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(54) HEATING AMORPHOUS METAL TO FACILITATE CUTTING.

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Description

This invention relates to a method for cutting a stack of superimposed sheets of amorphous metal such as the superimposed laminations of an amorphous metal core for an electrical transformer.

GB—A—2 081 611 describes a method of making a magnetic core from amorphous strip material for use in a transformer or similar electrical induction apparatus.

In accordance with this method, a continuous strip of non-annealed amorphous metal is wound around a mandrel to form an initially round core which thereafter is clamped in a predetermined way and cut entirely through one transverse section thereof while a rust inhibiting liquid coolant is applied thereto. The resulting unconnected strips are then separated into a number of groups which are assembled together in a predetermined manner to form a substantially oval core. This core, in its final shape, is annealed and simultaneously subjected to a magnetic field of predetermined strength.

Amorphous metal has a non-crystalline structure which provides superior electrical characteristics, relative to crystalline steel type metals, desired for electrical transformers. The superior electrical characteristics are manifested in reduced electrical losses in the amorphous metal core. The amorphous metal sheets have a critical temperature in the order of 450°C which when reached or exceeded may transform the amorphous metal from its non-crystalline state to its crystalline state.

The non-crystalline amorphous metal has a brittle glass-like structure which when subjected to a striking or penetrating force may cause the amorphous metal to shatter in a glass-like manner. The amorphous metal is typically made available in rolls formed of a continuous sheet of relatively thin material. A material thickness of 0.038 mm (1.5 mils) is typical.

In the fabrication process of an electrical transformer the amorphous metal sheet is typically arranged to form superimposed laminations of the core for the electrical transformer. Upon or during the arrangement of the amorphous metal into the superimposed laminations, severing of the amorphous metal sheet needs to be accomplished. It is desired that the severing produce a smooth, clean cut of the amorphous metal sheet. It is further desired that the structure of the amorphous metal sheets be maintained in their non-crystalline state.

Accordingly, an object of the present invention is to provide a method for cutting the amorphous metal sheets so as to provide a smooth, clean cut and no shattering or cracking of the amorphous metal sheets.

It is a further object of the present invention to provide a method for cutting the amorphous metal sheets so as to reduce the required cutting force and to also reduce the wear caused to the cutting device.

It is a still further object of the present invention to provide for a cutting operation in which the structure of the amorphous metal sheet is maintained in its non-crystalline state.

These and other objects of the invention will become apparent to those skilled in the art upon consideration of the following description of the invention.

In accordance with the present invention, a method of cutting with penetrating structure a stack of superimposed sheets of amorphous metal is provided. The method comprises the steps of:

(a) positioning the stack of amorphous metal sheets against a working surface;

(b) heating a predetermined region of the sheets of the stack to a temperature in the range of 80°C to approximatey 450°C so as to render the region plastic or softened but without causing crystallization of said region, and

(c) while said region is within said temperature range and still plastic or soft, during a penetrating structure toward said working surface through said region, thereby cutting the stack with a smooth clean cut.

The invention may be better understood by reference to the following description taken in conjunction with the accompanying drawings.

Brief Description of the Drawings

Fig. 1 is a block diagram illustrating certain features of a method for cutting superimposed amorphous metal laminations arranged for a wound-type amorphous metal core configuration.

Fig. 2 is a block diagram illustrating certain features of a method for cutting superimposed amorphous metal laminations arranged for a stacked-type amorphous metal core configuration.

Fig. 3 is a block diagram showing certain features of one embodiment of the present invention for cutting superimposed amorphous metal laminations arranged for a wound-type amorphous metal core configuration.

Fig. 4 is a block diagram illustrating features of a further embodiment of the present invention.

Fig. 5 illustrates the paper cutter type cutting operation of the embodiment of Fig. 4.

Fig. 6 is a block diagram illustrating features of a further alternate embodiment of the present invention.

Detailed Description of the Preferred Embodiment

Fig. 1 is a block diagram according to one embodiment of the present invention for cutting a stack of superimposed sheets of amorphous metal comprising superimposed laminations of a wound-type amorphous metal core for an electrical transformer.

The superimposed laminations of the amorphous metal core comprise a stack of superimposed amorphous metal sheets shown in Figure 1 as 22A, 22B, 22C, 22D, 22E, 22F, 22H . . . 22N and the core is generally designed by a reference number 22. The amorphous metal core 22 is arranged into the wound-type configuration by conventional winding technique prior to its cutting, shown in Figure 1, and to be described hereinafter. The winding of the amorphous core into its wound-type configuration, prior to its cutting is not considered part of this invention and will not be further described. Similarly, after the amorphous-metal core 22 of Fig. 1 is cut it is further processed into final form, which is an amorphous metal core for an electrical transformer. The subsequent processing steps for the amorphous metal core of Figure 1 are not considered part of this invention and will not be further described.

The amorphous metal core 22, shown in Fig. 1, is positioned so as to be disposed between an upper structure 24, having a penetrating shape of a blade arrangement, and a lower structure 16 having a generally rectangular shape. The amorphous core 22 is shown as positioned against the lower portion 16 which serves as a working surface for a cutting operation. The upper and lower structures, 24 and 16, respectively, are interconnected to a fluid motor 18 and a heating means 12.

Heating means 12 may be of the hot-liquid or hot-gas type available from Air Reduction Company (AIRCO) of New York, New York. Heating means 12 is coupled to the blade 24 and the working surface 16 by a heat carrying duct 15.

A controlled heat produced by heating means 12 and conducted by duct 15 is shown by an arrow 14. This controlled heat 14 is divided into the heat conducted to the blade 24 by duct 15, as shown by arrow 14A, and to the heat conducted to the rectangular block 16 by duct 15, as shown by arrow 14B. The heated blade 24 and the heated working surface 16 attain positions relative to each other under the control of a suitable fluid motor 18.

Fluid motor 18 may be of any suitable conventional form capable of imparting the desired downward force and speed to an output member. For the arrangement, shown in Fig. 1, the fluid motor 18 supplies a downward force to its coupled blade 24 as indicated by the direction of arrow 20. The amount of downward force and the sequence of its application to blade 24 described hereinafter with regard to the parameters for cutting the amorphous metal core 22.

The amorphous metal core 22 is arranged to be disposed between blade 24 and working surface 16 at a position desired for the cutting of the amorphous metal core 22. The resistance heating means 34 of Fig. 3 (soon to be described) supplies heat to the sheets so as to develop a desired heating and cutting region 25. The heating and cutting region 25 occupies a typical heated zone of 4.10 cu cm (0.25 cu in) and typical cutting zone of 0.16 cu cm (0.010 cu in) each measured about the mid-point of blade 24. The temperature of the region 25 is elevated to and maintained at a value that is greater than 80°C but less than approximately 450°C. The preferred temperature range is 100°C—300°C. The upper limit of 450°C is of critical importance because if such limit is equaled or exceeded, the amorphous metal laminations 22A . . . 22N may transistion from their non-crystalline to their crystalline state, which in turn, reduces the superior electrical characteristics of the amorphous metal laminations 22A . . . 22N desired for forming the amorphous metal core 22. The lower temperature of the desired range of region 25 is the temperature at which the amorphous metal begins to soften or become plastic, making the amorphous metal laminations 22A—22N more amenable to cutting so as to eliminate the shattering or cracking that may normally occur during the cutting of unheated amorphous metal laminations.

The desired temperature of region 25 is controlled by the amount of heat supplied by heating means 34, the dimensions of blade 24, the dimensions of working surface 16, and the number of laminations 22A . . . 22N desired to be cut.

In the practice of this invention, fifteen (15) amorphous metal laminations 22A . . . 22N each having a thickness of 0.038 mm (1.5 mils) and width of 25.4 mm (1.0 inch) were successfully cut. The region 25 was maintained between 100°C and 300°C. The temperatures of blade 24 and working surface 16 were also elevated and maintained within the range of 100°C to 300°C. The blade 24 had a volumetric capacity of approximately 147.48 cu cm (9.0 cu in). Similarly, working surface 16 had a volumetric capacity of approximately 294.97 cu cm (18.0 cu in).

In one embodiment for cutting the fifteen (15) sheets of amorphous metal, the blade 24 and working surface 16 were heated with a gas type source supplied by heating means 12 so as to provide flame-type heating. In another embodiment, the blade 24 and block 16 were supplied with a resistance-type heat. Both the flame and resistance-type heating successfully cut the 15 amorphous metal laminations 22A . . . 22N. Although amorphous metal laminations have been successfully cut using heat supplied to the tools from a flame and resistance type heater, it should be recognized that a hot air gun, an induction heater or other types of heat source may be also utilized for heating means 12 in the practice of this invention.

Fig. 1 shows the relative positions of amorphous metal laminations 22A . . . 22F after each has been cut by blade 24 and the position of amorphous metal lamination 22G having the blade 24 contacting it at a location 26. The blade 24, via the downward driving force supplied by fluid motor 18, applies a typical force of 2000 pounds (9896 N.) to the contact location 26. This force of 2000 pounds (9896 N.) applied to the heating penetrating blade 24 which is contacting the heated amorphous metal sheet 22G causes the blade 24 to penetrate through and thus cut the heated amorphous metal sheet 22G. The continued application of the force of 2000 pounds (9896 N.) applied to blade 24 continues the cutting of the remaining heated amorphous metal laminations comprising the amorphous metal core 22.

The desired force of 2000 pounds (9896 N.) is a considerable reduction from a force of 10,000 pounds (44.482 N.) typically desired to cut unheated amorphous metal lamination. Further, a reduced force of 2000 pounds (9896 N.) correspondingly reduces the wear to the cutting device, such as the penetrating structure 24, which in turn, increases the life of the cutting device 24.

The cutting of the amorphous metal laminations 22A . . . 22N by the present invention provides a smooth, clean edge at the cut portions. For example, for the previously discussed cutting of the 15 amorphous metal laminations, the edges of cut portions were relatively smooth, did not have any cracks, and had little burr.

A second embodiment of the present invention is shown by a block diagram representation 30 shown in Fig. 2. Fig. 2 has an arrangement similar to the arrangement of Fig. 1 and where applicable uses the same reference numbers of Fig. 1 to identify the same element described for Fig. 1. The main differences between the arrangement of Fig. 1 and the arrangement of Fig. 2 is that the working surface of Fig. 1 is replaced by a second blade 28 of Fig. 2, and wound-type amorphous metal core 22 of Fig. 1 is replaced with a stacked-type amorphous metal core 32.

The second blade 28 has dimensions as previously given for the first blade 24. The second blade 28 is positioned with respect to the first blade 24 so that raised portions of blades 24 and 28 contact each other when the fluid motor 18 applies the previously discussed downward force to blade 24.

The desired heat is supplied to blade 28, in the direction of arrow 14B, by the duct 15 coupled to the heating means 12. The heat supplied from resistance heating means 34 of Fig. 3 supplies heat to the sheets and develops a heating and cutting region 27 which is similar to the previously described heating and cutting region 25 of Fig. 1. The mid-point of region 27 is approximately located at contact point 26, previously described for Fig. 1, and shown in Fig. 2. The temperature of region 27 is elevated and maintained within the range of 80°C—450°C in a manner as previously described for region 25. The preferred temperature range for region 27 is between 100°C—300°C.

The stacked-type ammorphous metal core 32 is shown in Fig. 2 as a flat arrangement comprised of a stack of superimposed amorphous metal laminations 32A . . . 32N. The amorphous metal laminations 32A . . . 32N of Fig. 2 are cut by the penetrating blade 24 in a manner as previously described for blade 24 cutting of the amorphous metal lamination 22A . . .22N of Fig. 1. The smooth, clean edge at the cut portions previously desired for amorphous metal laminations 22A . . . 22N also results for the cut amorphous metal laminations 32A . . . 33N.

A still further embodiment of the present invention is shown by a block diagram representation 50 of Fig. 3. The amorphous metal core 22, previously discussed with regard to Fig. 1, is cut by the arrangement shown in Fig. 3 operating in a punch and die configuration wherein a blade 42 functions as the punch, and a solid block 48 functions as the die.

A major difference between operation of the arrangement 30 shown in Fig. 3 and that of the arrangements 10 and 30 shown and described for Figs. 1 and 2, respectively, is that only the amorphous metal core 22 shown in Fig. 3 is elevated in temperature whereas amorphous metal cores 22 and 32 and blades 24 and 28 (Figs. 1 and 2) and the working surface 16 (Fig. 1) are all elevated in temperature. The amorphous metal core 22 of Fig. 3, in particular, region 29 of the amorphous metal core 22 is elevated and maintained within a range of 80°C to 450°C, having the preferred range between 100°C—300°C, from controlled heat developed by a resistive heater 34.

Resistive heater 34 may be of the type A.C. Transformer with electronic control available from Taylor Winfield Corp. of Warren, Ohio. The resistance heating device 34 supplies a currrent in the directions shown by arrow 36, path 40, and arrow 38 to and through the amorphous metal core 22. The resistance heating means 34 is coupled to amorphous metal core 22 via its output transformer 35.

The electric current of the resistive heater 34 is primarily coupled to the amorphous metal core 22 by the path 40 shown in Fig. 3 The current from resistive heater 34 flows in path 40 and develops the heating region 29 which corresponds to the previously described region 25 of Fig. 1.

The path 40 is established, in part, by restricting the flow of current from resistive heater 34 to desired electrical conductive portions of a conductive block 44. The restriction of path 40 is accomplished by placing an insulating material 46 over the portions of conductive block 44, shown in a cross hatched representation, for which it is desired to inhibit current flow. The insulating material 46 may be of resin type paper and has a typical thickness of 3.17 mm (0.125 in). The insulating material 46 is also placed onto the cutting portion of punch 42.

The current through path 40 is further restricted from flowing within the die-type block 48 by the placement of an insulating material 49, shown with a circular type representation, which is similar to the previously mentioned insulating material 46.

The conductive block 44, in addition to its conductive portions supplying an electrical medium for path 40, provides the coupling means second pneumatic means 52 which drives the punch blade 42 in a downward-sequential manner to be described. Pneumatic means 52 may be of a Dual Air Action Cylinder type available from the Taylor Winfield Company of Warren, Ohio.

The blade 42, coupled to pneumatic means 50 acts as punch which is forced downward so as to strike and penetrate through the amorphous metal laminations 22A . . . 22N of amorphous metal core 22. The force supplied to blade 42 from pneumatic means 52 desired for sequentially penetrating each of amorphous metal laminations 22A . . . 22N is greatly reduced by elevating the temperature of the amorphous metal laminations 22A . . . 22N to be softened, or rendered plastic, in the heating and cutting region 29. For example, a striking force of 10,000 pounds (44482 N.) is typically desired to penetrate through unheated amorphous metal laminations, whereas a force of only 2,000 pounds (8896 N) is necessary to penetrate through the heated amorphous metal laminations of the present invention at a temperature of about 200°C.

Cutting is effected immediately after the heating region reaches the desired temperature range so that the amorphous metal in region 29 is still in its softened or plastic state while cutting is taking place.

The amorphous metal laminations 22A . . . 22N are cut in a sequential manner so as to have a V-type configuration 54 as shown in Fig. 3. The blade 42 is sequentially driven in a downward manner by pneumtic means 52 so as to only contact and strike an individual amorphous metal lamination. The blade 42 continues it downward movement until all of amorphous metal laminations 22A . . . 22N are penetrated and cleanly cut so as to have smooth cut portions.

A further embodiment of the present invention is shown in Fig. 4. Fig. 4 shows a block diagram 60 similar to the previously discussed block diagram 30 of Fig. 2 with the exception that the penetrating blades 24 and 28 of Fig. 2 are replaced with a paper-cutter type arrangement comprising an upper movable knife-type blade 62 which mates with a stationary knife-type blade 64. Fig. 4 shows the heating and cutting region 27 that is developed in a manner as previously discussed with regard to Fig. 2.

The knife-type portions 62 and 64 are operated similar to the well known paper cutter. The paper cutter embodiment of Fig. 4 is further shown in Fig. 5 by a side illustration of the cutting operation.

Fig. 5 shows the working surface as the stationary blade 64 and the penetrating structure as the movable knife blade coupled to the fluid motor 18. The movable knife blade 62 is positioned to initially contact one edge 70 of the amorphous metal core 32 comprised of the stack of the amorphous metal sheets 32A . . . 32N. The movable knife blade 62 is subjected to a downward force, in the order of 200 to 300 pounds (889,6 N. to 1.334,4 N.) by way of the fluid motor 18, in such a manner that the cut produced by the movable blade 62 and stationary blade 64 progresses transversely of the amorphous stack 32A . . . 32N as the movable blade 62 moves toward the stationary blade 64. The stationary blade 64 operates in a manner similar to the stationary portion of a paper cutter, whereas, the movable knife blade 62 operates in a manner similar to the knife blade of a paper cutter both for simultaneously cutting a plurality of amorphous metal sheets. The movable blade 62 and the stationary blade 64 may be of the combination steel and carbide type available from National Carbide Die of McKeesport, Pa.

A still further embodiment of the present invention is shown in Fig. 6. Fig. 6 shows a block diagram 80 similar to the previously discussed block diagram 60 of Fig. 4 with the exception that the movable knife blade 62 and the stationary blade 64 are respectively replaced with an upper shear or scissor type blades 66 and a lower shear of scissor type blade 68. The lower scissor blade 68 provides the working surface for the cutting operation, whereas, the upper scissor blade 66 provides the penetrating structure for the cutting operation. Fig. 6 shows a heating and cutting region 27 that is developed in a manner as previously discussed with regard to Fig. 2.

Claims

1. A method of cutting a stack of superimposed sheets of amorphous metal, comprising the step of:

(a) positioning said stack of amorphous metal sheets against a working surface;

(b) heating a predetermined region of the sheets of the stack to a temperature in the range of 80°C to approximatey 450°C so as to render the region plastic or softened but without causing crystallization of said region, and

(c) while said region is within said temperature range and still plastic or soft, during a penetrating structure toward said working surface through said region, thereby cutting the stack with a smooth clean cut.

2. A method according to claim 1 wherein said penetrating structure is a blade with a sharp cutting edge.

3. A method according to claim 1 wherein said amorphous metal sheets are elevated to said temperature range by supplying electric current to said amorphous metal sheets.

4. A method according to claim 1 wherein the penetrating structure is heated to a temperature in the range of 80°C to 450°C during the cutting operation.

5. A method according to claim 1 wherein said working surface is heated to a temperature in the range of 80°C to 450°C during the cutting operation.

6. A method according to claim 1 wherein said penetrating structure and said working surface are heated to a temperature in the range of 80°C to 450°C during the cutting operation.

7. A method according to claim 1 wherein said penetrating structure is heated to a temperature in the range of 80°C to 450°C by applying hot fluid thereto prior to and during the cutting operation.

8. A method according to claim 1 wherein said working surface of said penetrating structure is heated to a temperature in the range of 80°C to 450°C by applying hot fluid thereto prior to and during the cutting operation.

9. A method according to claim 1 wherein said working surface is a surface of a stationary blade

and said penetrating structure is a mating blade movable toward said stationary blade in such a manner that the cut produced by said blades progresses transversely of said stack as said movable blade moves toward said stationary blade.

10. A method according to claim 1 wherein said heating of said stack heats the region being cut to a temperature range of 100°C to 300°C.

11. A method according to claim 3 wherein said heating of said stack heats the region being cut to a temperature range of 100°C to 300°C.

12. A method according to claim 4 wherein said heating of said stack heats the region being cut to a temperature range of 100°C to 300°C.

13. A method according to claim 5 wherein said heating of said stack heats the region being cut to a temperature range of 100°C to 300°C.

14. A method according to claim 6 wherein said heating of said stack heats the region being cut to a temperature range of 100°C to 300°C.

Patentansprüche

1. Verfahren zum Schneiden eines Stapels von superpositionierten Blechen aus amorphem Metall, enthaltend die Schritte:

(a) Positionieren des Stapels von Blechen aus amorphem Metall gegen eine Arbeitsfläche,

(b) Erhitzen eines vorbestimmten Bereichs des Blechstapels auf eine Temperatur in dem Bereich von 80°C bis etwa 450°C, um so diesen Bereich plastisch oder weich zu machen, ohne eine Kristallisierung des Bereichs zu bewirken, und

(c) während der Bereich innerhalb des Temperaturbereichs und noch plastisch oder weich ist, Andrücken eine durchdringenden Struktur in Richtung auf die Arbeitsfläche durch den Bereich hindurch, wodurch der Stapel mit einem glatten, sauberen Schnitt geschnitten wird.

2. Verfahren nach Anspruch 1, wobei die durchdringende Struktur eine Schneide mit einer scharfen Schneidkannte ist.

3. Verfahren nach Anspruch 1, wobei die Bleche aus amorphem Metall auf den Temperaturbereich erhöht werden, indem den Metallblechen elektrischer Strom zugeführt wird.

4. Verfahren nach Anspruch 1, wobei die durchdringende Struktur auf eine Temperatur in dem Bereich von 80°C bis 450°C während des Schneidvorgangs erhitzt wird.

5. Verfahren nach Anspruch 1, wobei die Arbeitsfläche auf eine Temperatur in dem Bereich von 80°C bis 450°C während des Schneidvorgangs erhitzt wird.

6. Verfahren nach Anspruch 1, wobei die durchdringende Struktur und die Arbeitsfläche auf eine Temperatur in dem Bereich von 80°C bis 450°C während des Schneidvorgangs erhitzt werden.

7. Verfahren nach Anspruch 1, wobei die durchdringende Struktur auf eine Temperatur in dem Bereich von 80°C bis 450°C erhitzt wird, indem vor und während des Schneidvorgangs ein heißes Fluid aufgebracht wird.

8. Verfahren nach Anspruch 1, wobei die Arbeitsfläche der durchdringenden Struktur auf eine Temperatur in dem Bereich von 80°C bis 450°C erhitzt wird, indem vor und während des Schneidvorgangs ein heißes Fluid aufgebracht wird.

9. Verfahren nach Anspruch 1, wobei die Arbeitsfläche eine Oberfläche von einer feststehenden Schneide ist und die durchdringende Strucktur eine passende Schneide ist, die in Richtung auf die feststehende Schneide in der Weise bewegbar ist, daß der durch die Schneiden erzeugte Schnitt quer zum dem Stapel fortschrietet, wenn sich die bewegbare Schneide in Richtung auf die feststehende Schneide bewegt.

10. Verfahren nach Anspruch 1, wobei das Erhitzen des Stapels den geschnittenen Bereich auf einen Temperaturbereich von 100°C bis 300°C erhitzt.

11. Verfahren nach Anspruch 3, wobei das Erhitzen des Stapels den geschnittenen Bereich auf einen Temperaturbereich von 100°C bis 300°C erhitzt.

12. Verfahren nach Anspruch 4, wobei das Erhitzen des Stapels den geschnittenen Bereich auf einen Temperaturbereich von 100°C bis 300°C erhitzt.

13. Verfahren nach Anspruch 5, wobei das Erhitzen des Stapels den geschnittenen Bereich auf einen Temperaturbereich von 100°C bis 300°C erhitzt.

14. Verfahren nach Anspruch 6, wobei das Erhitzen des Stapels den geschnittenen Bereich auf einen Temperaturbereich von 100°C bis 300°C erhitzt.

Revendications

1. Procédé de découpe d'un empilage de tôles superposées en métal amorphe, comprenant les étapes consistant à:

(a) mettre en place l'empilage de tôles en métal amorphe contre une surface de travail,

(b) chauffer une zone prédéterminée des tôles de l'empilage à une température comprise dans la gamme allant de 80°C à approximativement 450°C de manière à rendre plastique ou ramollie ladite zone mais sans provoquer la cristallisation de la zone, et,

(c) alors que la zone se trouve dans la gamme de températures et reste plastique ou ramollie, entraîner une surface pénétrante vers la surface de travail par l'intermédiaire de la zone, d'où la découpe de l'empilage suivant une coupe régulière, nette.

2. Procédé selon la revendication 1, dans lequel la structure pénétrante est une lame présentant une arête vive.

3. Procédé selon la revendication 1, caractérisé en ce que les tôles en métal amorphe sont portées à la gamme de températures en appliquant un courant électrique aux tôles en métal amorphe.

4. Procédé selon la revendication 1, dans lequel la structure pénétrante est chauffée à une température dans la gamme allant de 80°C à 450°C lors de l'opération de découpe.

5. Procédé selon la revendication 1, dans lequel la surface de travail est chauffée à une température comprise dans la gamme allant de 80°C à 450°C pendent l'opération de découpe.

6. Procédé selon la revendication 1, dans lequel la structure pénétrante et la surface de travail sont chauffés à une température comprise dans la gamme allant de 80°C à 450°C pendant l'opération de découpe.

7. Procédé selon la revendication 1, dans lequel la structure pénétrante est chauffée à une température comprise dans la gamme allant de 80°C à 450°C en lui appliquant un fluide chaud avant et pendant l'opération de découpe.

8. Procédé selon la revendication 1, dans lequel la surface de travail de la structure pénétrante est chauffée à une température comprise dans la gamme allant de 80°C à 450°C en lui appliquant un fluide chaud avant et pendant l'opération de découpe.

9. Procédé selon la revendication 1, dans lequel la surface de travail est une surface d'une lame fixe et la structure pénétrante est une lame d'accouplement mobile vers la lame fixe d'une manière telle que la découpe produite par les lames progresse transversalement à l'empilage alors que la lame mobile se déplace vers la lame fixe.

10. Procédé selon la revendication 1, dans lequel le chauffage de l'empilage provoque le chauffage de la zone découpée à une gamme de températures allant de 100°C à 300°C.

11. Procédé selon la revendication 3, dans lequel le chauffage de l'empilage provoque le chauffage de la zone découpée à une gamme de températures allant de 100°C à 300°C.

12. Procédé selon la revendication 4, dans lequel le chauffage de l'empilage provoque le chauffage de la zone découpée à une gamme de températures allant de 100°C à 300°C.

13. Procédé selon la revendication 5, dans lequel le chauffage de l'empilage provoque le chauffage de la zone découpée à une gamme de températures allant de 100°C à 300°C.

14. Procédé selon la revendication 6, dans lequel le chauffage de l'empilage provoque le chauffage de la zone découpée à une gamme de températures allant de 100°C à 300°C.

Fig.1.

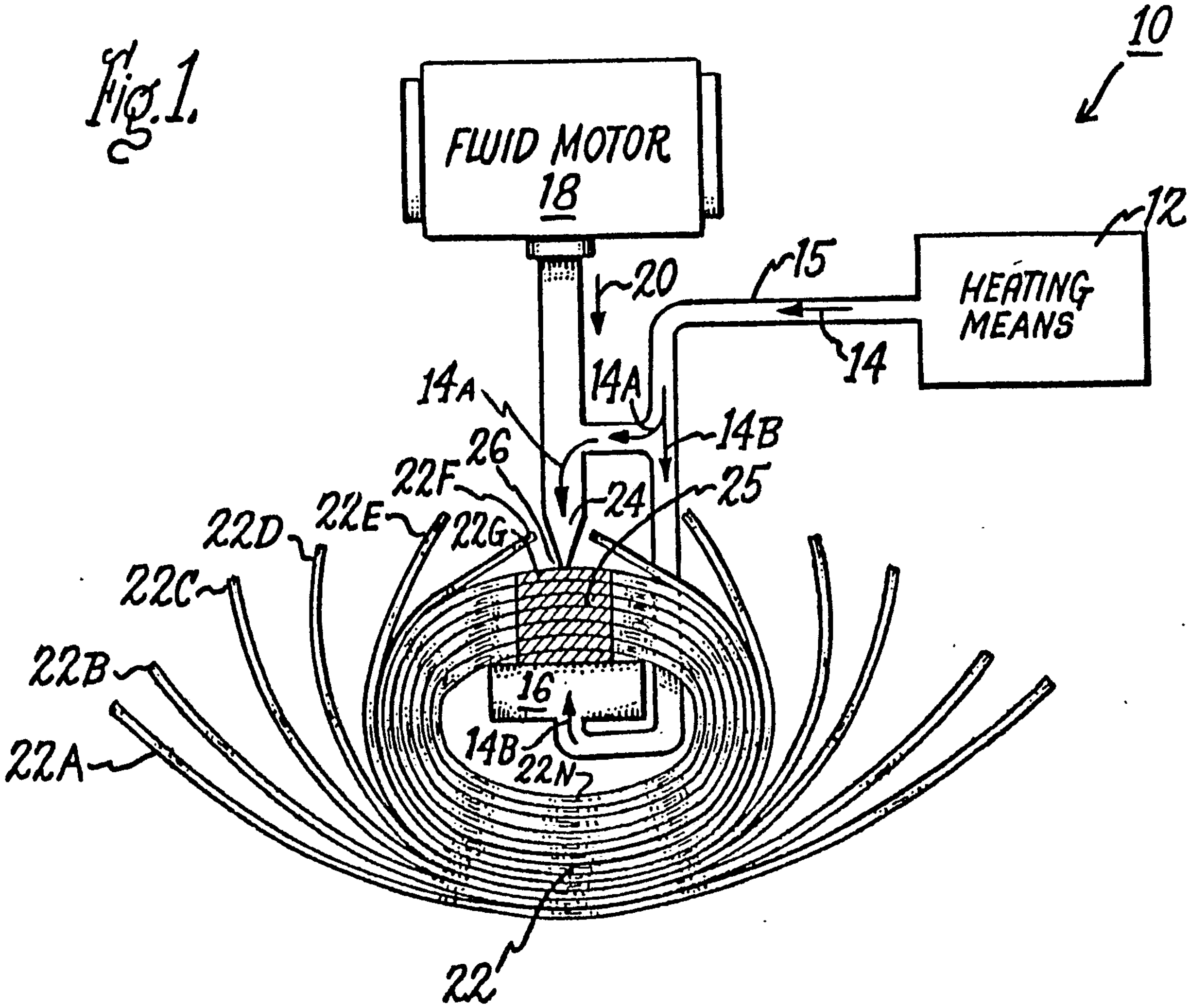

10
FLUID MOTOR
18
12
HEATING MEANS
15
14
20
14A
14A
14B
26
24
25
22F
22E
22G
22D
22C
22B
22A
16
14B
22N
22

Fig. 2.

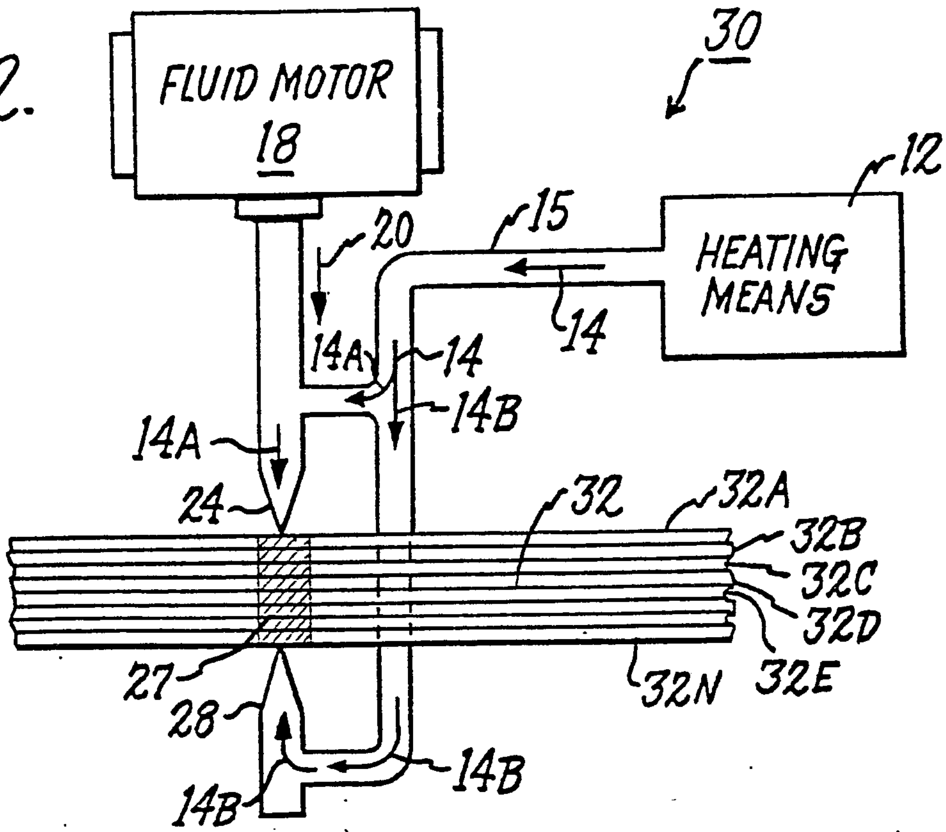
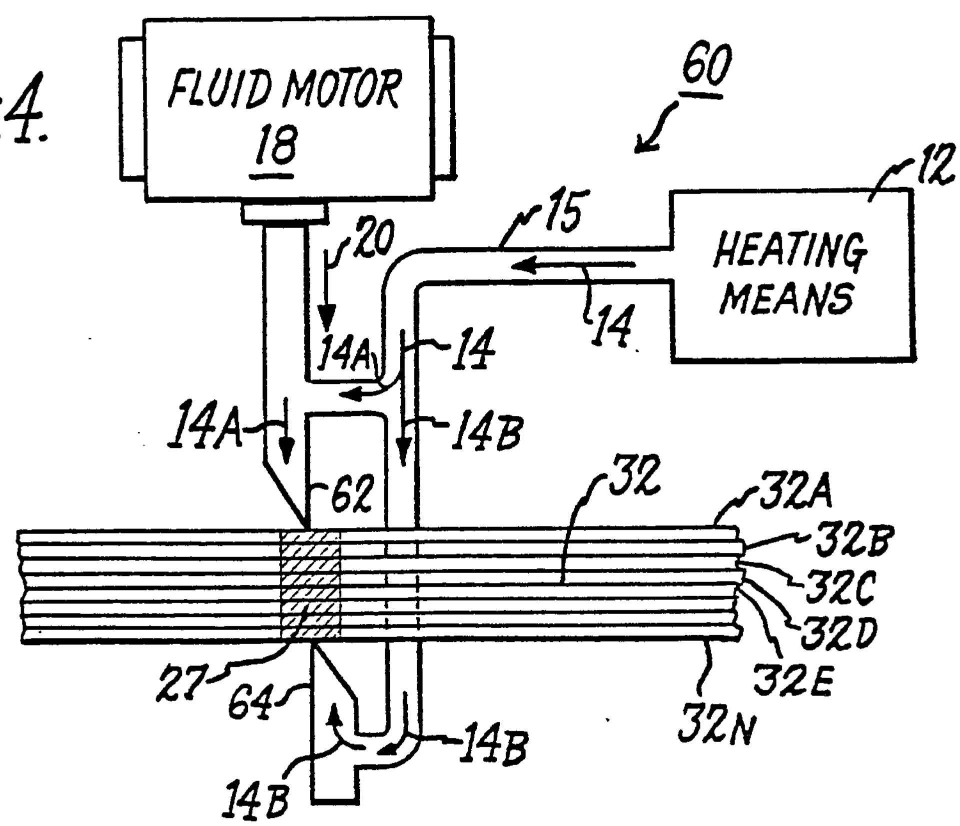

FLUID MOTOR
18
30
12
HEATING MEANS
15
20
14
14A
14
14B
14A
24
32
32A
32B
32C
32D
32E
32N
27
28
14B
14B

Fig. 4.


FLUID MOTOR
18
60
12
HEATING MEANS
15
20
14
14A
14
14A
14B
62
32
32A
32B
32C
32D
32E
32N
27
64
14B
14B

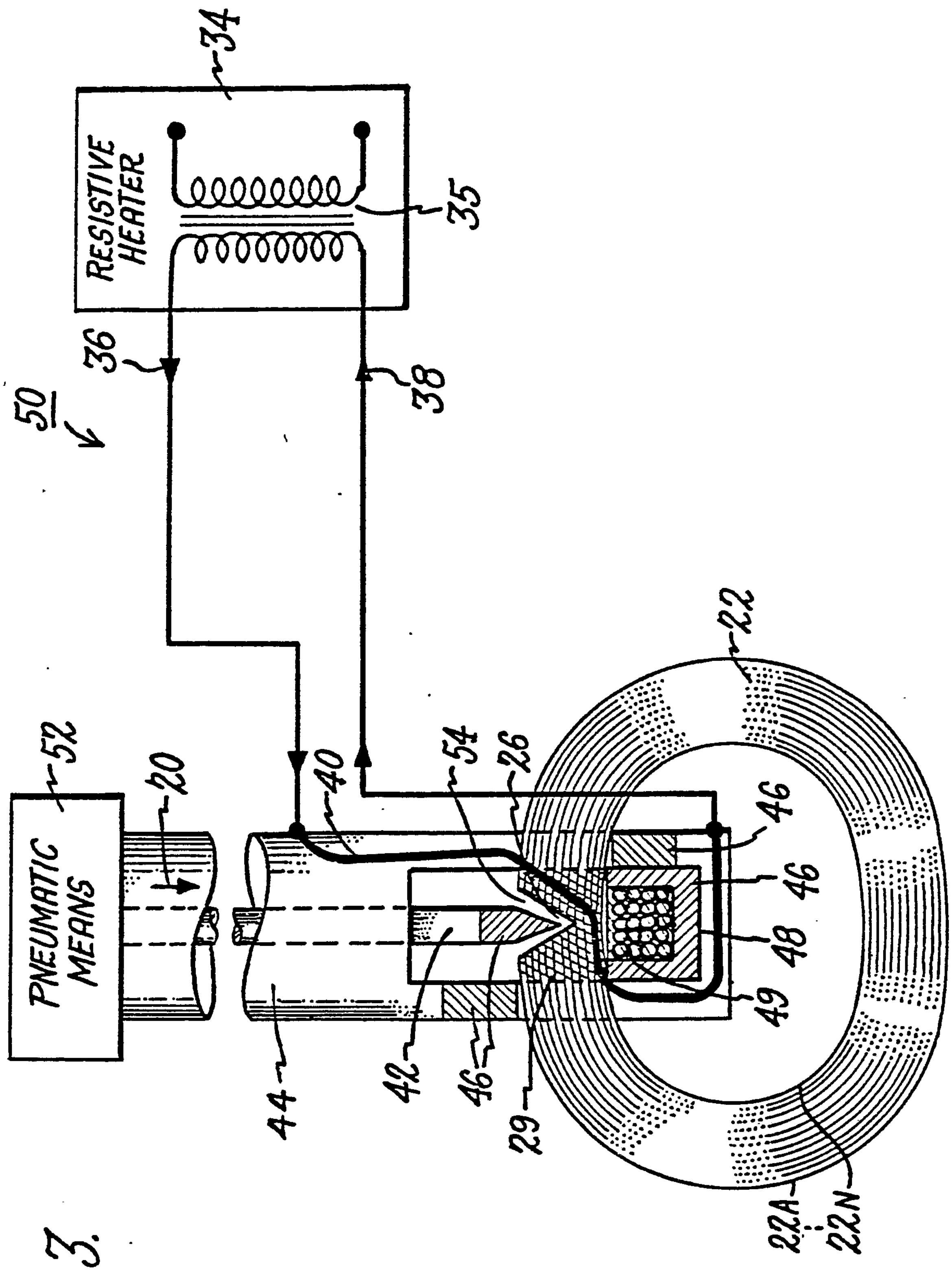

RESISTIVE HEATER
34
35
36
38
50
PNEUMATIC MEANS
52
20
40
54
26
46
46
48
49
22
44
42
46
29
22A
22N

Fig. 3.

Fig.5.

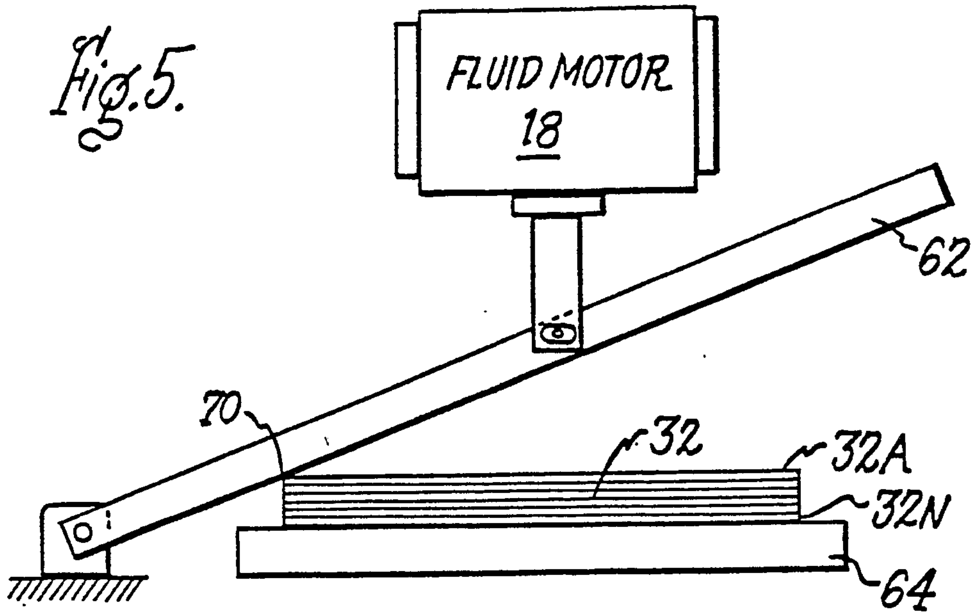
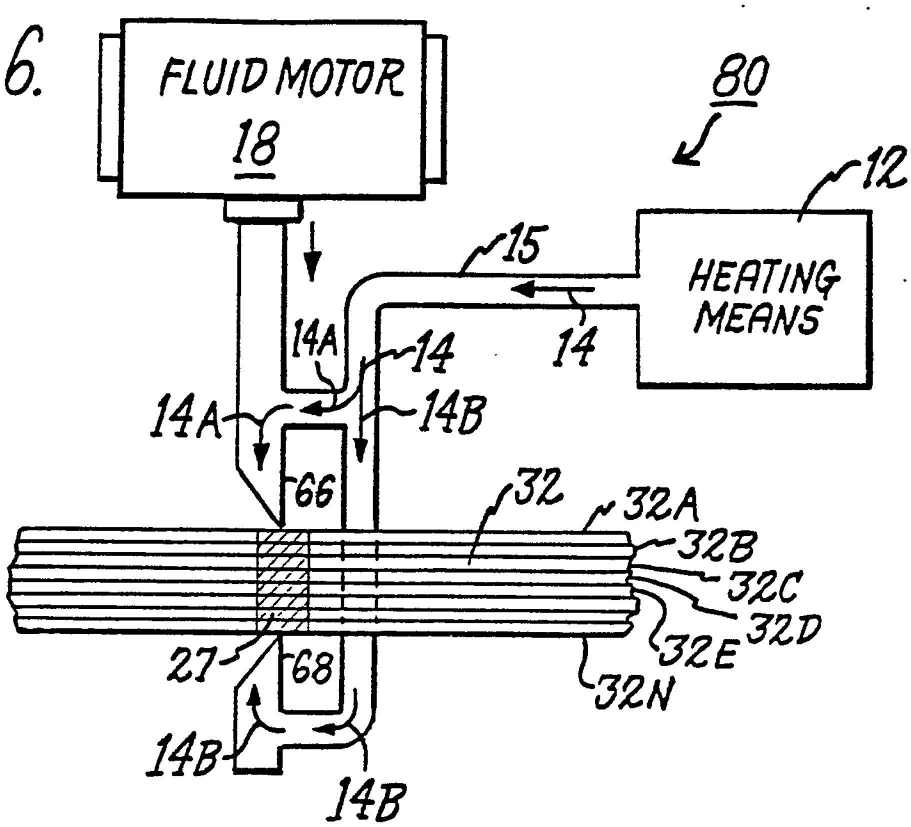

FLUID MOTOR
18
62
70
32
32A
32N
64

Fig.6.


FLUID MOTOR
18
80
12
15
HEATING MEANS
14
14A
14
14A
14B
66
32
32A
32B
32C
32D
32E
27
68
32N
14B
14B