 by energising the auxiliary primary winding 18. The problems due to magnetic leakage become more significant the longer the bars 14, and one solution is to provide a C-shaped laminated iron core 25 magnetically linking the bars 14 and onto which an additional primary winding 27 is wound. It should be possible to have a multiplicity of such C-cores 25 along the length of the power transfer system, and if necessary the local additional primary windings 27 could be switched in as the member 22 approached. If required, the member 22 could be turned about its longitudinal axis.

An alternative system (not shown) similar to that of Figure 1, has the secondary winding 20 wound onto the C-core 25 which is made movable along the long bars 14, and if necessary has additional primary windings 18 wound on static members 22.

In Figure 2 is a slightly different single phase power transfer system from that of Figure 1, the main difference being in the plane of the laminations which are indicated in the same manner as in Figure 1. The system comprises primary windings 10 (all the windings being represented by broken lines) wound onto a laminated end portion 30. Two straight, elongate laminated iron bars 14 extend from the end portion 30, and at their far end are linked by another end portion 30 onto which an auxiliary primary winding 18 may be wound. A secondary winding 20 is wound onto a C-shaped laminated iron core 32 which makes wiping contact along the sides of the bars 14.

The power transfer system of Figure 2 operates in a similar manner to that of Figure 1, the C-core 32 providing a low reluctance flux path between the bars 14. If it is found necessary to augment the magnetic flux from the primary windings 10, this may be done by energising the auxiliary primary winding 18, or by energising additional primary windings (not shown) wound on C-shaped laminated iron cores (not shown) similar to the C-core 32 but fixed to the bars 14 on the other side to that of the C-core 32.

A three-phase power transfer system may be arranged as in Figure 3 utilising three magnetic core portions 12 of Figure 1, three primary windings 10 and, if required, three auxiliary primary windings 18 (only two are shown). Three secondary windings 20 (only two are shown) are wound onto a laminated iron E-shaped core 34, the E-core 34 being slidable along the magnetic core portions 12.

If required, additional primary windings 27 may be wound on fixed laminated iron E-shaped cores 36 linking the magnetic core portions 12 and spaced along their length on the opposite side to that of the slidable E-core 34.

In Figure 4 is shown a simpler design of three-phase power transfer system comprising three elongate bars 14 linked at each end by laminated iron E-shaped cores 38. On one E-core 38 three primary windings 10 are wound, and three auxiliary primary windings 18 are wound on the other E-core 38. Three secondary windings 20 are wound on a laminated iron E-shaped core 34 which is slidable along the top side of the bars 14.

The elongate bars 14 may be 50mm thick, 75mm wide and 2m long. If a longer power transfer system is required, the design of Figure 4 may be modified as shown in Figures 5 and 5a by laying the bars 14 end to end to the required length, primary windings 10 being wound onto an E-shaped core 38 at one end of the system and additional primary windings 27 being wound onto E-shaped cores 36 on the underside of the bars 14. The E-cores 36 are situated on either side of every butt joint between adjacent bars 14. As in the system of Figure 4, secondary windings 20 are wound on an E-shaped core 34 which is slidable along the upper side of the bars 14. Only the primary windings 10 or additional primary windings 27 in the vicinity of the E-core 34 need be energised. Sequential energising of the additional primary windings 27 produces the effect of a magnetic commutator.

In the power transfer systems described with reference to Figures 1 to 5, straight bars 14 are used to define regions of the stationary magnetic core portions. In these systems, the path along which the secondary windings 20 move and along which electrical power is available is a straight line. It will be understood that where electrical power must be supplied along a curved path, the elongate bars 14 may themselves be curved. Alternatively, elongate bars 14 may be laid end to end, as in the system of Figure 5, but so as to define a generally curved path. In each case, the two or more regions of the stationary core portion 12 must be separated by a constant distance along their length.

Operation of the power transfer system at higher frequencies, for examples 5kHz, enables smaller cores to be used to transmit the same power and increases the efficiency of the system. In addition, cores may be made of a ferrite or iron powder, rather than laminated iron.

If desired, the high frequency e.m.f. induced in the secondary windings may be subsequently converted to 50 or 60 Hertz using for example a controlled rectifier and a direct current link inverter.

In order to reduce the air gap between the magnetic core portions, a magnetic liquid such as Ferrofluid may be introduced between the portions. However, when the power transfer system is de-energised, an auxiliary low power electric supply may be necessary to provide sufficient residual magnetism in the core portions to retain the Ferrofluid.

In some applications of the invention a relatively thin non-magnetic material may be interposed between the first core portion and the second core portion, for example the wall of a tank enclosing a radioactive environment.

Claims:

1. An alternating current electric power transfer system comprising a transformer means, said transformer means comprising: a first magnetic core portion defining at least two spaced-apart regions thereof which extend in a direction along which power supply is to be provided; a first winding wound around the first core portion; a second magnetic core portion of limited extent in the said direction, providing a low reluctance flux path between the spaced-apart regions of the first core portion so as to complete a magnetic flux circuit therewith, and being movable relative to the first core portion along the said direction; a second winding wound around the second core portion; and an auxiliary primary winding wound around the first core portion remote from the first winding.

2. A power transfer system as claimed in Claim 1 wherein the regions extend in a straight line in parallel relationship to each other, the system comprising a plurality of first windings wound around a plurality of first magnetic core portions, the first core portions being arranged end to end such that the regions of each core portion are aligned with the regions of the adjacent core portion, the second core portion being movable relative to all the first core portions in sequence and providing a low reluctance flux path between the regions of the first core portion to which the second core portion is adjacent.

3. A power transfer system as claimed in Claim 2, wherein only the first winding adjacent to the second core portion is arranged in operation to be energised.

4. A power transfer system as claimed in any one of the preceding Claims wherein the number of regions is at least three, and at least three second windings are wound around

the second core portion, whereby polyphase electric power may be transferred.

5. A power transfer system as claimed in any one of the preceding Claims, wherein a magnetic liquid is located between the first core portion and the second core portion.

6. A power transfer system as claimed in Claim 5, including an auxiliary relatively low power source for magnetising the first core portion and the second core portion.

7. A power transfer system as claimed in any one of the preceding Claims, wherein a relatively thin non-magnetic material is interposed between the first core portion and the second core portion.

8. A power transfer system as claimed in any one of the preceding Claims, wherein both the first core portion and the second core portion are of ferrite.

9. A power transfer system substantially as hereinbefore described and with reference to Figure 1, or Figure 2 or Figure 3, or Figure 4, or Figures 5 and 5a, of the accompanying drawings.