

EUROPEAN PATENT SPECIFICATION

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⑧ **Magnetic cores assembly plant for electric transformers and the like.**

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Description

5 The invention refers to a plant for assembling magnetic cores for electric transformers or other made up of die-cut laminations, comprising at least a store for said shaped laminations, an assembling plane onto which the core is formed, and gripping and transferring means for transferring said laminations from said store to said assembling plane.

10 DE—B—1,268,719 discloses a plant of this type in which two stores are placed on the sides of an assembling plane. On each of said stores there are piled up layers of laminations which are alternately drawn by gripping and transferring means. Said means piles up the laminations onto said assembling plane in such a way that the layers of the core being formed are drawn alternately from the said two stores. The laminations on each store are placed one with respect to the other in the same position which they will have in the assembled core.

15 After completion of the core, the letter must be opened in order to insert the coils onto the columns. This known plant is designed for assembling only cores having rectangular cross section. Furthermore the laminations must be placed on each store in a rigidly predetermined position and are adjacent to each other. The positioning of the laminations, which is done with help of special abutments, is an extremely slow and costly operation.

20 DE—A—2,845,676 discloses a plant for assembling transformer cores of the above mentioned type, in which there are provided two sets of stores placed along the sides of a central conveyor.

25 A gripping means draws the laminations from the stores and lets them fall on the conveyor, on which laminations are positioned by way of gravity against abutments provided thereon. The number of stores provided in the plant corresponds to the number of layers of laminations forming the core being assembled. This renders the plant extremely costly and cumbersome and useful only for very high productions as it lacks in flexibility.

30 Furthermore, this known plant is able to assembly only cores having a rectangular cross-section and cannot be used for assembling stepped cores.

35 The object of the invention is to provide an assembly plant for transformer cores and the like of the above mentioned type which overcomes the drawbacks of the known plants. More particularly, the object of the invention is to provide a flexible plant which is able to assembly cores of different dimensions and of different cross-sections, and also stepped cores. These and further objects which will become apparent to those skilled in the art by reading the following description, are obtained by an assembly plant in which a plurality of stores are provided, which are able to be alternately positioned in a single drawing position. The gripping and transferring means draw a set of said laminations forming one step of the core from the store which in that moment is placed in said drawing position and place them onto said assembling plane. The movements of said gripping and transferring means and of said stores are controlled by a programmable central unit and can be modified as a function of the type of core to be assembled.

40 The number of stores can be varied according to the type and size of the cores which have to be assembled. For example, if the core has a rectangular cross section only two stores are sufficient for its assembling while by simply varying the number of stores and the program which controls the movements of the stores and the gripping means, stepped cores can be assembled with the same plant. Due to its flexibility, the plant can be used also for assembling a small amount of cores for each size or kind. Moreover the dimensions of the plant may be adapted to the specific temporary production by simply adding or eliminating stores.

45 In a particularly advantageous embodiment of the invention, the gripping and transferring means comprise mobile frames which move between said drawing position and said assembling plane. On each of said mobile frames, members are provided moving in a direction orthogonal to the moving direction of said frames and forming vertical guides for sucker lift means or the like. The sucker lift means grip the laminations placed on the relevant store. Said members may be moved one relative to the other so that the laminations may be moved one with respect to the other prior to be placed onto the assembling plane. In this way, the position of the laminations on the relevant store needs not to be the same as the final position that they have in the assembled core. This eases the positioning of the laminations on the stores. In particular, said moving members and/or said frames may be operated — by catches or step-by-step motors or other equivalent means — to bring the laminations close to each other in the assembly arrangement and stagger subsequent laminations or groups of laminations.

50 In order to make the plant particularly flexible, each of said stores may comprise a platform or carriage displaceable along rail tracks or equivalent guiding means. Said guiding means may be placed perpendicularly to the trajectory of said mobile frames.

55 Each of the gripping and transferring means may comprise at least two suckers capable of engaging the lamination towards the ends thereof, and a central catch in order to achieve a convex curvature in the lower part of the lamination which is being lifted, apt to facilitate the separation thereof from the remaining pile of the laminations.

60 As an alternative, or in addition to said central catch, there may be provided magnets or electromagnets able to induce a homopolar local magnetization in the adjacent laminations in order to cause a repulsion between the close ends of the superimposed laminations, so as to facilitate the separation of the lamination being lifted out from the remaining pile of laminations.

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If needed for production requirements, the plant may comprise two assembling planes which operate out of phase.

The following description and the attached drawing disclose in more detail — but, however, in a rough, exemplifying and, therefore, non limitative way — the present invention, reference also being made to the prior art. In the drawing:

Figs. 1 and 2 show a core and a local cross section of one element thereof;

Figs. 3 and 4 show a group of shaped laminations which may be utilized to form a layer of an assembly of components and the relative position taken up by said laminations in the partial composition of a core for the mounting of the windings;

Figs. 5 and 6 are, respectively, a plan view and an elevation view of one embodiment of a plant according to the invention; and

Fig. 7 shows a diagram of the stages succession of a work-cycle.

A three-phase magnetic core is made up of three straight parallel elements, called columns, and of two elements, called yokes, also parallel between them but at right angle to the columns, which yokes close the magnetic circuit. Each of the above elements consists of a plurality of matched ferromagnetic laminations. Both the yokes and columns have sections of generally square or rectangular shape or inscribed in a circle and with a steps-like pattern. The stepped, or staircase section represents the most general case, while the square and rectangular ones are particular cases. In general, the stepped section is obtained by forming shaped laminations into rectangular packs, the laminations width corresponding to a certain set of strips, while the thickness of the packs is a consequence of the condition to achieve the perfect inscription of the cross section into a circle. By increasing the number of steps, the filling coefficient of the circular section approaches the unity. For constructive reasons, the number of steps is usually dependent on the cross-section diameter of the core components (yokes and columns) and is usually kept to a low value in order to simplify the shearing and assembly operations.

An example of a complete magnetic core is shown in Figs. 1 and 2, Fig. 1 showing the core as a whole, while Fig. 2 shows the stepped section of the columns and yokes. The external columns C_E have the interspace I_0 and the yokes G have the interspace H_0 . The central column is indicated by C_C . In the cross section, Φ_N is the diameter of the circumscribed circumference and E, F are, respectively, the minimum and maximum width of the used lamination strips.

In a proper and up-to-date construction, the magnetic lamination strips are sheared according to the patterns or outlines shown in Fig. 3 in which, on the left, there is indicated an outline for the columns C_E , in the centre an outline for column C_C and on the right an outline for one of the yokes G . In Fig. 4 there is shown the relative position between the laminations of Fig. 3, to allow the assembly of the windings on the columns prior to the core completion with the second yoke. It must be observed in Fig. 4, that the successive laminations, making part of the assembly illustrated in Fig. 4, are slightly staggered as indicated with dotted line differentiated in respect to the solid line; the laminations of columns C_E and of the yoke are only axially staggered, while the double cusp laminations of the central columns C_C have the cusps diverted in opposite directions and are assembled in overturning condition to each other according to a longitudinal axis. In a six-step core, for example, six assortments of patterns are utilized as illustrated in Fig. 3, and each assortment corresponds to a certain length of strips.

The following table shows, for a series of different electric powers, the sizing, the number of steps and the total weight of a core, by way of example only.

TABLE

Power KVA	Φ_N	N_{STEPS}	I_{g0}	H_0	E	F	Weight Kg
50	114	4	420	355	100	40	119
250	161	5	580	500	150	50	343
500	188	6	660	585	180	40	555
1000	201	7	740	745	190	50	770
2000	231	7	820	1000	220	60	1275

The three patterns (Fig. 3) of each assortment are usually mounted by hand on a plane provided with catches according to the positioning shown in Fig. 4 in which — as already mentioned — the solid line indicates the assembly of the patterns of the layers subsequently superimposed to the one indicated with dotted line, thereby the air-gaps between the laminations of the two adjacent planes or layers are displaced of a few millimeters to each other, which is a requirement arising from the characteristics of the magnetic material used. By successive-overlaps of layers the thickness is obtained of the step corresponding to a predetermined width of laminations. At this point the assembly is carried out of the patterns having width

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corresponding to the next step.

The above described assembly is usually carried out by hand with an endless repetition of similar movements and work-times which can be hardly quantified since the laminations have a thickness ranging within a few tenths of a millimeter.

5 . By the plant according to the invention the automatic arrangement is provided of the laminations intended to make up cores lacking in a yoke, and of dimensions that can broadly vary between a maximum and a minimum value. Figs. 5 and 6 show respectively a plan view and an elevation view of the structural arrangement of the system.

10 On a straight length of a track 12 there are placed stores of laminations relevant to the various steps, under the form of carriages 14 rigidly interconnected (or of a single platform). On each carriage, the lamination components intended to form one step of the core are piled up; the piles of laminations are suitably spaced apart for handling requirements, relative to the position that the same laminations must take up after the assembly (Fig. 4), with the only difference that for the central column, two piles of laminations are provided in two laying arrangements overturned one in respect to the other in order to achieve the stagger in the step forming the pack.

A motorized rack device, not shown, causes the displacement of the train of carriages 14 which are subsequently disposed and blocked at a precise work position P, and whose center line corresponds to the centre of the gap between the aerial guides of a track 16, this track being placed according to a direction X orthogonal to the movement direction Y of the track 12. Numeral 18 indicates a positioning device.

20 On each of carriages 14 there are placed the laminations necessary to form one step of a predetermined group of cores to be formed one after the other. Suitable catches determine exactly the positions of the packed laminations in the various patterns, in the above mentioned arrangement.

As illustrated in the elevation of Fig. 6, the guides 16 are at a level above the carriages 14 and the relevant laminations piles, even with the maximum extent of the load.

25 Two motorized frames 20 and 22 can move along the guides 16. The frame 22 may be caused to slide on guides 16 or on the frame 20, always in the direction X.

The frame 20 bears three mobile members or equipment 24, 26, 28 which are able to move in a direction Y orthogonal to guides 16, that is, parallel to guides 12.

The frame 22 carries only one member 30 being also able to move in the direction Y.

30 Each of members or equipment 24 to 30 carries vertical slide means for grip members each having two or more suckers connected to a vacuum plant and being selectively controllable.

The travels of frames 20 and 22 as well as those of members 24 to 30 are operated by sets of screws and nut screws actuated by small motors of suitable power, and said travels are exactly delimited by fixed catches previously positioned, or by other control systems, which may be changed upon variation of the cores dimensions.

35 An assembly plane 32, suitably provided with a pallet support in the working position, is disposed on a weighing unit made up of load cells or the like. On said assembly plane 32 the core is formed in the arrangement indicated in Fig. 4 with the laminations being picked up one at a time by the carriage 14 in the position P in order to form then the laminations packs which form each step. After that, the carriage 14 is replaced in the position P in order to form the pack of another step, and so on. The catches of frame 20 and those of member 30 are alternatively staggered of the few millimeters intended to obtain the staggered arrangement of the next layers of laminations and ensure the best connection of the magnetic flux at the intersection between yoke and columns. The member 26 is intended to alternatively pick up — from the two laminations piles — the laminations which are to form the central column. The two members 24 and 28 pick up the laminations of the two external columns and bring them close to each other in the assembling arrangement. In particular, the member 30 picks up the laminations of the yokes and places them to be assembled by performing a displacement of a few millimeters according to the axis Y.

40 In an alternative and more advanced system than the one described hereinbefore, the travels of frames 20, 22 and of the mobile members 24 to 30 carried by the frames, instead of being delimited by fixed stops or catches of mechanical type, may be exactly delimited by step-by-step or direct current small motors which are controlled through tachymetric dynamos or encoders.

45 The vertical movements of the suckers grip members may be realized by double-acting air pistons operated by electrovalves. The lifting of the suckers is operated by an electric impulse; their stoppage is caused by reaching a predetermined level; the lowering of the suckers is also operated by an electric impulse; while the stoppage of said lowering takes place when the suckers reach the pile of laminations to be picked up from the carriage 14 at the position P, respectively when they reach the laminations pack to be formed on the assembly plane 32.

50 The operation of the plant is conceptually simple, and a working diagram of the displacements of frames 20 and 22, of members 24, 26, 28, 30 and of the suckers is synthesized in Fig. 7. The displacements are operated by the motion realized by the small motors and through the interventions of the electrovalves on the air and vacuum circuit.

In Fig. 7 the actuation phases are shown relevant to the positioning of the laminations of the two successive layers with staggered air-gaps. After the formation of a step the replacement of the store-carriage will also occur.

65 The succession of the various operations may be controlled by a program recorded on a

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microprocessor or computer having several outputs. The signals coming from the microprocessor, and being processed within suitable interfaces, generate the operative controls for the opening and closing of the feeding circuits of the actuators (motors and electrovalves).

Having described the structural arrangement of the plant, its working may be easily understood.

5 Once the number of cores to be assembled has been predetermined, each carriage 14 is loaded with the patterns of sheared laminations corresponding to a determined step for a total weight approximately equivalent to the requirement of one step (double) multiplied by the number of cores. In this phase the laminations may also be counted.

10 The displacement of the group of carriages 14 causes the position P to be reached by the carriage of the step that, according to the work schedule, must be firstly assembled, and in said work position P said carriage is centered and blocked by the device 18. At this moment, the carriage 20 moves along the guides 16 up to the carriage vertical in the position P, and the members 24 and 28 reach a position above the groups of laminations of the external columns and the member 26 moves above one of the two piles of laminations of the central column. Figs. 5 and 6 show the frame 22 while reaching, together with member
15 30, the position above the laminations pile of the yoke.

At this point, the suckers move downwards and lift the laminations.

20 The three members 24, 26, 28, by sliding on the guides of frame 20, place themselves at distances equal to the center distances of the columns on the core. The frame 20 moves above the assembly plane 32 and the suckers with the picked up laminations move down from the members 24, 26, 28 to lay the laminations thereon. The frame 22 which is previously moved up to a position corresponding to the store of the yoke patterns and which has been centered on the laminations pack, picks up, by the suckers lowering, the yoke lamination and brings it at the desired level. The frame 22 is then moved above the assembly plane 32 along the guides 16 (or above the frame 20, parallel to guides 16), and from the member 30 suitably positioned on the assembly plane 32 the suckers lower and lay down the yoke lamination.

25 The two frames 20 and 22 move back above the carriage 14 at the position P. The movements for the formation of the next layer are the same, but the travels of the frames and members vary of those short lengths corresponding to the overlap of air-gaps, while the member 26 is brought above the opposite pile of laminations for the central column.

30 Since upon the moment the stores are loaded it is possible to determine, for each step, the average weight of the laminations, the number of laying operations can be determined by a counting.

In correspondence of the various steps, or of the half of central step, the already mounted part of the core is weighed, being provided that, to this purpose, the assembly plane is resting on load cells; possible differences from the provided weight may be thus compensated by adding or taking away laminations to and from the various steps or to and from the only central step. A final weighing may be performed after
35 the core completion, especially for statistical control.

40 From some tests which have been carried out, there has been noted that the most crucial moment of the whole operation for the transfer and positioning of laminations, occurs upon the separation of the lamination, already seized by the suckers, from the remainder of the pack of laminations stored on the carriage, as an air vacuum generates between the lamination being lifted and the next one. As a result, in some cases it may likely occur the lift also of the second lamination which then falls down in disorder. This drawback may be avoided by taking advantage of the great flexibility of the laminations and thus by lifting firstly the ends and then the central part thereof; in this way the air penetrates between the laminations upon the lifting and nullifies the vacuum zones. This may be obtained by placing the suckers towards the
45 end of the laminations and a mechanical catch at the centre between the suckers. A similar result can be achieved by suitably positioning magnets or electromagnets relative to the pack of laminations in the stores and towards the laminations ends, so as to induce a magnetization on same laminations; a mutual repulsion is thus determined between the laminations getting a flux of the same polarity and, consequently, a lift of those being on the top. The two actions, properly combined, are utilized for rendering the separation operation perfectly reliable. The centering catches in the stores keep the laminations in the
50 proper position before they are picked up.

Instead of the interconnected carriages 14 which contain the packs of the laminations to be mounted, it is possible to provide either a single bench which moves to subsequent work positions, or a number of carriages individually driven along common or diverse guides for to and from movement.

55 The plant may also be provided with two or more assembly stations properly spaced apart and apt to be fed by the same stores but with a suitably staggered assembly cycle of one station relative to that of the other. The number of store-carriages may be suitably increased.

Claims

60 1. Assembly plant for assembling of magnetic cores for electric transformers or other, made up of die-cut laminations, comprising at least a store (14) for said shaped laminations, an assembling plane (32) onto which the core is formed, and gripping and transferring means for transferring said laminations from said store (14) to said assembling plane (32), characterized in that: a plurality of said stores (14) is provided, able to be alternatively positioned in a single drawing position (P); that said gripping and transferring means
65 (20, 22, 24, 26, 28, 30) draw a set of said laminations forming one step of the core from the store (14) placed

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in said drawing position (P) and place them onto said assembling plane (32); and that the movements of said gripping and transferring means and of said stores are controlled by a programmable central unit.

2. A plant according to claim 1, characterized in that: said gripping and transferring means comprise mobile frames (20, 22) which move between said drawing position (P) and said assembly plane (32); and in that on each of said mobile frames (20, 22) members (24, 26, 28) are provided moving in a direction orthogonal to the moving direction of said frames (20, 22) and forming vertical guides for sucker lift means or the like.

3. A plant according to claim 2, characterized in that said moving members (24, 26, 28) and/or said frames (20, 22) are operated by catches or step-by-step motors or other equivalent means to bring the laminations close to each other in the assembly arrangement and stagger subsequent laminations or groups of laminations.

4. A plant according to claim 3, characterized in that each of said stores comprises a platform or carriage (14) displaceable along rail tracks (12) or equivalent guiding means perpendicularly to the trajectory of said mobile frames (20, 22).

5. A plant according to claim 2, characterized in that each of the gripping and transferring means comprises at least two suckers capable of engaging the lamination towards the ends thereof, and a possible central catch in order to achieve a convex curvature in the lower part of the lamination which is being lifted, apt to facilitate the separation thereof from the remaining pile of the laminations.

6. A plant according to claim 1 or 5, characterized in that it comprises magnets or electromagnets able to induce a homopolar local magnetization in the adjacent laminations in order to cause a repulsion between the close ends of the superimposed laminations, apt to facilitate the separation of the lamination being lifted out from the remaining pile of laminations.

7. A plant according to the preceding claims, characterized in that it comprises at least two assembly planes, operating out of phase.

Patentansprüche

1. Vorrichtung zum Schichten von Magnetkernen für elektrische Transformatoren oder dgl., die aus gestanzten Blätter aufgebaut sind, mit wenigstens einem Magazin für die geformten Blätter, einer Montageebene (32), auf der der Kern gebildet wird, und Greif- und Transferelementen zum Transferieren der Blätter von dem Magazin (14) zu der Montageebene (32), dadurch gekennzeichnet, daß mehrere dieser Magazine (14) vorgesehen sind, die alternativ in einer einzigen Abziehposition (P) positioniert werden können; daß die Greif- und Transfer Elemente (20, 22, 24, 26, 28, 30) einen Satz der Blätter, welche eine Stufe des Kerns bilden, vom Magazin (14), welches in der Abziehposition (P) plaziert ist, abziehen und diese auf der Montageebene (32) plazieren; und daß die Bewegungen der Greif- und Transfermittel der Magazine durch eine programmierbare Zentraleinheit gesteuert werden.

2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Greif- und Transfermittel mobile Rahmen (20, 22) aufweisen, die zwischen der Abziehposition (P) und der Montageebene (32) laufen; und daß auf jedem der mobilen Rahmen (20, 22) Elemente (24, 26, 28) vorgesehen sind, die in einer Richtung rechtwinkelig zur Bewegungsrichtung der Rahmen (20, 22) verschiebbar sind und vertikale Führungen für Saughebeeinrichtungen oder dgl. bilden.

3. Vorrichtung nach Anspruch 2, dadurch gekennzeichnet, daß die beweglichen Elemente (24, 26, 28) und/oder die Rahmen (20, 22) — durch Flaschenzüge oder Schrittschaltmotoren oder andere, entsprechende Einrichtungen — betätigt werden, um die Blätter in der Montageanordnung eng aufeinander zu bringen und darauffolgend oder Gruppen von Blättern zu stapeln.

4. Vorrichtung nach Anspruch 3, dadurch gekennzeichnet, daß jedes der Magazine eine Plattform oder einen Wagen (14) aufweist, der entlang von Schienen (12) oder entsprechender Führungsmittel rechtwinkelig zum Bahnverlauf der mobilen Rahmen (20, 22) verschiebbar ist.

5. Vorrichtung nach Anspruch 2, dadurch gekennzeichnet, daß jedes der Greif- und Transfermittel wenigstens zwei Sauger, die die Blätter an ihren Enden ergreifen können und einen möglichst zentralen Flaschenzug hat, um eine konvexe Krümmung des unteren Teils des angehobenen Blattes zu erzielen, um die Trennung des Blattes vom verbleibenden Stapel Blätter zu erleichtern.

6. Vorrichtung nach Anspruch 1 oder 5, dadurch gekennzeichnet, daß Magnete oder Elektromagnete vorgesehen sind, um in den benachbarten Blättern eine gleichmäßig polare lokale Magnetisierung zu induzieren, um zwischen den nebeneinanderliegenden Enden der übereinanderliegenden Blätter eine Abstoßung zu bewirken, die das Trennen des vom verbleibenden Stapel Blätter abzuhebenden Blattes erleichtert.

7. Vorrichtung nach den vorstehenden Ansprüchen, dadurch gekennzeichnet, daß wenigstens zwei Montageebenen, die phasenverschoben arbeiten, vorgesehen sind.

Revendications

1. Dispositif pour l'assemblage de noyaux magnétiques pour transformateurs électriques ou autres appareils, réalisés à partir de lamelles découpées à l'emporte-pièce, comprenant au moins un stock (14) pour ces lamelles profilées, un plan d'assemblage (32) sur lequel est formé le noyau, et des moyens de

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préhension et de transfert pour amener ces lamelles depuis le stock (14) vers le plan d'assemblage (32), caractérisé en ce que: il est prévu plusieurs stocks (14), aptes à être positionnés alternativement dans une position unique de traction (P): en ce que des moyens unique de préhension et de transfert (20, 22, 24, 26, 28, 30) extraient une série de ces lamelles formant une étape du noyau à partir du stock (14) placé dans la position de traction (P) et les positionnent sur la plan d'assemblage (32); et en ce que les mouvements des moyens de préhension et de transfert ainsi que des stocks sont commandés par une unité centrale programmable.

2. Dispositif selon la revendication 1, caractérisé en ce que: les moyens de préhension et de transfert comprennent des châssis mobiles (20, 22) qui se déplacent entre la position de traction (P) et le plan d'assemblage (32); et en ce que sur chacun des châssis mobiles (20, 22) sont prévus des éléments (24, 26, 28) se déplacent dans une direction orthogonale par rapport à la direction de déplacement des châssis (20, 22) et formant des guidages verticaux pour un système de levage par aspiration ou similaire.

3. Dispositif selon la revendication 2, caractérisé en ce que les éléments mobiles (24, 26, 28) et/ou les châssis (20, 22) sont entraînés — par des engrènements ou des moteurs pas-à-pas ou autres moyens équivalents — pour amener les plaquettes à proximité l'une de l'autre dans l'agencement d'assemblage et placer alternativement les plaquettes subséquentes ou groupes de plaquettes.

4. Dispositif selon la revendications 3, caractérisé en ce que chacun de ces stocks comprend une plateforme ou chariot (14) pouvant se déplacer le long des rails (12) ou des moyens de guidage équivalents perpendiculairement à la trajectoire des châssis mobiles (20, 22).

5. Dispositif selon la revendication 2, caractérisé en ce que chacun des moyens de préhension et de transfert comprend au moins deux ventouses capables d'engager la plaquettes vers les extrémités de celle-ci, et un engrènement central éventuel pour réaliser une courbure convexe dans la partie inférieure de la plaquette qui est en cours de levage, facilitant ainsi séparation de la pile restante de plaquettes.

6. Dispositif selon la revendication 1 ou 5, caractérisé en ce qu'il comprend des aimants ou électro-aimants capables d'induire une magnétisation locale homopolaire dans les plaquettes contiguës afin d'entraîner une force impulsive entre les extrémités proches des plaquettes superposées et facilitant ainsi la séparation de la plaquette qui est en train d'être soulevée de la pile restante de plaquettes.

7. Dispositif selon les revendications précédentes, caractérisé en ce qu'il comprend au moins deux plans d'assemblage, en fonctionnement déphasé.

Fig.1

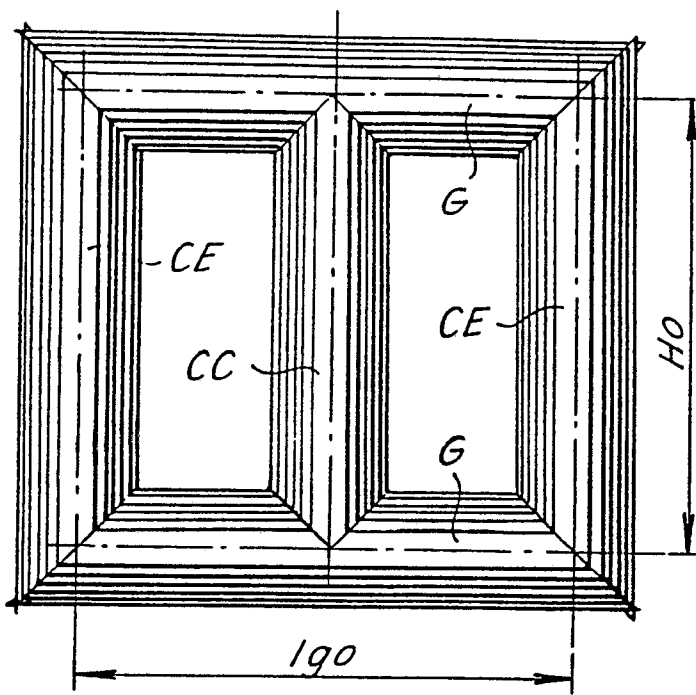


Fig.2

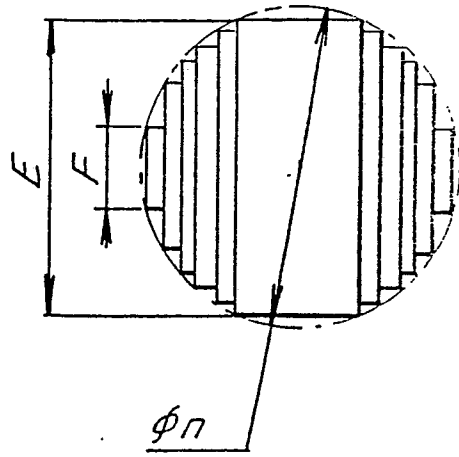


Fig.3

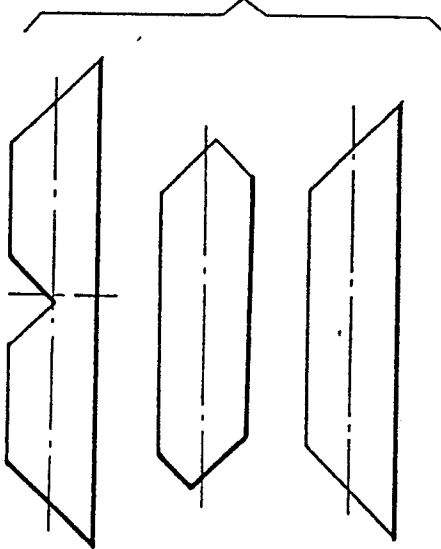
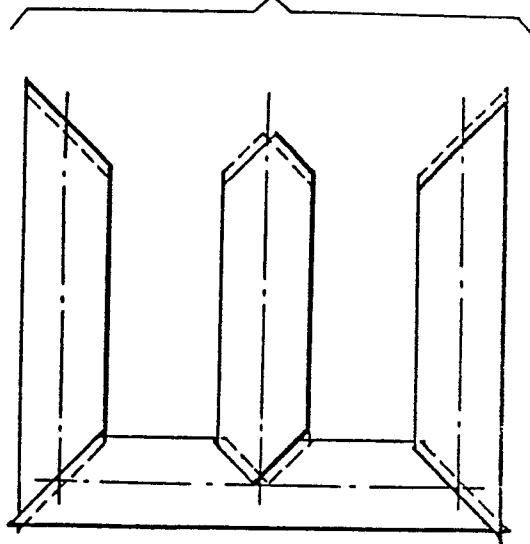


Fig.4



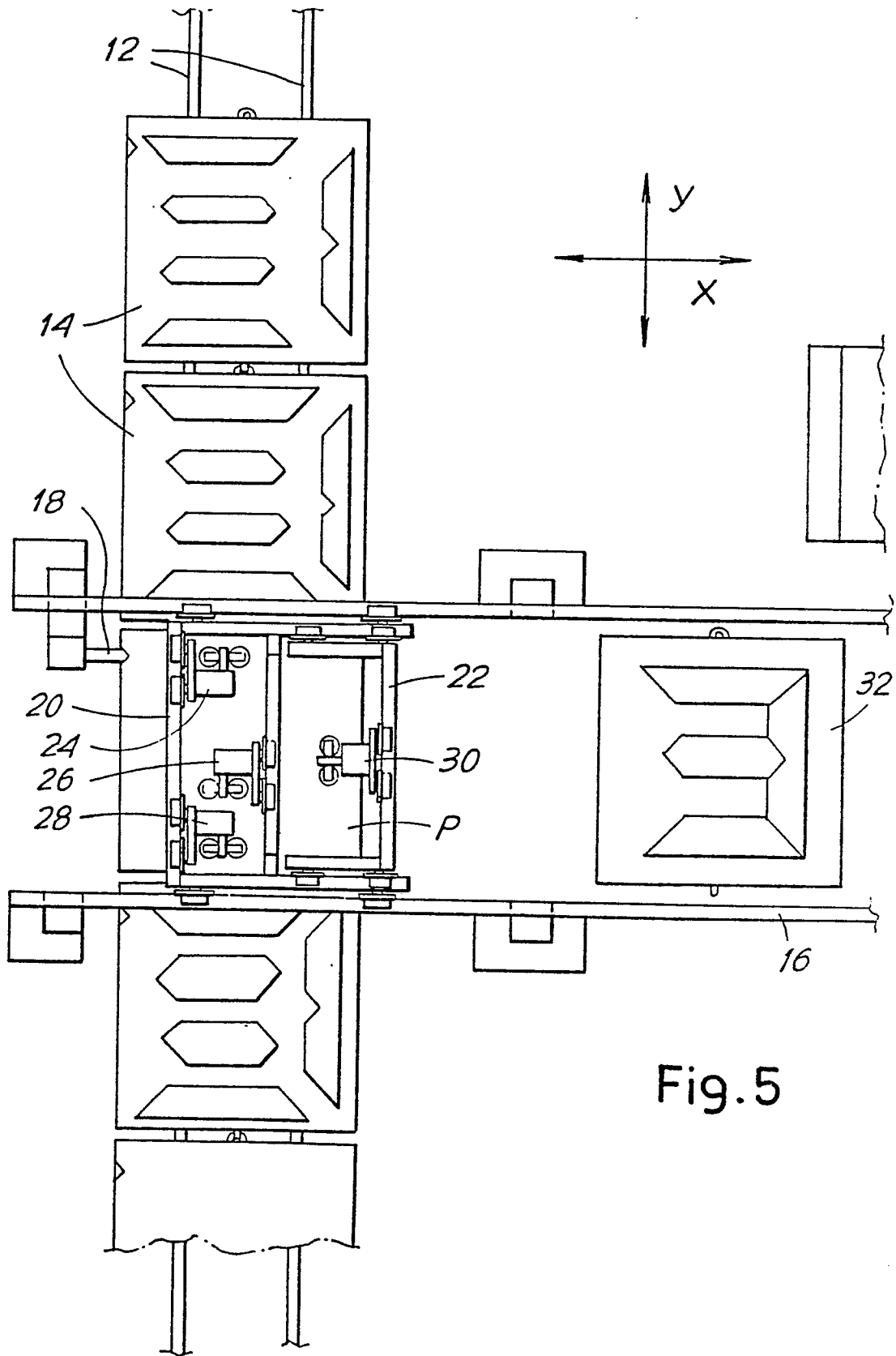


Fig.6

