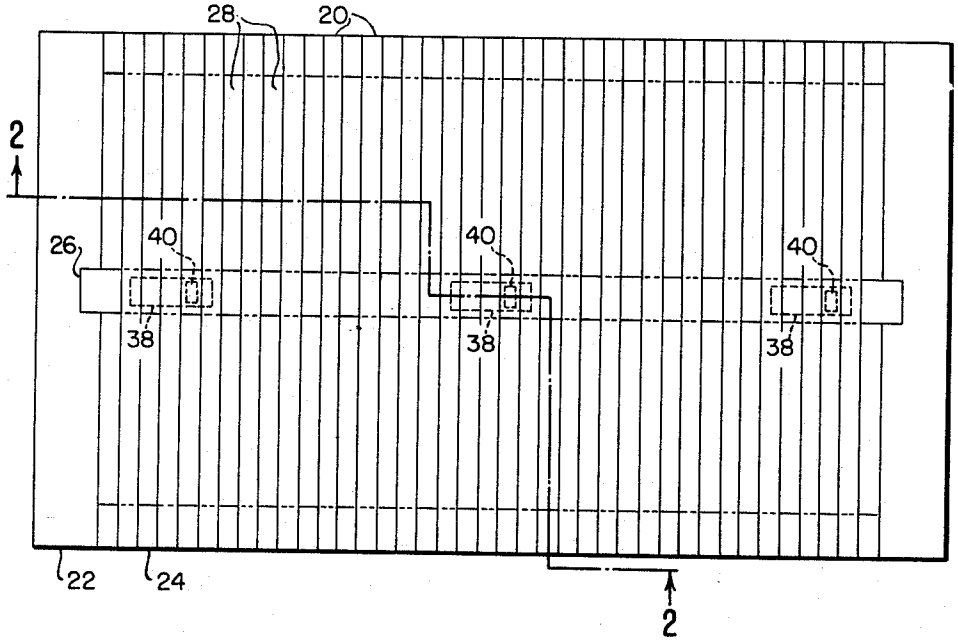
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PERMANENT MAGNETIC CHUCK

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FIG. 1



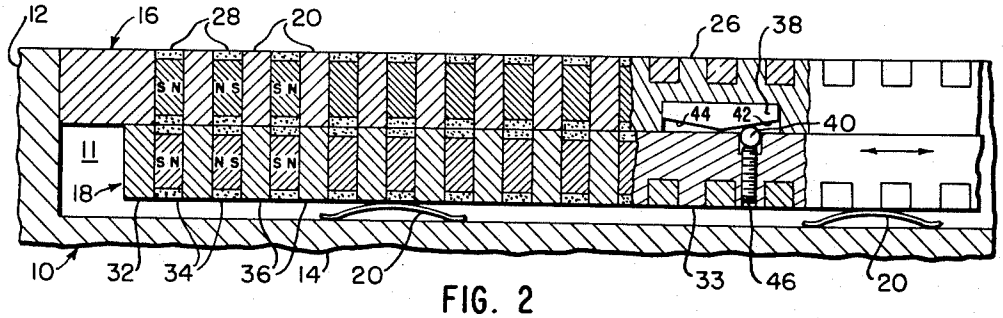


FIG. 2

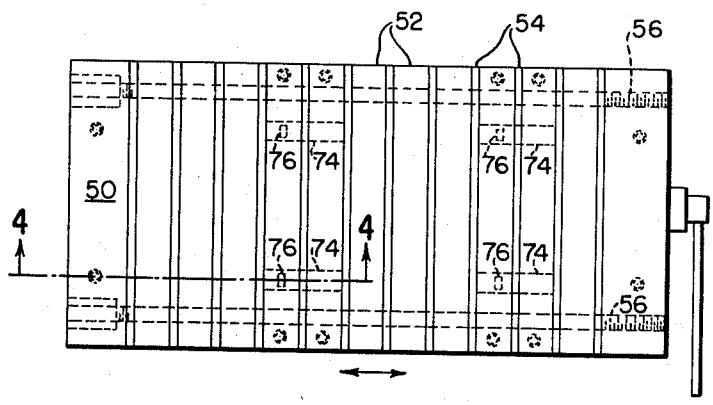
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ATTORNEYS

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PERMANENT MAGNETIC CHUCK

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FIG. 3



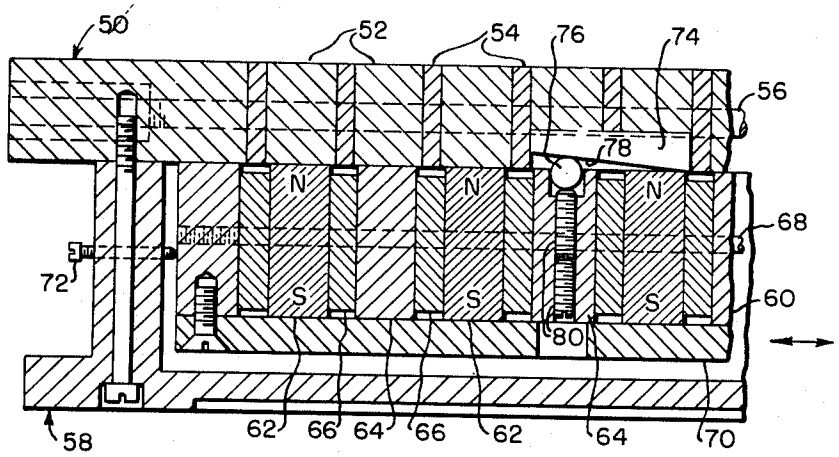


FIG. 4

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3,010,054

PERMANENT MAGNETIC CHUCK

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6 Claims. (Cl. 317—159)

This invention relates to magnetic chucks of the permanent magnetic type and, more particularly, to novel and improved means for releasing work pieces from magnetic chucks of the permanent magnetic type.

This invention is particularly concerned with magnetic chucks of the permanent magnetic type wherein the chuck includes magnetic work holding means comprising a pair of plates disposed in stacked overlying parallel relationship with cooperating magnetic means on the plates for providing a magnetic circuit for holding a magnetizable work piece on one of the plates. In chucks of this type, the plates are normally mounted for relative movement in a direction parallel to the general plane of the plates and between a work holding first position and a work releasing second position. In the work holding position of the plates, the cooperating magnetic means on the plates provides a strong magnetic field for holding the work on one of the plates. In the work releasable position, this magnetic field is substantially reduced or neutralized in order to permit easy removal of the work from the supporting plate.

Magnetic chucks of this type fall into two general categories, one wherein the magnetic means for the chuck is polarized in a direction extending at right angles to the general plane of the plates, and the other wherein the magnetic means is polarized in a direction extending parallel to the general plane of the plates. A chuck of this latter type is described and claimed in copending application Serial No. 606,017, filed August 24, 1956, in the name of John Engelsted. In both general classes of permanent magnet chucks, the plates are normally relatively strongly attracted to each other in one or the other of the work holding or work releasable positions of the plates. Thus, in one direction of relative movement between the plates, the magnetic force attraction between the plates, which serves to engage the plates firmly together, results in an increased frictional resistance to relative sliding movement between the plates so that a relatively large force is required to relatively shift the plates. This large force requirement often necessitates the use of special hydraulically or pneumatically operated actuating devices, which are, of course, costly and many times of undesirably large size.

Accordingly, it is the primary object of this invention to provide in a permanently magnetic chuck of the type described novel and improved means for facilitating relative movement of the plates between their work holding and work releasing positions which will appreciably reduce the force necessary to effect relative movement between the plates out of the position thereof wherein the plates are magnetically attracted.

A detailed understanding of this invention together with the advantages thereof may be had by reference to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a plan view of an exemplary permanently magnetic chuck incorporating the present invention;

FIG. 2 is an enlarged fragmentary side view, partly in section, of the chuck of FIG. 1;

FIG. 3 is a plan view of an exemplary permanently magnetic chuck of an alternative construction and incorporating an alternative embodiment of the present invention; and

FIG. 4 is an enlarged fragmentary cross sectional view substantially along the line 4—4 of FIG. 3.

With reference to FIGS. 1 and 2 of the drawings, the chuck shown therein is generally the same as that described and claimed in the aforementioned copending application. The chuck comprises a housing **10** of non-magnetic material such as aluminum and has a recess defined by side walls **11**, end walls **12**, and a bottom wall **14**. Received in this recess are a pair of plates **16** and **18** engaged in stacked overlying parallel relationship. The upper plate **16** is firmly attached to the casing, while the lower plate **18** is free to move within the recess and relative to the housing in opposite directions generally parallel to the general plane of the plates and in the direction of the arrow in FIG. 1. The movement of the lower plate **18** may be guided by any suitable means, such as by engagement with the side walls of the housing. For a purpose hereinafter apparent, the lower plate **18** is spaced from the bottom wall **14** of the housing and is resiliently supported in engagement with the underside of the upper plate **16** by suitable means, such as the springs **20**.

The upper plate **16** comprises a frame including end bars **22**, side bars **24**, and a central bar **26** extending parallel to and between the side bars **24**. The bars are made of a non-magnetizable material, such as stainless steel or brass, and are welded to each other to provide a rigid frame. A plurality of elongated, rectangular cross section, permanent magnets **28** extend at right angles to and are fixed to the side bars and central bar with the magnets being arranged in parallel laterally spaced relationship. Engaged between each next adjacent pair of magnets **28** is an elongated spacer **20** of soft iron. The spacers are also fixed to the bars **24** and **26**, and the upper surfaces of the spacers in part form the work supporting surface of the chuck.

In the specific embodiment shown, the magnets **28** are fabricated of material which is ceramic or partly ceramic in nature, such as the barium-iron oxide ceramic or compositions of bismuth and manganese, and, as shown in FIG. 2, the magnets are polarized in a direction extending generally parallel to the general plane of the upper plate **16** and at right angles to the longitudinal axis of the magnets. The polarity of next adjacent magnets is in reverse relationship, so that the next adjacent poles of next adjacent magnets are of like polarity. Being ceramic in nature, the magnet materials are not always suitable for exposures directly as part of the work holding surface of the chuck due to their sometimes brittle nature. Accordingly, as shown in FIG. 2, the magnets are preferably recessed below and above the upper and lower faces of the plate **16**, with the recesses being filled with suitable non-magnetic material of wear-resistant properties, such as stainless steel.

The lower plate **18** is substantially identical with the upper plate **16** comprising end bars **32**, side bars (not shown) and a central bar **33**. The lower plate further comprises a plurality of permanent magnets **34** and spacers **36** similar to and arranged similarly to the magnets **28** and spacers **30** of the upper plate, with the magnets of the lower plate being polarized in the same direction as the magnets of the upper plate. Consequently, when the upper and lower plates are in a work holding position, such as shown in FIG. 2, wherein the magnets of the upper and lower plates are in vertical alignment, the pairs of aligned magnets are equivalent to a plurality of magnets extending the full height of the upper and lower plates. As will be apparent from FIG. 2, in the work holding position of the plates, the magnets and next adjacent spacers are linked by a strong magnetic flux field, and a work piece of magnetizable material supported on the upper plate **16** will be firmly held by this flux. In order to release such a work piece held by the chuck, suitable means

(not shown) are provided to move the lower plate 18 relative to the upper plate 16 parallel to the general plane of the plates and in the direction of polarization of the magnets in an amount corresponding to one pole pitch of the magnets. As will be apparent from FIG. 2, the aligned magnets will now be in opposite polarity relationship, and flux linking between the magnets will take place vertically between the upper and lower magnets and little, if any, of the flux will extend above the top surface of the upper plate.

In chucks of this type, when the plates are in the work holding position of FIG. 2, the relationship of the polarities of the magnets of the upper plate to the polarities of the magnets of the lower plate is such that the magnets tend to repel each other and force the plates apart. The springs 20, however, are of sufficient strength to maintain the plates in engagement when the plates are in work holding position. Correspondingly, when the plates are in work releasing position, there will be a strong attraction between the magnets of the upper and lower plates tending to hold the plates firmly in engagement. This results in a substantial frictional resistance to sliding movement of the lower plate along the bottom surface of the upper plate.

In accordance with the invention, a plurality of wedge-like cam members 38 are carried by the upper plate and are engageable with follower rollers 40 carried by the lower plate so as to move the plate downwardly at right angles to the general plane of the plates in response to movement of the lower plate in the direction of polarization of the magnets. More specifically, as shown in FIG. 2, the cams 38 are received in closely fitting relationship in recesses in the underside of the central bar 26 of the upper plate. The cams or wedges 38 are provided on their undersides with two symmetrically arranged inclined surfaces 42, 44, extending in the direction of movement of the lower plate between the work holding and work releasing relative positions of the plates. The inclined surfaces 42, 44 extend toward each other in a downward direction and meet in the center of the cam to provide a V-shaped configuration. The roller 40 is partially received in a recess in the upper surface of the lower plate 18 and is supported by the end of an adjusting screw 46 threadably received in the lower plate and providing accurate positioning of the roller. With the plates in the work holding position shown in FIG. 2, the rollers 40 are engaged with the inclined surface 42 on the right side of the cam, as viewed in FIG. 2. Accordingly, when the plate is moved to the left, as viewed in FIG. 2, the cams and rollers will cooperate to move the lower plate downwardly away from the upper plate immediately upon initial shifting movement of the lower plate. Continued movement of the lower plate to the left will result in engagement of the rollers 40 with the inclined surfaces 44. The positioning of the apex of the inclined surface of each cam laterally of the magnets 28 is such that when the lower plate has been shifted to the left a distance equivalent to one pole pitch, the lower plate will be reengaged with the upper plate by the mutual attraction of the magnets 28 and 34, and there will be no substantial bearing pressure between the rollers and cams. The reengagement of the plates when in their work releasing relative position is desired in order to enhance the neutralizing of the magnetic field of the magnets.

Thus, it can be seen that during shifting of the lower plate there is effectively no sliding engagement between the plates and the only friction resisting movement of the lower plate is that from the rolling contact between the rollers and the cams. Thus, it will be apparent that the force necessary to shift the lower plate between work holding and work releasing positions has been materially reduced from the case where the lower plate merely slides along the underside of the upper plate. As will be apparent, upon subsequent movement of the lower plate to the right, as viewed in FIG. 2, the strong attraction between the plates tending to hold them together tends to be substantially reduced by the vertical separation of the plates prior to any significant horizontal movement of the lower plate in the direction of polarization of the magnets. The specific configuration of the cams and rollers shown is, of course, only by way of example, and other suitable or alternative structure could be employed. Further, the geometrical arrangement of the cooperating cams and rollers or the like could, if desired, be different from that shown without departing from the invention.

With reference to FIGS. 3 and 4, the magnetic chuck therein shown comprises an upper plate 50 including a plurality of elongated soft iron rods 52 arranged in parallel laterally spaced relationship with strips 54 of magnetic insulating material such as aluminum being engaged between next adjacent rods 52. A plurality of draw bolts 56 maintain the rods 52 and strips 54 in assembly. The upper plate 50 is secured to a casing 58 of non-magnetic material, such as aluminum. The casing defines a recess in which is received a lower plate 60. The lower plate 60 comprises a plurality of elongated permanent magnets 62 of rectangular cross section and polarized in a direction extending vertically at right angles to the general plane of the plates 50 and 60. The magnets 62 extend parallel to each other and the rods 52 and are laterally spaced apart. In the space between each next adjacent pair of magnets is disposed an elongated soft iron rod 64 separated from the adjacent magnets by a non-magnetic strip 66 of material such as aluminum. The magnets 62, rods 64, and strips 66 are held in assembly by a plurality of draw bolts 68 extending therethrough. A soft iron flux return member 70 is engaged with the bottoms of the iron rods 64 by screws threadably engaged in certain of the rods 64. The bottom of the flux return member 70 is spaced from the bottom wall of the housing or casing 58 so as to permit a limited amount of downward movement of the lower plate relative to the upper plate.

The lower plate is reciprocable relative to the upper plate in the direction of the arrows in FIGS. 3 and 4 or in a direction extending at right angles to the direction of polarization of the magnets and parallel to the general plane of the plates. Suitable means (not shown) are provided for shifting the lower plate in the direction of the arrows of FIGS. 3 and 4 between a work holding position, as shown in FIG. 4 wherein the lower plate is engaged against a limit pin 72 on the casing 58, and a work releasing position wherein the lower plate will be offset to the right, as viewed in FIG. 4, a distance equal to one-half the lateral dimension of a magnet in the direction of movement of the lower plate. As will be apparent from FIG. 4, in the work releasing position of the lower plate the magnets will be centered under the magnetic non-conducting strips 54 of the upper plate, and next adjacent magnets will be registering equally with a pair of next adjacent soft iron rods 52 in the upper plate so as to tend to neutralize the effect of the magnets on a magnetizable work piece supported on the upper plate. As will further be apparent from FIG. 4, when the lower plate is in work holding position, there will be a strong attraction of the lower plate to the upper plate tending to resist shifting movement of the lower plate and increasing the frictional resistance of any sliding of the lower plate along the underside of the upper plate.

In accordance with the invention, a plurality of cams 74 and cooperating rollers 76 are carried respectively by the upper and lower plates and are engageable during shifting of the lower plate from the work holding position to the work releasing position to separate the plates in a direction extending at right angles to the general plane of the plates and tend to neutralize the magnetic field of the magnets as it affects a work piece supported on the upper plate. More specifically, as shown in FIG. 4, the cams 74 are received in closely fitting relation in recesses in the upper plate 50 and are each provided with a single inclined cam surface 78 extending downwardly toward the lower plate and in the direction of movement

of the lower plate from work holding position to work releasing position. The rollers **76** are engaged with the cam surface **78** and are received in recesses in the upper surface of the lower plate **60**. The rollers are supported by the ends of adjusting screws **80** threadably received in the lower plate for accurately positioning the rollers relative to the cams. As will be apparent from FIG. 4, as the lower plate is moved to the right, it will be cammed downwardly and away from the upper plate **50**, thus materially reducing the magnetic attraction between the upper and lower plates and appreciably decreasing the amount of force necessary to move the lower plate relative to the upper plate. In the embodiment of FIG. 4, the spacing of the upper and lower plates when the plates are in work releasing position will, of course, contribute to the reduction in the effect of the flux of the magnets on a work piece supported on the upper plate. The lower plate will, of course, still be attracted to the upper plate even when in work releasing position, and this attraction may be sufficient to hold the lower plate off the bottom of the housing. If desired or necessary, springs such as those shown at **20** in FIG. 2 may be utilized to bias the lower plate upwardly.

While the invention has been described in terms of the specific embodiments shown in the drawings, it is to be understood that the foregoing description and accompanying drawings are to be taken only in an illustrative sense. In this connection, for example, the embodiment shown in FIGS. 1 and 2 could be utilized, if desired, with a chuck of the type shown in FIGS. 3 and 4; and, correspondingly, the embodiment of FIGS. 3 and 4 could, if desired, be utilized in a chuck such as shown in FIGS. 1 and 2. Therefore, it is intended that the invention is to be limited only by the appended claims, which shall include within their scope all structure which logically comes within the language of the claims.

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

1. In a magnetic chuck, a pair of plates disposed in parallel stacked relation, means for effecting relative movement between the plates parallel to the general plane of the plates and between a work holding first position and a work releasing second position, a plurality of permanent magnets carried by one of the plates, means on the other of the plates cooperating with said magnets to provide a magnetic flux circuit for holding a work piece of magnetizable material on the chuck when the plates are in said first position and cooperating with said magnets to tend to neutralize the magnetic flux thereof when the plates are in said second position, and means for separating the plates in response to relative movement between the plates from one of the positions thereof to the other of the positions thereof including a cam surface on one plate inclined toward the other plate, and means on said other plate engageable by said cam surface for the initiation of separation of the plates at right angles to said general plane in response to initiation of relative movement between the plates from said one of the positions to said other of the positions.

2. In a magnetic chuck, a pair of plates disposed in parallel stacked relation, means for effecting relative movement between the plates parallel to the general plane of the plates and between a work holding first position and a work releasing second position, a plurality of permanent magnets carried by one of the plates, means on the other of the plates cooperating with said magnets to provide a magnetic flux circuit for holding a work piece of magnetizable material on the chuck when the plates are in said first position and cooperating with said magnets to tend to neutralize the magnetic flux thereof when the plates are in said second position, and means for separating the plates in response to relative movement between the plates from one of the positions thereof to the other of the positions thereof including a cam surface on one plate inclined toward the other plate, and follower means on said other plate engageable with said cam surface in rolling contact to effect separation of the plates at right angles to said general plane during relative movement between the plates from said one of the positions to said other of the positions.

3. In a magnetic chuck, a pair of plates disposed in parallel stacked relation, means for effecting relative movement between the plates parallel to the general plane of the plates and between a work holding first position and a work releasing second position, a plurality of permanent magnets carried by one of the plates, means on the other of the plates cooperating with said magnets to provide a magnetic flux circuit for holding a work piece of magnetizable material on the chuck when the plates are in said first position and cooperating with said magnets to tend to neutralize the magnetic flux thereof when the plates are in said second position, and means for separating the plates in response to relative movement between the plates in both directions between said positions thereof including a generally V-shaped cam surface on one plate facing generally toward the other plate and follower means on said other plate engageable with said cam surface in rolling contact to effect separation of the plates at right angles to said general plane during relative movement between the plates between said positions thereof and parallel to said general plane.

4. In a magnetic chuck, an upper plate and a lower plate disposed in parallel stacked relation, means for moving the lower plate relative to the upper plate in a direction parallel to the general plane of the plates and between a work holding first position and a work releasing second position, a plurality of permanent magnets carried by the lower plate, means on the upper plate cooperating with said magnets to provide a magnetic flux circuit for holding a work piece of magnetizable material on the upper plate when the lower plate is in said first position and cooperating with said magnets to tend to neutralize the magnetic flux thereof when the lower plate is in said second position, and means for separating the plates in response to movement of the lower plate from one of the positions thereof to the other of the positions thereof including a cam surface on one plate inclined toward the other plate, and a roller carried by said other plate engageable by said cam surface to effect separation of the plates at right angles to said general plane during movement of the lower plate from said one of the positions to said other of the positions.

5. In a magnetic chuck, an upper plate and a lower plate disposed in parallel stacked relation, means for moving the lower plate relative to the upper plate in a direction parallel to the general plane of the plates and between a work holding first position and a work releasing second position, a plurality of permanent magnets carried by the lower plate, means on the upper plate cooperating with said magnets to provide a magnetic flux circuit for holding a work piece of magnetizable material on the upper plate when the lower plate is in said first position and cooperating with said magnets to tend to neutralize the magnetic flux thereof when the lower plate is in said second position, and means for separating the plates in response to movement of the lower plate from one of the positions thereof to the other of the positions thereof including a cam surface on one plate inclined toward the other plate, follower means carried by said other plate engageable with said cam surface in rolling contact to effect separation of the plates at right angles to said general plane during movement of the lower plate from said one of the positions to said other of the positions, and an adjusting screw carried by said other plate and supporting the follower means in a direction extending at right angles to said general plane and operative to move the follower means toward said cam surface.

6. In a magnetic chuck, an upper plate and a lower plate engaged in parallel stacked relation, a plurality of

elongated permanent magnets carried by each of the plates, the magnets on each plate extending in parallel laterally spaced relation, a plurality of magnetic flux conductive spacers engaged between each pair of next adjacent magnets on each plate, the magnets on each plate being polarized in a direction parallel to the general plane of the plates and at right angles to the longitudinal axis of the magnets with the next adjacent oppositely facing poles of each next adjacent pair of magnets on each plate being of the same polarity, means for moving the lower plate parallel to the general plane of the plates in the direction of polarization of the magnets and between a work holding first position and a work releasing second position, and means for separating the plates in response to movement of the lower plate between the first and second positions thereof including a generally V-shaped cam surface on the upper plate facing generally toward the lower plate, a roller on said lower plate engageable by said cam surface to effect separation of the plates at right angles to said general plane during movement of the lower plate between said positions, and an adjusting screw carried by the lower plate and supporting said roller at one end of the screw to position the roller in engagement with said cam surface when the lower plate is in both its first and second positions.

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