

M. KUBO.
ART OF MAKING CORES FOR ELECTRICAL APPARATUS,
APPLICATION FILED OCT. 14, 1915.

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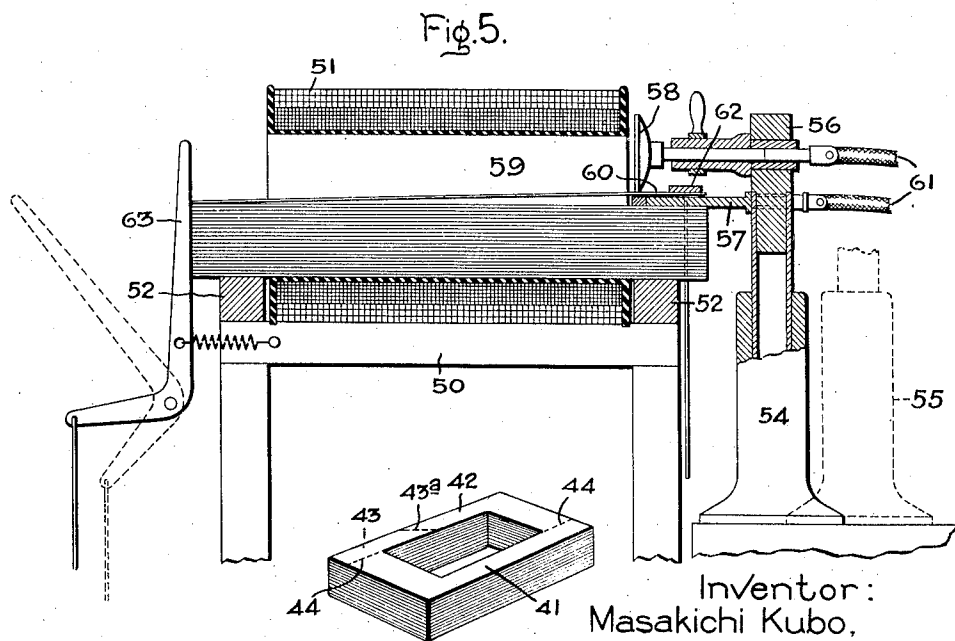
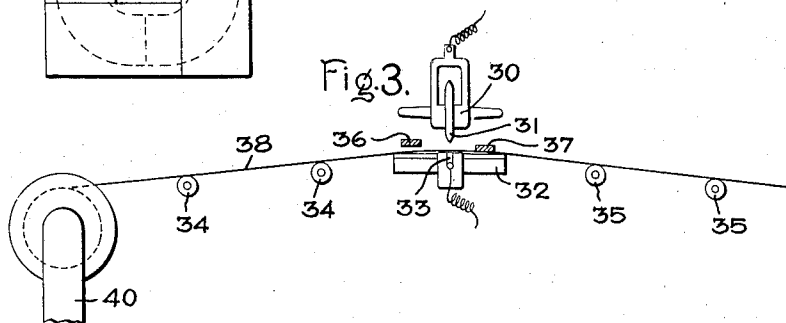
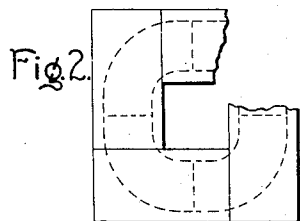
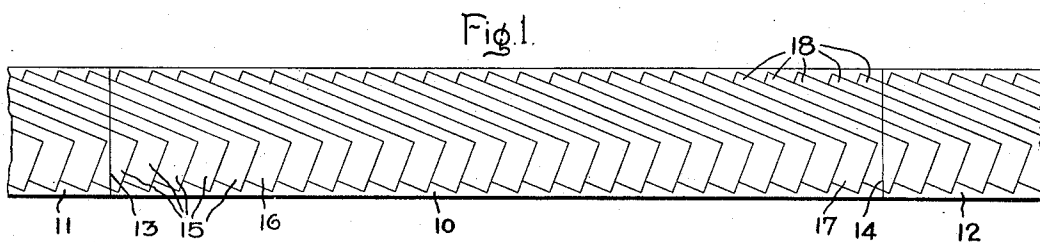


Fig. 4.

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ART OF MAKING CORES FOR ELECTRICAL APPARATUS.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, MASAKICHI KUBO, a subject of the Japanese Empire, and resident of Tokyo, Japan, have invented certain new and useful Improvements in the Art of Making Cores for Electrical Apparatus, of which the following is a specification.

My invention relates to the manufacture of laminated iron cores which form parts of, or the entire magnetic circuits of electrical apparatus of various types. Among the objects of my invention are the reduction of the amount of material wasted in the manufacture of such cores, and the more or less complete elimination of the air gaps at the joints within the core and the consequent reduction of the operating losses of such cores. While my invention in its broad aspect is applicable to many types of electrical apparatus, its most immediate application will probably be found in the manufacture of transformers, to which it is particularly applicable; so for the sake of simplicity, I shall mostly confine the following description to transformer practice. Its broader application to other electrical apparatus will be readily understood therefrom.

The importance and application of my invention will be better understood after a brief consideration of the general construction of transformer cores. Commonly such cores are built up of thin iron or steel laminations, each lamination consisting of a number of parts or sections punched from iron or steel sheets; two or more parts or sections are butted together to form a single lamination comprising, so far as possible, a complete magnetic circuit; a corresponding number of air gaps have heretofore necessarily occurred at the joints where the sections meet each other. The sheets from which the sections are taken have been obtainable in lengths varying up to a maximum of about 120 inches. Heretofore it has been common to design the cores and laminations thereof, with a view to getting the greatest number of complete lamination sections from each single sheet of metal, but although a great deal of ingenuity has been exercised toward this end, it has in the most common practice, especially for the smaller sizes of machines, been found impossible to avoid wasting a surprisingly great part of each sheet. In the manufacture of trans-

former cores, the greatest part of this waste occurs at the ends of the sheets; for example, in manufacturing a certain small sized transformer, for about every forty-six complete lamination sections taken from a 120 inch sheet, it is necessary to leave at the two ends of the sheet an amount of material, the area of which would be sufficient to form the parts of four more sections if it were of the proper shape and which must be thrown away as scrap; or to say it another way about, about eight per cent. of the material of the sheets is lost (except for its scrap value) due to the impossibility of utilizing the entire length of the sheet. By my invention, substantially all of this eight per cent. of the total material may be saved and even the operating losses due to the joints, which heretofore it has been impossible to avoid, may be minimized.

Now my invention is to be applied in a number of ways. For example, a number of the sheets from which the lamination sections are to be taken, may be welded together to form what is hereinafter called a strip,—in effect an extended sheet of a definite or indefinite length, from which the lamination sections may be taken to better advantage; though in general probably the sheets will be welded end to end. The sections may then be punched from the strip as they have been punched before from single sheets, but without the usual waste at the ends of each of the original sheets. The strip may be fed continuously direct from a welder to a punch press, in which case the press works on what is an indefinitely long strip and the end waste is substantially entirely eliminated. In a transformer core built up of lamination sections struck from such a strip, some of the lamination sections are made up of parts of different original sheets; however, since the parts of these respective sections are welded together, these sections are as complete as the other sections and may be assembled into a core as readily as the others, and entail no additional operating losses due to open butt joints between their parts. However, instead of welding the sheets of metal into strips, the parts of the sections produced at the ends of separate sheets may be welded together after the punchings are struck out. In fact all the joints between parts and sections of all the laminations may be welded if desired, with

the consequent elimination of the air gaps at the joints.

It should be observed that the material at the welds between parts and sections of a lamination for a core for electrical apparatus, should be of but very little greater thickness than the rest of the lamination; preferably it should be of no greater thickness at all, in order that there may be no waste of space within the confines of the core. Unutilized space here, as it will be well understood, necessitates additional material, otherwise unnecessary, in other parts of the completed apparatus. Such a weld may be secured by an electrical butt welding process hereinafter described, but my invention obviously is not limited to this particular process.

The accompanying drawing, to which reference is made in the following detailed description, forms a part of this specification. Figure 1 illustrates a portion of a strip of sheets welded end to end; the transformer core lamination sections which may be punched therefrom are indicated. Fig. 2 illustrates another strip made up of metal sheets otherwise arranged the instance illustrated showing a side and an end edge welded together in order that punchings such as arcuate shapes, which are here indicated, may be taken out. Fig. 3 illustrates a process of welding which may be used in carrying out my invention. Fig. 4 illustrates a completed lamination and transformer core embodying my invention. Fig. 5 illustrates another method of applying my invention.

The portion of the strip illustrated in Fig. 1 is made up of a complete original sheet 10 and portions 11 and 12 of two other sheets. These three sheets are welded end to end at 13 and 14. The pieces or lamination sections to be taken out are indicated. It will be observed that commencing at the weld 13 and reading to the right, the first five sections, 15, are incomplete (except as they are completed by the material from the sheet 11), parts only of these sections coming from original sheet 10. The first section complete in the original sheet 10 is 16. Likewise at the other end of the sheet 10, immediately to the left of the weld 14, it will be observed that after the last complete section 17 is taken out, there is sufficient material for parts 18 only of five more sections. As transformers have heretofore been constructed the lamination sections have been taken from separate sheets like 10, and it has been necessary to throw away as scrap the five lamination or section parts 15 and the five parts 18. According to my invention, however, a number of sheets are first welded together as at 13 and 14 to produce an indefinitely long strip of sheet metal and the sections are

taken from the strip rather than from the separate sheets. The parts of sections and laminations similar to those of 15 and 18 are not wasted, for as will be apparent from this figure, the parts 15 of sheet 10 are completed by the supplementary parts at the right-hand end of the sheet 11 and leave the punch press as complete sections of laminations, and likewise the parts 18 are completed from sheet 12.

In some cases it may be desirable to arrange the sheets in other manners to produce a strip from which the pieces desired may be taken out most advantageously. Fig. 2 illustrates one such other arrangement. In Fig. 2 pieces are desired of such a shape and size that it is impossible to get a complete piece from a single sheet. In this particular case the sheets are welded to each other at right angles as illustrated, and from the strip so produced, the pieces may be taken complete.

In Fig. 3 is illustrated a process by which the sheets may be electrically welded without increasing the thickness of the material at the joints. This has heretofore been pointed out as a feature which it is substantially necessary to incorporate in the manufacture of cores for electrical apparatus. It will be understood that only such portions of the welding machine are illustrated as will be necessary to understand the process. The exact form of the machine, it will be understood by those skilled in the art, may vary very considerably. The head 30 of the machine carries the disk electrode 31 which may rotate within the head 30; the head 30 is movable in a plane perpendicular to the plane of the drawing and also to and from the work. Immediately below the electrode 31 is a table 32 carrying the lower electrode 33 in the form of a copper bar. The head 30 (and therethrough the electrode 31) and the lower electrode 33 are connected to opposite sides of a suitable source of electrical energy. Carriers 34 and 35 support the work. Clamps 36 and 37 clamp the work to the table 32 as and when desired. The welding process is carried out as follows: The end of a sheet carried by the carriers 35 is abutted against the end of the strip 38 on the bar electrode 33 so that the seam lies just below the disk electrode 31. The clamps 36 and 37 are then lowered and clamp the strip 38 and the sheet to the table 32 in these positions. The head 30 and the electrode 31 are then pressed downward on the work at one end of the seam, and as current passes between the electrodes 31 and 33, the disk 31 is rolled from one end of the seam to the other and the weld made. The clamps 36 and 37 prevent the sheet and strip from separating

at the seam. It will be observed that the welding pressure is exerted on, and the welding current passed through the work at right angles to the juncture. After one weld is completed, the clamps 36 and 37 are released and the lengthened strip 38 pulled to the left until its new end reaches the table 32, when the process is repeated with another sheet. It will also be observed that by this welding process the material at the weld is no thicker than the material of the original sheets; if anything, it may be a little thinner. The device 40 is any device for receiving the strip 38; for example it may be a pulley directing the further travel of the strip 38, or a reel on which the strip 30 may be wound until needed, or it may be a punch press by which the pieces are taken from the completed strip.

It may be further noted, although it will be readily obvious to those skilled in this art, that my invention possesses an advantage not hereinbefore specifically referred to, in that it greatly expedites the work of punching out the laminations. Punch presses for punching out lamination sections are so constructed and arranged that once a sheet of metal is properly placed in position in the machine, and the machine started in operation, the laminations are punched out from that sheet successively with considerable rapidity. However, according to the practice universal prior to my invention, it is necessary to stop the machine at the end of each of the mill sheets, and the operator must place another sheet in the machine before the work may be proceeded with. The time lost is very considerable, for as before indicated the sheets as received from the mill are fairly short, varying from about fifty (50) inches to one hundred twenty (120) inches. By my invention this loss may be substantially entirely eliminated and a very considerable saving in time and in cost of the laminations secured even though the lamination sections made up of welded parts may not be utilized in the construction of electrical apparatus, because by employing my invention it is unnecessary to introduce each of the original sheets into the punch press separately, each following another automatically and the punch press working substantially continuously on an indefinitely long strip. Obviously when my invention is considered solely from this standpoint, that is saving time and cost in getting out lamination sections, it is not so material to minimize the thickness of the material at the weld.

In Fig. 4 is illustrated a transformer core embodying my invention, the joints in the top lamination being shown by the dotted lines. It will be observed that the top lamination is made up of three parts; the in-

herently complete section 41 and the two parts 42 and 43 of the second section of the lamination. These two parts are welded at 43^a, and the two sections may be welded at 44. Of course, not every lamination of this transformer core is necessarily made up of more than two parts, for as will be understood by reference to Fig. 1, only a small portion of all the lamination sections of a given core are likely to be made up of two parts. All or a part only of the welds may be made prior to punching the laminations as has been described heretofore, or after the sections and parts of the laminations have been punched out of separate sheets (that is from sheets not welded together as hereinafter referred to). One method of welding these parts and sections as the core is being assembled is illustrated in Fig. 5. According to this method the coils of the transformer are first wound up on forms or frames and the lamination sections and parts are inserted singly until the complete core is built up therein. A table 50 carries the coils 51; the first section of a lamination is laid on the blocks 52. As other sections or parts of this lamination are laid down, they are welded at their contacting edges to the part or parts already in place. Other laminations are built up on the first and succeeding laminations in the same way. This welding is done by the machine shown at the right of the figure, the essential parts of which only are illustrated. This machine comprises a standard 54 which may be moved backward and forward as illustrated in dotted lines at 55. The head 56 of this standard 54 may be raised and lowered at will and carries a lower electrode 57 in the shape of a plate, and a disk electrode 58 which may be rolled along the plate for a distance corresponding to the length of the seam to be welded. Two lamination parts 59 and 60 are laid in place and their edges abutted above the plate 57 which is inserted into the core space for that purpose. The electrode 58 is then rolled along over the seam between the parts 59 and 60 and energy is supplied to the electrodes 57 and 58 by the cables 61. After the weld is completed, the disk electrode 58 is moved from contact with the lamination and the standard 54 moved away from the transformer, removing the plate 57 from the core space and allowing the lamination to drop down into place. The clamps 62 and 63 hold the lamination parts in place during the welding operation. It will be observed that this welding process is substantially the same as that described with reference to Fig. 3.

My invention as hereinafter defined delineates the new method by which I have thus advanced the art of manufacturing core lamination; the article or product thereof

being the subject of my copending application Serial No. 246,032, filed July 22, 1918, which is a division of this application.

While I have described the principle of my invention and the best mode I have contemplated for applying this principle, other modifications will occur to those skilled in this art and I aim in the appended claim to cover all modifications which do not involve a departure from the spirit and scope thereof.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

The method of manufacturing core laminations for electrical apparatus whose di-

mensional component longitudinally of the stock is a non-multiple of the stock's longitudinal dimension; which consists in welding strips of stock together edge to edge, and in successively striking laminations from said stock in continuous advance transverse to the welded edge.

In witness whereof I have hereunto set my hand this fifteenth day of September, 1915.

MASAKICHI KUBO.

Witnesses:

GUS BINDER,
GEORGE KURIBARA.