May 27, 1941. J. BING ET AL 2,243,616

LIFTING MAGNET

Filed Dec. 3, 1938

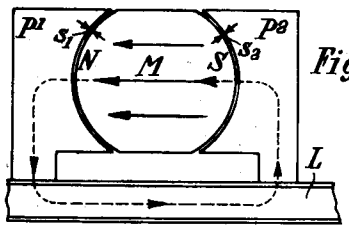


Fig. 1

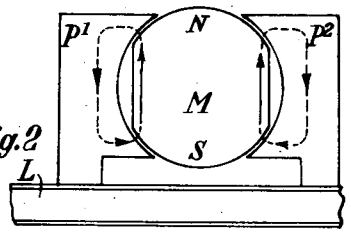


Fig. 2

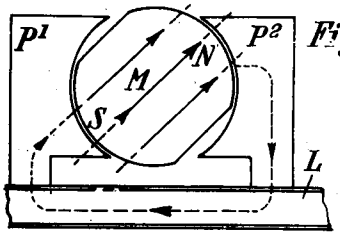


Fig. 3

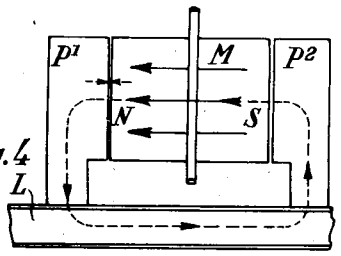


Fig. 4

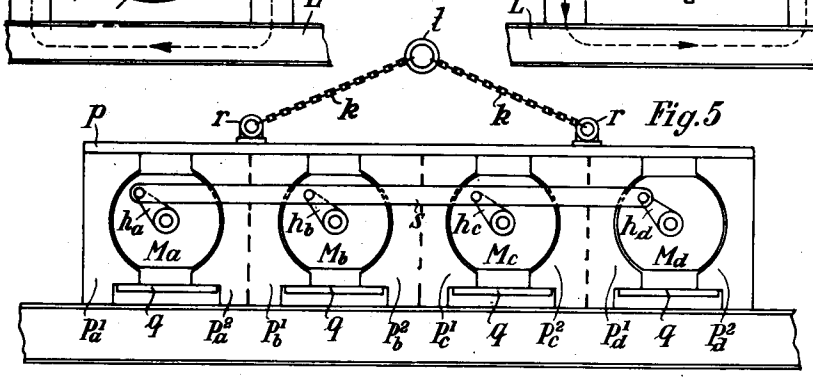


Fig. 5

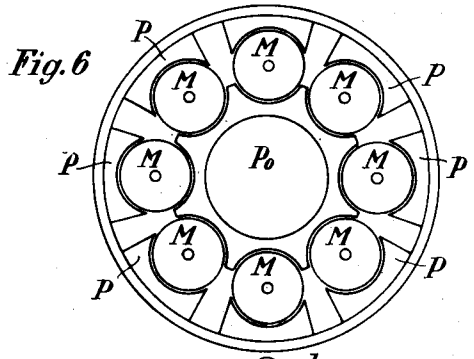


Fig. 6

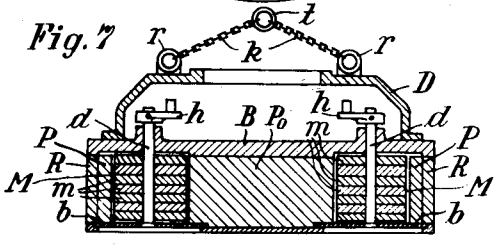


Fig. 7

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LIFTING MAGNET

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2 Claims. (Cl. 175—367)

As is well known, lifting magnets require for attaining high attractive forces very strong magnetic fields, which it has hitherto been only possible to produce economically by means of windings excited with continuous current. Since it has become possible however to produce steel alloys having very high coercive properties with a high magnetic saturation, lifting magnets may also be produced by using this material, which for many purposes advantageously replace the lifting magnets excited with continuous current. Difficulties are only offered by the de-excitation and reversal of polarity of the flow of lines of force, required for releasing the lifted load, which operations are brought about, as is well known, with the magnets excited by continuous current through employing a switch which effects a reversal of the current.

Our invention relates to a constructional arrangement which makes it possible to produce very powerful permanent magnetic fields and to remove these fields in a simple manner by short circuiting and reversing them, so that the load may drop off.

In the accompanying drawing several constructional examples of the arrangement according to our invention are illustrated.

Figs. 1 to 3 show diagrammatically a constructional form in three different operative positions,

Fig. 4 a second constructional form also diagrammatically,

Fig. 5 shows a third constructional form in side elevation and

Figs. 6 and 7 in plan view after the removal of the cover and in vertical central section respectively a fourth constructional form.

The substantially cylindrical permanent magnet body M, Fig. 1, is magnetically strongly polarised in the direction of a diameter and thus forms two oppositely disposed magnetic poles N and S. The positive direction of the lines of force is indicated in the drawing by the direction of the arrows. This permanent magnet which may be of any length is mounted so as to be capable of turning about its central cylinder axis. The arcuate poles are embraced with a narrow air gap s^1, s^2 concentrically by two oppositely disposed soft iron bodies or pole pieces P^1, P^2, which serve the purpose of leading the lines of force emerging from the poles to the adhesion surface of the lifting magnet, which is formed by the bottom end surfaces of the pole pieces P^1, P^2. In the arrangement illustrated the lines of force extend in a closed path through the permanent magnet M, the two air gaps s^1 and s^2, the pole pieces P^1 and P^2 and the iron body L to be lifted, which is held fast in this way.

On the magnet body M being turned in the clockwise direction through an angle of 90° to the initial position into the position shown in Fig. 2, the bulk of the lines of force emerging from the poles will select the shorter path through the enveloping pole pieces of the soft iron bodies P^1 and P^2. The magnetic field is in this way short-circuited, two symmetrically disposed short circuiting fields being produced, the magnetic tractive effects of which on the body L will cancel one another. The small remainder of lines of force and the remanence of the mass being lifted and of the conductive bodies is then removed by a reversal of polarity. This is effected very simply by continuing to turn the magnet body M beyond the short circuiting position (Fig. 2) into a position shown by way of example in Fig. 3.

In this position the pole pieces P^1, P^2 will come opposite the poles of opposite polarity of the permanent magnet, the direction of the lines of force both in the pole pieces and in the mass to be lifted being reversed with respect to the initial position, so that even the lightest parts of the material being lifted will all drop from the adhesion surface.

The permanent magnet system described is in all positions of its magnet body M practically completely neutralised as regards the tractive effect of its lines of force to the outside, so that for turning it only small forces are necessary. The turning motion may be effected by hand or by mechanical or electrical means. As it is desirable to keep the air gaps as narrow as possible; it is also readily possible to effect the journalling of the cylindrically shaped magnet body directly in the correspondingly cylindrically shaped cavities of the pole pieces. A special rotary shaft thus becomes superfluous. Instead of being a solid cylinder, the magnet body may also be made as a hollow cylinder.

In the constructional form just described the axis of rotation is assumed to be horizontal. Fig. 4 shows a constructional form with the axis vertical. In special cases an inclined position of the axis of rotation may be of advantage.

For building larger lifting magnets a plurality of the above described magnet systems must be combined. In order in this case to effect a change of the magnetic field conditions uniformly over the whole of the magnet, all the magnet

systems must be positively coupled with one another. This may be effected by means of levers, gear wheels, chains and the like.

In Fig. 5 a rectangular lifting magnet consisting of four systems of the described kind is illustrated, in which the coupling of the magnet bodies M_a, M_b and so forth is effected by means of levers h_a, h_b and so forth, which are connected to a common coupling bar s. This bar can be moved for instance by means of a bell crank (not shown) which is pivoted on the plate p of non-magnetic material which connects the upper sides of all the pole pieces with one another, the downwardly directed arm of the said bell crank being pivotally connected to the bar s. The lower ends of the pole pieces of the pairs of pole pieces P^1_a and P^2_a, P^1_b and P^2_b, P^1_c and P^2_c and so on belonging to magnet bodies M_a, M_b, M_c and so on respectively are connected with one another by plates q of non-magnetic material, for instance manganese steel, so as to cause together with the plate p the whole arrangement to hold together. The front side and rear side of the whole arrangement may also be covered each by a common plate in the manner of the plate p, in which case the journals, if any, of the magnet body may be supported in these side plates. Through one of these side plates the journals carrying the levers h_a, h_b, h_c and so on would in any case have to be taken, so that the said levers and the bar s connecting them will be outside the casing formed by the connecting plates. All the plates will be connected with the associated pole pieces, suitably by screws. Each two adjacent pole pieces P^2_a and P^1_b, P^2_b and P^1_c and so on, belonging to different magnet bodies, consist in the example illustrated of a common iron piece. They may however also be made as separate pieces, as indicated by the middle dash lines. In this case a lifting magnet having a plurality of magnetic systems may easily be built up on a common connecting plate p by placing next to one another separate aggregates which are exactly like one another and which may be made in a simple manner by mass production.

Rings r are rigidly connected to the whole arrangement, for instance by being screwed into the pole pieces. The rings r are connected by chains k to a common ring t. This arrangement forms the means for suspending the lifting magnet from a crane or the like.

Figs. 6 and 7 show a round lifting magnet with eight radially arranged pole systems and with axes of rotation of the magnet bodies M disposed at right angles to the adhesion surface. The latter are in the present case built up out of a plurality of round discs m having a central hole, which are threaded on a common spindle d. This mode of construction is specially suitable for large lifting magnets, as it is considerably easier to make thinner discs from the highly coercive magnetic material and to magnetise them than massive bodies, the dimensions of which are great in all directions. The spindles d may be journalled at the bottom in a ring-shaped cover plate b and at the top in a cover plate B as shown, or the magnet bodies M may be rotatably supported directly in the cylindrical recesses of the associated pole pieces P_o and P. The central piece P_o is common to all eight pole systems. The plates B and b together form with a rim-shaped wall R and the centre piece P_o a ring-shaped casing which is completely closed to the outside and the free hollow spaces of which, more particularly when the magnet bodies M are not specially journalled, as in the case of the construction shown in Fig. 5, are suitably filled with thick lubricating oil or grease. The wall R may be made of iron and may be made integral with the pole pieces P. The levers h have their free ends pivotally attached to a common adjusting member (not shown) which may consist for instance of a ring-shaped disc with internal teeth, which is mounted concentrically with the centre axis of the lifting magnet and in the teeth of which a toothed pinion engages, which can be turned by hand or by motor.

On the cover plate B is fixed a cover D which encloses the operating gear above described and on which is provided the suspending means which as in the previously described constructional form consists of chains k which are connected at one end with rings r fixed to the cover D and at the other end with a common ring t for the crane hook or the like.

The magnet bodies M, instead of being formed, as shown in Fig. 7, by stringing discs together, may be formed in the case of larger units by placing a granular mass of the highly coercive alloy in a thin-walled cylindrical hollow body.

The permanent magnet bodies need not have the lateral flat places shown in Figs. 1 to 5, but may, as indicated in Fig. 6, be made completely cylindrical.

In constructions with only a single pole system (Figs. 1 to 3 and 4) the pole pieces P^1, P^2 will of course be connected with one another at least on one side, but preferably on all four sides as in the construction shown in Figs. 5, 6 and 7, by plates of non-magnetic material. The units so formed would of course have to be provided with suspending means, for instance like the chain suspension illustrated in Figs. 5 and 7.

The number and arrangement of the pole systems, in aggregates containing a plurality of pole systems is of course not limited.

We claim:

1. A lifting magnet comprising, a plurality of rotatably supported permanent magnets the lines of force of which pass through the permanent magnets in substantially parallel straight lines transversely of the axes of rotation of the magnets, two pole pieces of soft iron for each rotatable magnet, each pole piece being formed with a concave cylindrical surface adjacent the associated permanent magnet the axis of curvature of which coincides with the axis of rotation of the permanent magnet leaving narrow annular gaps between the magnet and the pole pieces, a non-magnetic plate secured to all the pole pieces on one side of the magnets, flexible suspending means attached to said non-magnetic plate, a non-magnetic plate secured to the pole pieces on the other side of the magnets, a shaft secured to each permanent magnet, and a bell crank lever secured to each shaft for simultaneously rotating the permanent magnets.

2. A lifting magnet comprising, a plurality of rotatably supported permanent magnets the lines of force of which pass through the permanent magnets in substantially parallel straight lines transversely of the axes of rotation of the magnets, two pole pieces of soft iron for each rotatable magnet, each pole piece being formed with a concave cylindrical surface adjacent the associated permanent magnet the axis of curvature of which coincides with the axis of rotation of

the permanent magnet leaving narrow annular gaps between the magnet and the pole pieces, a non-magnetic plate secured to all the pole pieces on one side of the magnets, flexible suspending means attached to said non-magnetic plate, a non-magnetic plate secured to the pole pieces on the other side of the magnets, a shaft secured to each permanent magnet, a bell crank lever secured to each shaft, and means for simultaneously rotating the permanent magnets.

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