MAGNETIC CLAMPING APPLIANCE

Filed May 19, 1938

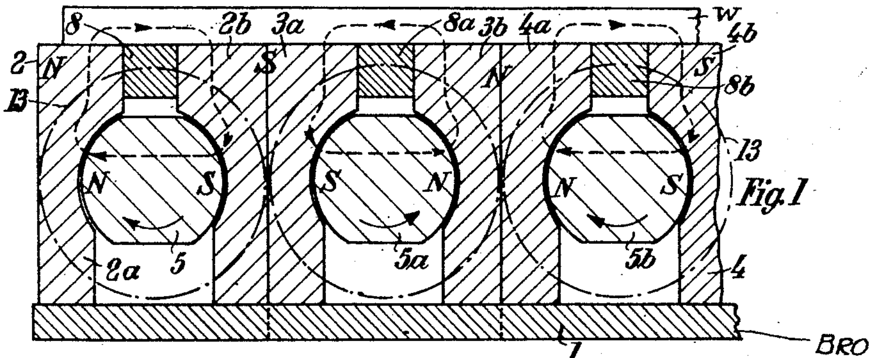

Fig. 1

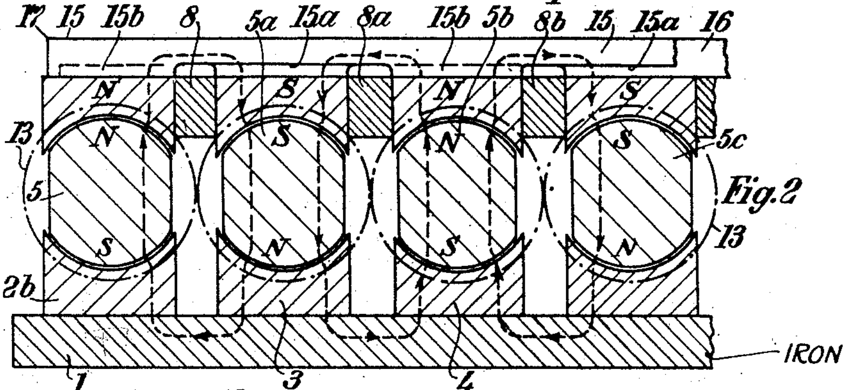

Fig. 2

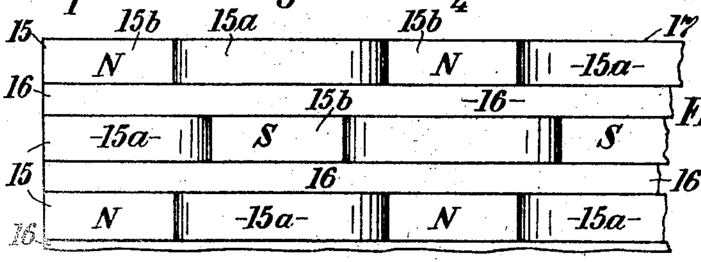

Fig. 3

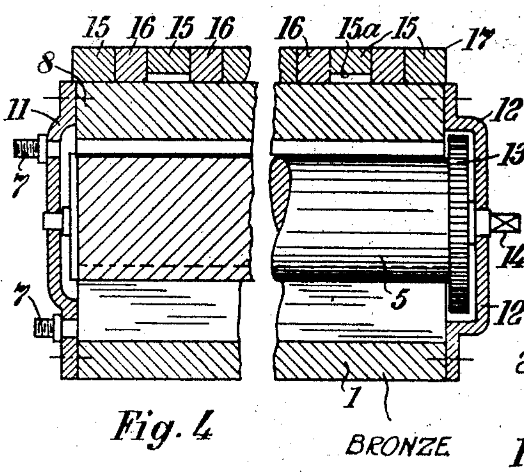

Fig. 4

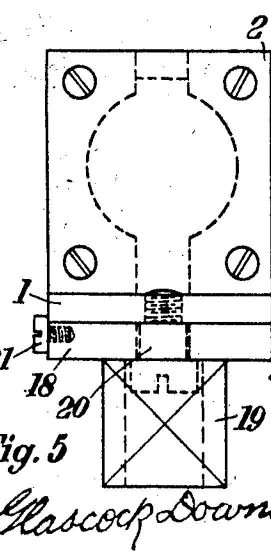

Fig. 5

Inventors:
J. Bing
+ O. Block

By: Glascock Downing & Seebold
Attorneys.

Patented July 30, 1940

2,209,558

UNITED STATES PATENT OFFICE

2,209,558

MAGNETIC CLAMPING APPLIANCE

Julius Bing and Otto Block, Berlin, Germany, assignors to Karl Otto Goettsch, Silvahof, Bern, Switzerland

Application May 19, 1938, Serial No. 208,947
In Germany April 22, 1937

9 Claims. (Cl. 175—367)

Our invention relates to magnetic clamping appliances, such as are mainly used in connection with machine tools, particularly grinding machines, for fixing the work.

In general in such appliances the magnet is excited by continuous current, that is, by electromagnetic means. It has however also already been proposed to provide for this purpose permanent magnets of very great coercive force, which usually consist of an alloy of aluminium, nickel and iron, with certain other additions. Now in such holding devices the removal of the work gives rise to difficulties on account of the so-called residual magnetism remaining in them and also in the soft iron parts of the apparatus even after the cessation of the magnetic excitation, owing to the permanent magnet. Furthermore the known clamping devices of this nature require the exertion of comparatively large forces in the relative displacement between the permanent magnets and the associated soft iron parts of the magnetic circuit, this displacement bringing about the excitation and de-excitation.

The principal object of our invention is to provide a magnetic clamping appliance of the permanent magnet type in which the said disadvantages are obviated. A further object is to provide a clamping appliance of the class referred to in which a better utilisation of the space available is obtained. Still a further object is to provide a clamping appliance of the permanent magnet type which easily may be manufactured on mass production lines.

With these and other objects in view, which will appear from the following description taken in connection with the drawing, our invention is essentially characterised by the feature that in a magnetic clamping device of the permanent magnet type the parts that are displaceable relatively to one another for the excitation and deexcitation of the magnetic system or systems can be rotated so far beyond the relative positions corresponding to the short-circuiting of the permanent magnet or magnets that not only does the magnetic influence of the permanent magnet or magnets upon the other members of the magnetic circuit or circuits become a minimum, but a reversal of polarity is also effected, whereby the result is reliably obtained that the attraction exerted upon the work assumes a zero value.

A further feature of our invention resides in the fact that the permanent magnet or magnets are constructed as revolving bodies, the axes of which are transverse to the lines of force passing through the revolving bodies in a substantially unaltered direction, and that the supporting of the revolving bodies in relation to the associated parts of the magnetic circuit in question is effected in such a way that the magnetic forces exerted upon them substantially counterbalance one another, so that for the shifting of the rotary bodies only very small forces are required.

Further features and advantages of our invention will be gathered from the ensuing description and the claims attached thereto.

In the accompanying drawing, in which some preferred forms of construction of the new clamping appliance are illustrated by way of example,

Figure 1 shows a sectional elevation transverse to the axes of rotation of the magnet bodies, through a portion of the clamping appliance;

Figure 2 is a similar view showing a modified form of construction;

Figure 3 is a view from below of a portion of a special clamping plate, which may advantageously be employed in conjunction with the new clamping appliance;

Figure 4 is a vertical section through one of the axes of rotation of the permanent magnet bodies, showing the end parts of an appliance upon which a clamping plate according to Figure 3 is mounted, and

Figure 5 is an end view of an embodiment of a clamping appliance consisting of a single magnet unit.

In the embodiment illustrated in Figure 1, upon a base plate 1 of non-magnetic material, is mounted a number of magnet units corresponding to the length of the clamping appliance, these units being denoted by the numerals 2, 3, 4 and so forth. The individual units mainly consist in each instance of two limbs 2a, 2b 3a, 3b and so forth of soft iron, and of permanent magnets 5, 5a, 5b and so forth rotatably mounted between the said pairs of limbs. The spaces between the upper ends of the limbs are filled up, in a manner known in connection with magnetic clamping plates, by bars 8, 8a, 8b and so forth of non-magnetic material.

The permanent magnet bodies 5, in the embodiments illustrated, form circular cylinders with diametrically opposite flats, which may however alternatively be omitted. They are supported with minimum clearance between the cylindrically hollowed limbs, this being obtained either in the manner indicated in Figure 4, by the aid of special pivots passing through corresponding bores in cover plates 11 and 12 for the ends of the magnet units, or else by the magnet bodies themselves being supported by their peripheries in the cylindrical cavities (pole arcs) of the magnet limbs pertaining to them. They then form as it were their own bearing journals, while the pole arcs constitute the bearing bushings. The cavities formed on the one hand by the magnet limbs **2a**, **2b**, **3a** and **3b** and so forth, their connecting bars **8**, **8a**, **8b** and so forth, and the base plate **1**, and on the other hand by the end cover plates **11**, **12** are preferably filled with oil or solid grease, as a result of which in the first place the rotary bodies **5** are lubricated in their bearings formed by the pole arcs, and on the other hand the penetration of dust from grinding, moisture or the like into the interior of the units is prevented. Lubricating nipples **7**, **7**, shown in Figure 4, may be provided for the purpose of moving the oil or grease to and fro.

As indicated in Figures 1 and 2 by incomplete dotted circles, and as shown clearly in Figure 4, toothed wheels **13** are rigidly connected with the permanent magnet bodies **5**, **5a**, **5b** and so forth, the two toothed wheels of adjacent magnet bodies meshing with one another, so that by rotating a crank to be mounted upon the square stud **14** projecting through the cover **12** a rotary movement through the same angle can be imparted simultaneously to all the magnet bodies.

The magnet cores **5**, **5a**, **5b** and so forth are so magnetized that their lines of force pass through them diametrically, and substantially parallel to the aforementioned flats where such are provided. The poles thereby formed on the peripheral arcs facing one another are marked N and S. In the position of the magnet cores illustrated in Figure 1 the lines of force meet with comparatively little reluctance at the air gaps between the cylindrical portions of the magnet cores and the pole arcs facing them of the limbs **2a**, **2b** and so forth, so that if there is a workpiece W of magnetic material upon the top of the magnet limbs, which is ground smooth in the usual way, strong systems of lines of force are produced, which take the course indicated by dotted lines, so that the work W is powerfully attracted.

If the work is to be removed after termination of the grinding or the like, all the magnet cores **5**, **5a**, **5b** and so forth are rotated through an angle of about 90° in the direction of the arrows in Figure 1 in the manner described above by means of a crank to be mounted upon the square stud **14**. The magnetic flux then becomes gradually weaker, since the reluctances between the overlapping parts of the poles of the magnet cores on the one hand, and of the pole arcs of the magnet limbs on the other hand are continually becoming greater. After a rotation of 90° the magnet cores are magnetically short-circuited by the associated magnet limbs and the actions of the pairs of flux systems then arising counteract one another. In consequence of the residual magnetism both of the limbs of the magnets and of the workpiece, however, the latter still adheres, so that the removal causes difficulties in some circumstances. In order to eliminate even the last traces of magnetism all that is necessary is to rotate the magnet cores **5**, **5a**, **5b** and so forth through a small angle further. The leakage flux passing through the limbs of the magnets and through the work then increases again. Now however the lines of force are in the reverse direction, so that the residual magnetism can be caused to disappear completely. After putting on fresh workpieces the magnet cores **5**, **5a**, **5b** and so forth are brought back by suitable rearward rocking into the original position (Fig. 1), in which the flux systems are completely restored, so that the workpieces are securely fixed again.

In the form of construction illustrated in Figure 2 the foot plate consists of magnetic material, for instance iron. Here the magnet cores **5**, **5a**, **5b**, **5c** and so forth, likewise constructed as cylinders, are supported between the pole arcs, located perpendicularly one above another, of the magnet limbs **2a**, **2b** and so forth, the latter of which are mounted directly upon the base plate **1**. In this manner the flux systems are formed in the paths indicated by dotted lines. For the rest the manipulation and action are the same as in the case of the construction illustrated in Figure 1.

Our invention is not restricted to the bi-polar magnet systems illustrated, but the permanent magnets may instead be so magnetised as to have more poles. In a four-pole system of magnets the rotation of the permanent magnet bodies through an angle of 90° at most would be sufficient to attain with certainty, after the short-circuiting, also the reversal of polarity facilitating the removal of the workpieces.

The alloys used as material for the permanent magnets are very difficult to work. For this reason it may be advisable, at least when the shape of the magnet bodies is not very simple, to lodge the alloys in a granulated condition in thin-walled sheaths which are shaped to correspond to the desired form of the magnet bodies. For example instead of the solid cylinders described, consisting of the alloy material, thin-walled hollow cylinders of iron might be employed, which are filled with granulated alloy material, with the addition, it may be, of binding agents. The positive mutual connection of the permanent magnet bodies, which ensures the identity of their displacement movements, may of course be obtained otherwise than by means of interengaging toothed wheels, for instance by means of levers, toothed racks and the like.

Magnetic clamping appliances of the kind described, as contrasted with those hitherto usual, admit of being very easily manufactured on mass production lines. For this purpose a start is made from the individual units, which form as it were the foundation elements of a clamping appliance as a whole, to which any desired superficial extent may be given by arranging a greater or smaller number of individual units of various lengths in a row. It is therefore only necessary to manufacture and keep in stock individual units of the various clamping appliance plates in question of suitable length, and to arrange them side by side upon a base plate as required in the manner illustrated in Figure 1. The opposite open ends are then covered by cover plates of non-magnetic material of the nature of the plates **11** and **12** represented in Figure 4, which may serve at the same time for supporting the permanent magnets **5**. The magnet limbs **2a**, **2b**, **3a**, **3b** and so forth, may be formed in the simplest manner from sections of suitable drawn profile material. To the units there may also pertain the foot plates, which mechanically connect the lower ends of the limbs of the magnets with one another but insulate them magnetically, as indicated in Figure 1 by the dotted lines passing through the plate **1** and forming a continuation of the joints between the individual devices. The units would then have to be mounted also upon a separate bottom plate extending throughout the entire length of the apparatus.

In order to have available for the machining of relatively small workpieces as fine a subdivision of poles of the actual clamping surface as possible, it is advisable to equip the clamping appliance with one or more separate clamping plates, which are mounted as required upon the surface of the magnet limbs, which ordinarily themselves serve as a clamping plate, and which are connected with one another by the magnetically insulating intermediate bars 8.

These special clamping plates are composed, as illustrated more particularly by Figures 3 and 4, of numerous comparatively narrow strips or square rods 15, 16 of alternately magnetic and non-magnetic material, for instance iron and brass. The iron rods 15 are provided at distances from one another corresponding to the subdivision of the top of the clamping appliance, with downwardly directed projections 15b, which are separated from one another by shallow recesses 15a. The length of the projecting portions 15b corresponds to the breadth of the portions of the magnet limbs 2a, 2b located in the surface of the clamping appliance. The clamping plate composed of the rods 15 and 16 and denoted as a whole by 17 is so placed upon the surface of the clamping appliance that the said rods extend at right angles to the axes of rotation of the magnet cores 5, and therefore also to the joints parallel thereto in the top of the appliance. By varying the breadth on the one hand of the iron rods and on the other hand of the brass rods, the clamping plate can be adapted to the most varied requirements, particularly as regards the size of the workpieces.

In Figure 5 is represented a particular embodiment of the clamping appliance, which consists of one unit only, this unit being of comparatively small length, so as to yield a magnetic system of substantially cubic shape. The construction of the magnetic system is the same as has been described above. The unit rests by its base plate 1 upon the flange 18 of a holder 19, which may conveniently form a square stud, and which serves for clamping between the jaws of a vice or the like. The base plate 1 is connected with the holder 19 by means of a screw 20, which is accessible through a bore in the holder pin 19, and which permits rotation of the clamping appliance 2 itself, in relation to the holder 18, 19. A device is preferably also provided which enables the clamping appliance 2 to be secured in various angular positions. Such a device may consist for example of a drag spring, lodged in the flange 19, and acting upon the base plate 1. In Figure 5 merely a set screw 21 is provided for this purpose.

It may be observed that the construction of the permanent magnet as a simple solid of revolution, particularly in the form of a cylinder, yields remarkably short paths for the lines of force, which is of great importance on account of the small magnetic permeability of the highly coercive material used for the permanent magnets.

We claim:

1. In a magnetic clamping appliance; a magnetic circuit comprising a rotatable substantially cylindrical permanent magnet, two soft iron bodies having cylindrical pole-arcs disposed opposite each other and snugly fitting with the cylindrical surface of said permanent magnet so as to form a journal-bearing for the latter, and means to rotate said permanent magnet.

2. A clamping appliance as claimed in claim 1, characterised by the feature that the soft iron bodies are connected one to the other at the top, at the bottom and at the end faces so as to form a casing enclosing said rotatable magnet, and being adapted to be filled with lubricant.

3. In a magnetic clamping appliance, a magnetic circuit comprising a substantially cylindrical rotatable permanent magnet polarised in such a way that the lines of force pass through it substantially diametrically and at right angles to its axis of rotation, and two soft iron limbs each having a cylindrical hollow pole-arc forming with the permanent magnet a cylindrical air gap, each of the limbs having a surface lying in a common plane parallel to the axis of rotation of the permanent magnet, and means to rotate the permanent magnet, the pole peripheries of the permanent magnet, the peripheral extension of the hollow pole arcs and the distances between the limbs being dimensioned in such a manner that with a rotation of the permanent magnet corresponding to about half the pole pitch the permanent magnet is short-circuited by the pole arcs of the associated limbs, whereas when this angle of rotation is exceeded the polarity is reversed.

4. A magnetic clamping appliance comprising a rotatable and substantially cylindrical permanent magnet, which is polarised transversely to its axis of rotation, two soft iron limbs forming the work-holding surface, and means to rotate the magnet with respect to the limbs into a position in which its flux is short-circuited by the limbs, each limb having a hollow cylindrical pole arc, and the two limbs embracing the magnet at diametrically opposite positions and forming cylindrical air gaps co-axial with the axis of rotation of the magnet.

5. A magnetic clamping appliance as claimed in claim 4, in which the permanent magnet is flattened on two diametrically opposite sides, the flat surfaces thereby formed being substantially parallel to the lines of force passing through the body of the magnet.

6. A magnetic clamping appliance comprising a plurality of substantially cylindrical permanent magnets, each polarised transversely to its axis, a plurality of soft iron limbs, having surfaces lying in a common plane to form the work-holding surface, and each having a hollow cylindrical pole arc, two limbs being associated with each magnet and being placed on diametrically opposite sides thereof so that the pole arcs form cylindrical air gaps co-axial with the axis of rotation of the magnet, and means for rotating all the magnets together through the same angle, the pole peripheries of the permanent magnets, the peripheral extension of the hollow pole arcs and the distances between the limbs being dimensioned in such a manner that with a rotation of the permanent magnets corresponding to about half the pole pitch the permanent magnets are short-circuited by the pole arcs of the associated limbs, whereas when this angle of rotation es exceeded, the polarity is reversed.

7. A magnetic clamping appliance consisting of a plurality of units, each comprising a substantially cylindrical rotatable permanent magnet, which is polarised transversely to its axis, two soft iron limbs, each of the limbs having a surface lying in a common plane parallel to the

axis of the magnet for forming the work holding surface, and each limb having a cylindrical hollow pole arc forming with the magnet a cylindrical air gap, means to rotate the magnet with respect to the limbs into a position in which its flux is short-circuited by the limbs, and two members of non-magnetisable material connecting the top and bottom ends of the limbs and serving to support the permanent magnet.

8. A magnetic clamping appliance as claimed in claim 4 having a projection suitable for gripping in a vice.

9. A magnetic clamping appliance as claimed in claim 4 having a projection suitable for gripping in a vice and connected with the unit so as to be rotatable relative to it and means for fixing the projection in various angular positions.

JULIUS BING.
OTTO BLOCK.