Nov. 6, 1956 H. E. BERRY 2,769,642

SELF-CENTERING MAGNETIC CHUCK

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FIG. 1

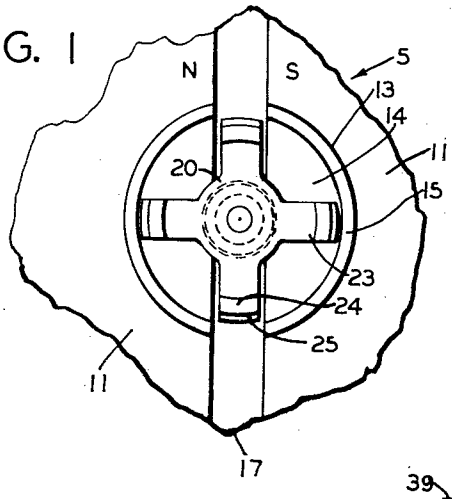


FIG. 4

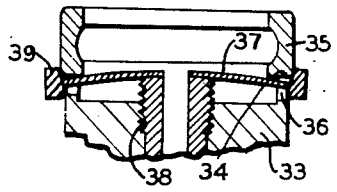
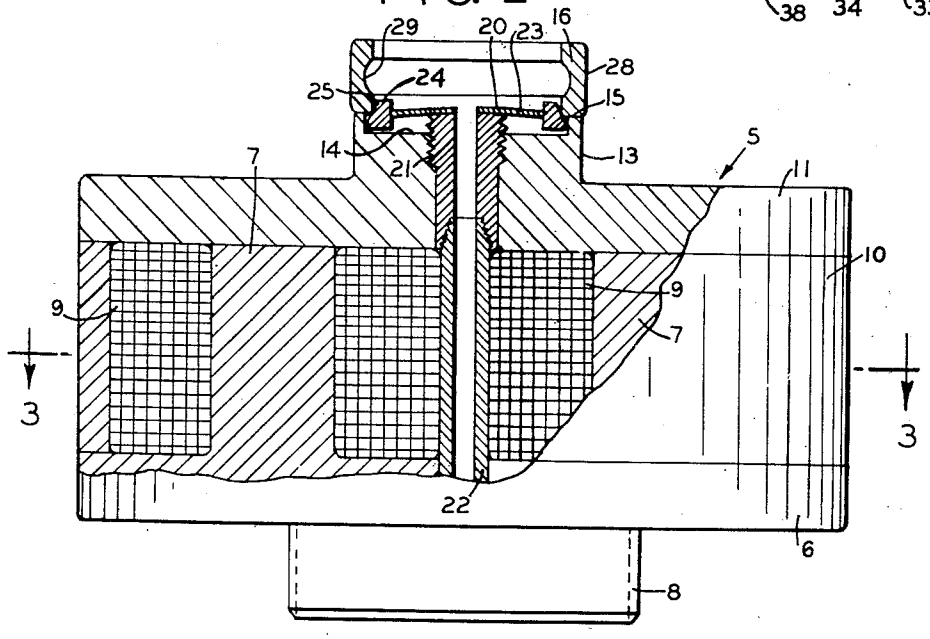


FIG. 2



INVENTOR.
HUGH E. BERRY
BY John P. Chandler
his ATTORNEY.

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FIG. 3

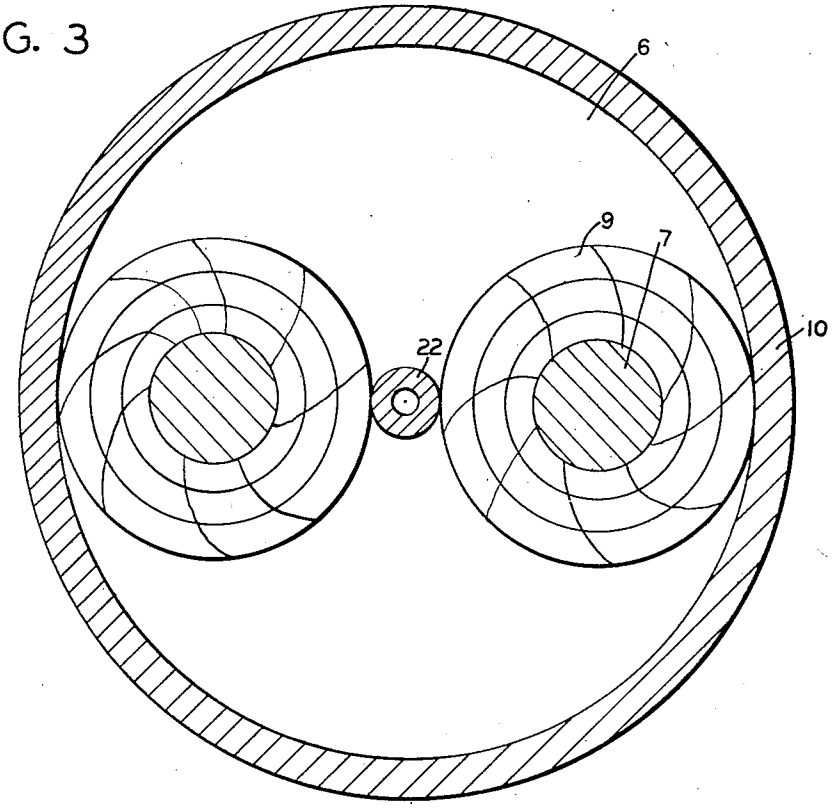
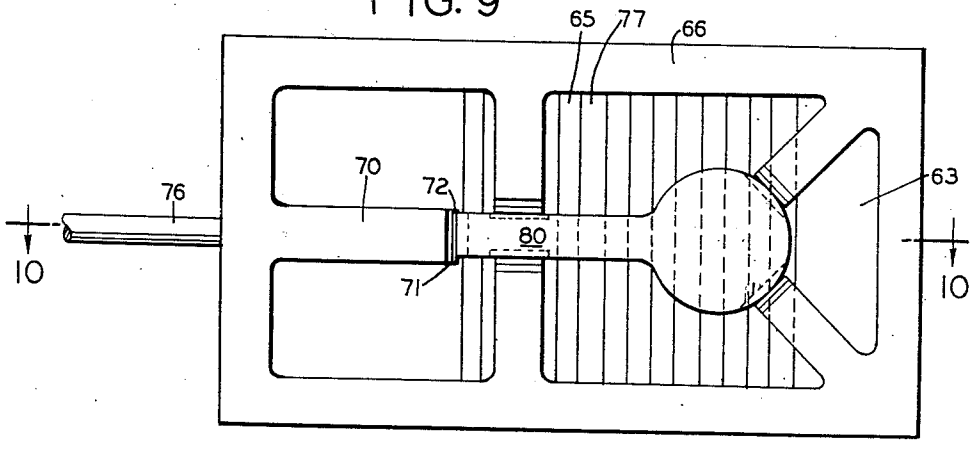


FIG. 9



INVENTOR.
HUGH E. BERRY

BY John P. Chandler

his ATTORNEY.

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FIG. 5

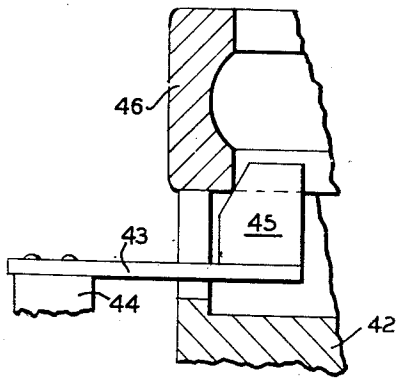


FIG. 6

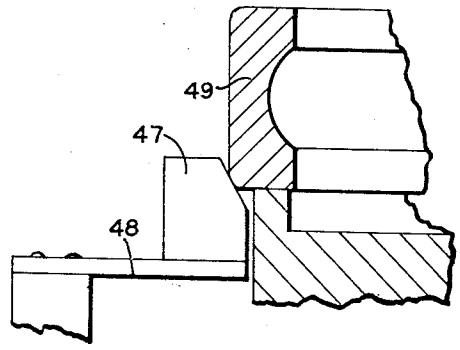


FIG. 7

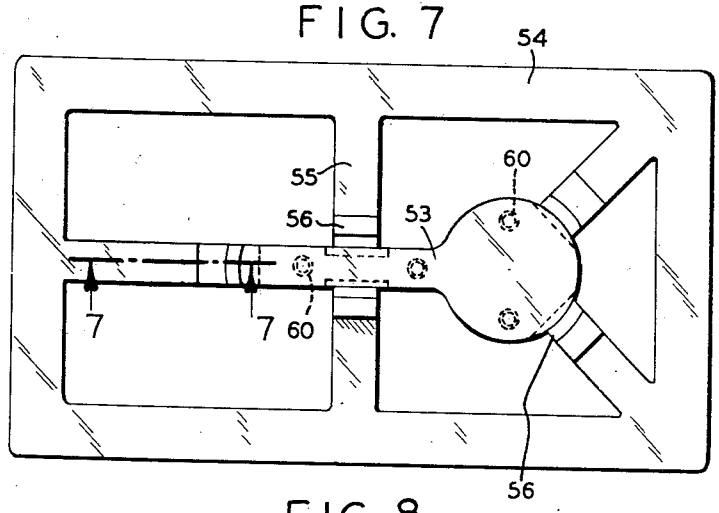
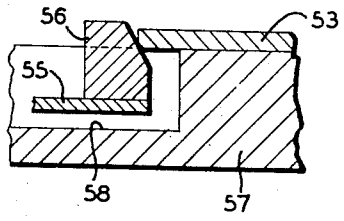


FIG. 8



INVENTOR.
HUGH E. BERRY
BY John P. Chandler
his ATTORNEY.

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SELF-CENTERING MAGNETIC CHUCK

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FIG. 10

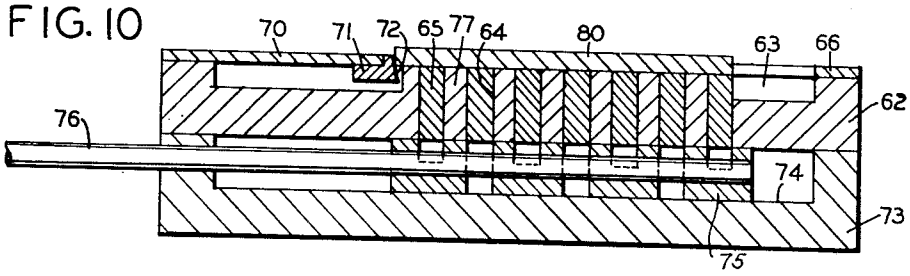


FIG. 11

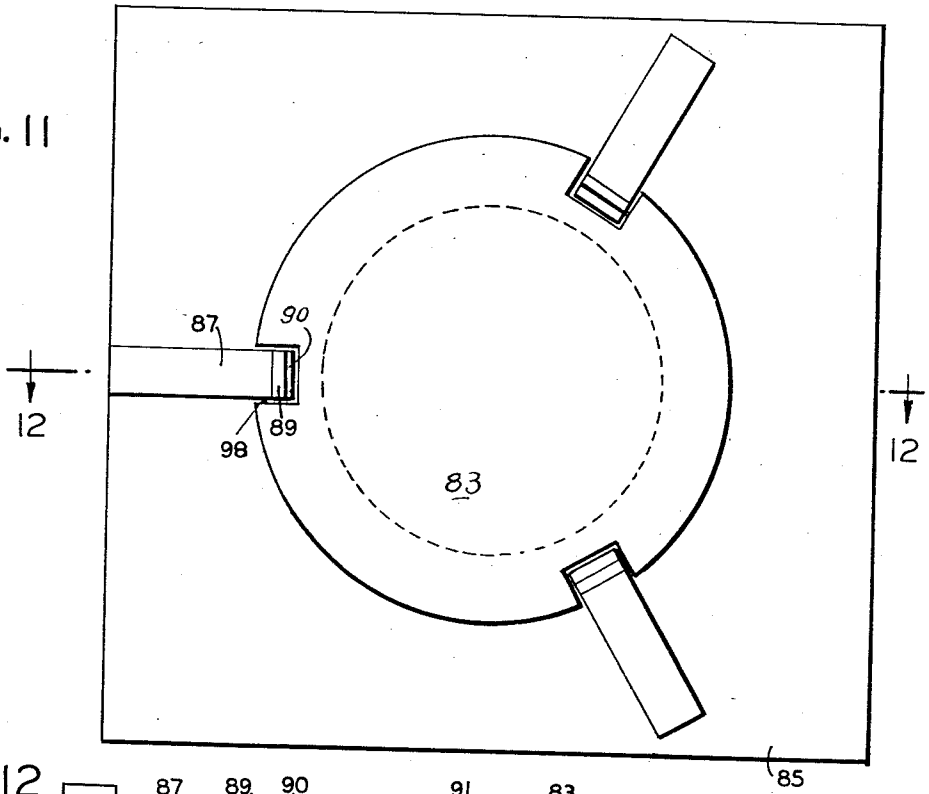
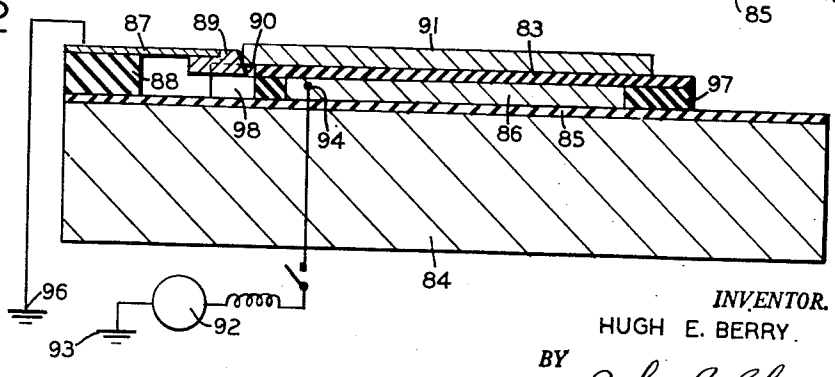


FIG. 12



INVENTOR.
HUGH E. BERRY.
BY
John P. Chandler
his ATTORNEY.

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2,769,642

SELF-CENTERING MAGNETIC CHUCK

Hugh E. Berry, Scarsdale, N. Y., assignor to Norma-Hoffmann Bearings Corporation, Stamford, Conn., a corporation of New York

Application December 31, 1954, Serial No. 479,049

10 Claims. (Cl. 279—1)

This invention relates to chucks and relates more particularly to improvements in work holders of the type having a substantially flat face forming a seat for the work piece and wherein the major holding force is essentially normal to the face of the chuck.

The invention has particular reference to chucks wherein there is some attractive force such as a magnet or a vacuum holding the work piece flat against the face. An important object of the invention is to provide improved means for accurately positioning the work piece initially and for securing it against sidewise movement relative to the flat seat while a machining or other operation is being performed thereon.

The chuck of the present invention may employ as the principal holding force magnetic or electrostatic attraction, a vacuum, a strong adhesive or other suitable means and the chuck may rotate or it may reciprocate or be stationary.

Another object of the invention is to provide an improved chuck having a face forming a seat for the work piece, and a plurality of beveled or tapered contact blocks, each block being mounted at one end of a bendable arm such as a leaf type of flat spring, the other end of the arm being mounted on some portion of the chuck and the free ends of the arms carrying the tapered contact blocks are resiliently movable towards the face of the chuck. If desired, a spider arrangement of the arms may be provided wherein all of the arms extend inwardly or outwardly from an annular member. The contact blocks are so arranged that each arm is under some measure of bending stress when it has contacted the edge of the work and the work piece is accurately in place. This feature is particularly important in ring-like work pieces wherein unroundness is present since the arms will deflect more or less to accommodate the unroundness and still provide positive contact between the contact blocks and the work.

If a magnetic chuck is provided the magnetic element may be either a permanent magnet or an electro-magnet. If there is any marked variation in the size of the work piece some of the arms may be under an appreciable bending stress and other under very little stress. In any event, the magnetic influence holds the work firmly against the face of the chuck and against the inclined faces of the contact blocks which prevent lateral movement of the work piece relative to the axis of the chuck in the case of a rotating element.

The chuck of the present invention has particular usefulness in connection with the grinding of outer rings for ball bearings and it permits the bearing race to be machined simultaneously with machining of the outer periphery of the ring to proper size.

Magnetic chucks have been used for grinding bearing races but it has always been found necessary to provide some supplemental holding means for preventing shifting of the ring away from the axis, and also no satisfactory means has been found for precisely centering the ring in the first instance.

In one embodiment of the present invention the chuck

is formed with an annular face of slightly less outer diameter than that of the finished ring in order to permit the external grinding wheel to reciprocate back and forth across the external surface without contacting the chuck. A spider diaphragm is disposed in the central area defined by the annular face of the chuck and at the outer ends of the several radial arms forming the spider there are secured contact blocks whose outer faces are beveled or tapered.

The diaphragm itself is formed of springy metal and sufficient space is provided to the rear of the contact blocks to allow them to recede as the ring is applied in the first instance. Since all of the arms are subjected to a greater or lesser bending stress as the ring is applied to the face of the chuck, the ring becomes automatically centered, after which the magnet is energized in the case of an electro-magnet.

In the case of ring-like work pieces the contact blocks may engage either the inner or outer edges and in the case of an imperforate work piece, circular in shape or otherwise, they engage the outer edge section. In the event of an apertured work piece of irregular shape the blocks may engage inner or outer edge sections.

It will be seen from the foregoing that the strut action of the spider transmitted across the contact blocks will provide the necessary rigidity to prevent side slip or movement of the part under the action of the grinding forces.

Another object of the invention is to provide automatic and positive centering means for the ring even though the ring is slightly out of round. As soon as the work contacts the tapered blocks it starts to center itself and when it finally engages the face it is accurately centered.

In the drawings:

Fig. 1 is a broken front elevation of an electro-magnetic chuck embodying the present invention and showing a spider diaphragm with radial arms supporting the contact blocks.

Fig. 2 is a side elevation, partly in section, of the chuck and showing the work piece in place.

Fig. 3 is a section taken on line **3—3** of Fig. 2.

Fig. 4 is a broken section showing a modification wherein the tapered blocks engage the outer periphery of the work piece.

Fig. 5 is a broken section taken through a modified arrangement.

Fig. 6 shows another modified arrangement.

Fig. 7 shows a modified arrangement wherein the work piece is non-circular in shape.

Fig. 8 is a broken section taken on line **7—7** of Fig. 7.

Fig. 9 is a plan view of a chuck of the present invention employing a permanent magnet as the attractive force.

Fig. 10 is a section taken on line **10—10** of Fig. 9.

Fig. 11 is a plan view of a chuck embodying the present invention and employing an electrostatic force as the holding means.

Fig. 12 is a section taken on line **12—12** of Fig. 11.

In the first embodiment of the invention (Figs. 1, 2 and 3) the work holder **5** is of circular shape and includes a body section **6** formed with poles **7** on its forward face and an annular flange **8** on its rear face for attachment to a rotating spindle. Electro-magnetic coils **9** are carried on the poles and the coils are enclosed by a ring **10**. A cover plate **11** formed in two sections is suitably secured to the body section, said plate having a central circular projection **13**. The projection is formed with an annular recess **14**, thus providing an annular face or seat **15** which receives a ring-like work piece **16**. If desired a non-magnetic element **17** is positioned between the two sections of plate **11**.

The spider diaphragm **20** is formed of spring steel or other resilient metal and is secured to or is formed integral with an externally threaded bushing **21** which is received in a threaded central opening in the work holder. A duct **22** for coolant may pass into the opening. The diaphragm **20** has a plurality of radially disposed arms **23** and at the outer end of each arm a contact block **24** having a tapered outer face **25** is secured. The angle of the tapered or beveled face relative to the edge of the work piece may vary but it should be about 30°. Also, in the case of a ring-like work piece the face should be convexly curved as shown in Fig. 1 and should form the arc of a circle of lesser diameter than that of the work piece.

When the parts are at rest there is a clearance between the contact blocks and the inner face of recess **14**. When the ring-like element is to be applied to the work holder it is pressed against the annular face **15** and the tapered blocks automatically center the ring, after which the magnet is energized. If the ring is slightly elliptical the two opposed blocks contacting the shorter diameter section will retract further into recess **14** than will the remaining two but the ring will be accurately centered relative to the axis.

The ring can be operated upon to simultaneously grind the outer periphery **28** to exact size and also to grind the bearing race **29**.

In the form of the invention shown in Fig. 4 the chuck **33** has an annular seat **34** for the work piece **35** and a plurality of notches **36** within which the arms **37** are positioned. The spider element is again carried by a bushing **38**. The tapered contact blocks **39** carried at the outer ends of the arms engage the outer edge of the work piece. This arrangement is particularly useful in cases wherein the outer surface of the ring has been machined accurately and the inner surface has not.

In Fig. 5 the arms **43** are fixed at their outer ends as to a member **44** carried by the chuck **42** and the contact blocks **45** engage the inner surface of the work piece **46**. The same general arrangement is shown in Fig. 6 except that the contact blocks **47** carried by radial arms **48** engage the outer surface of the work piece **49**.

In the embodiments of the invention shown in Figs. 1 to 5 the purpose of the recess in the face of the chuck is to permit the bendable arms and the contact blocks to move rearwardly in the direction of said face when the beveled contact blocks engage the work and the arms are under a bending stress. In Fig. 6 the construction is such that sufficient clearance is provided for rearward travel of the blocks and arms without cutting away a portion of the chuck.

In Figs. 7 and 8 there is shown a non-circular work piece **53** in the shape of a key. The spider diaphragm **54** has inwardly extending arms **55** carrying the tapered contact blocks **56**. The face of the chuck **57** will, of course, have suitable recesses **58** for the contact blocks and arms to move rearwardly. Vacuum means are provided for holding the work piece firmly against the face of the chuck and this includes a plurality of ports **60** leading to the face and which are connected with a suitable source (not shown) of negative pressure.

The chuck shown in Figs. 9 and 10 employs a permanent magnet arrangement. An upper plate **62** of magnetic material is formed with recesses **63** on its upper face and with a plurality of through vertical slots **64** within which are positioned filler strips **65** of brass or other non-magnetic material. A spider diaphragm **66** is secured to the upper surface of this plate, the diaphragm having inwardly extending arms **70** having the contact blocks **71** with tapered faces **72** secured at their free ends.

A lower plate **73** of non-magnetic material is carried by the upper plate, said lower plate being recessed at **74**, and having a plurality of generally U shaped permanent magnets **75** secured to a push-and-pull rod **76**. The magnets are so proportioned relative to the magnetic land portions **77** remaining after slots **64** are formed as to contact two adjacent land portions when in the position of Fig. 10 and to be in contact with the non-magnetic filler strips when moved in the direction of the arrow.

The work piece is shown at **80** and before the work piece is applied to the chuck the pull rod is moved to cause the permanent magnets to contact the filler strips and as soon as the tapered contact blocks **71** have properly positioned the work piece the magnets are moved to the position of Fig. 10.

Figs. 11 and 12 show a chuck of the present invention employing an electrostatic force as the work holding means. A metallic base **84** supports a sheet of insulation **85** to which is secured a high voltage conductor **86**. On the upper surface of the conductor plate a thin sheet **83** of mica or other insulating material is secured. Flat springs **87**, mounted on spacer blocks **88**, support the contact blocks **89** formed with tapered faces **90**. The work is shown at **91** and after the work has become centered as a result of contact with the tapered contact blocks **90** an electrostatic generator **92**, grounded at **93** and connected at **94** with the high voltage conductor, is energized. Contact with the work is effected through the contact blocks **89** and arms **87**, the latter of which are grounded as at **96**. In order to completely insulate the plate **86** from the work a ring **97** of insulating material surrounds the plate and underlies the peripheral margin of insulation sheet **83**. The insulation sheet and the ring have square notches **98** to enable contact blocks **89** to contact the work.

While there have been described herein what are at present considered preferred embodiments of the invention, it will be obvious to those skilled in the art that many modifications and changes may be made therein without departing from the essence of the invention. It is therefore to be understood that the exemplary embodiments are illustrative and not restrictive of the invention, the scope of which is defined in the appended claims, and that all modifications that come within the meaning and range of equivalency of the claims are intended to be included therein.

What I claim is:

1. A chuck for supporting a work piece while an operation is performed thereon, said chuck having a face forming a seat for the work piece and principal work holding means wherein the major holding force is essentially normal to said face, a plurality of contact blocks arranged to contact the edges of the work piece at a plurality of spaced points to aid in properly positioning the work piece and to secure it against sidewise movement while the operation is being performed thereon, and bendable arms supported at one end thereof by the chuck, one of the contact blocks being secured at the opposite end of each arm and having a beveled face which contacts a section of said edges, the free ends of the arms being movable under a bending stress in a direction normal to the face of the chuck when the edges of the work piece are moved against and are contacted by said beveled faces.

2. A chuck for supporting a work piece while an operation is performed thereon, said chuck having a face forming a seat for the work piece and principal work holding means wherein the major holding force is essentially normal to said face, a plurality of contact blocks arranged to contact the edges of the work piece at a plurality of spaced points to aid in properly positioning the work piece and to secure it against sidewise movement while the operation is being performed thereon, a spider element carried by the chuck and formed with radially extending, bendable arms, one of the contact blocks being secured at the free end of each arm and having a beveled face which contacts a section of said edges, the free ends of the arms being movable under a bending stress in a direction normal to the face of the chuck when the work

piece is positioned on said face and the edges thereof are contacted by said beveled faces.

3. A chuck for supporting a work piece while an operation is performed thereon, said chuck having a face forming a seat for the work piece, principal work holding means wherein the major holding force is essentially normal to said face, a plurality of contact blocks formed with beveled faces which contact the edges of the work piece at a plurality of spaced points to aid in properly positioning the work piece and to secure it against sidewise movement while the operation is being performed thereon, and bendable arms supported at one end thereof by the chuck, one of the contact blocks being secured at the opposite end of each arm, the face of the chuck having sufficient clearance for the blocks and arms to retract in the direction of said face when the beveled faces of the blocks contact said edges and the free ends of the arms move in a direction normal to the face of the chuck under a bending stress.

4. A chuck for supporting a work piece while an operation is performed thereon, said chuck having a face forming a seat for the work piece, principal work holding means which provide an attractive force which draws the work piece firmly against said face, a plurality of contact blocks formed with beveled faces which contact the edges of the work piece at a plurality of spaced points to aid in properly positioning the work piece and to secure it against sidewise movement while the operation is being performed thereon, and bendable arms supported at one end thereof by the chuck, one of the contact blocks being secured at the opposite end of each arm, the face of the chuck having sufficient clearance for the blocks to move in the direction of said face when the beveled faces of the blocks contact said edges and the free ends of the arms move in a direction normal to the face of the chuck under a bending stress.

5. A chuck for supporting a work piece while an operation is performed thereon, said chuck having a face forming a seat for the work piece and magnetic work holding means wherein the holding force is essentially normal to said face, a plurality of contact blocks arranged to contact the edges of the work piece at a plurality of spaced points to aid in properly positioning the work piece and to secure it against sidewise movement while the operation is being performed thereon and bendable arms supported at one end thereof by the chuck, one of the contact blocks being secured at the opposite end of each arm and having a beveled face which contacts a section of said edges, the free ends of the arms being movable under a bending stress in the direction normal to the face of the chuck when the edges of the work piece are contacted by said beveled faces.

6. A chuck for supporting a ring-like work piece while an operation is performed thereon, said chuck having an annular face forming a seat for the work piece, and magnetic work holding means carried by said chuck and wherein the holding force is essentially normal to said face, a plurality of contact blocks arranged to contact the edges of the work piece at a plurality of spaced points to aid in properly positioning the work piece and to secure it against sidewise movement while the operation is being performed thereon and bendable arms supported at one end thereof by the chuck, one of the contact blocks being secured at the opposite end of each arm and having a beveled face which contacts a section of said edges, the free ends of the arms being movable under a bending stress in a direction normal to the face of the chuck when the edges of the work piece are contacted by said beveled faces, the body of the chuck having sufficient clearance to allow said bending movement.

7. A chuck for supporting a work piece while an operation is performed thereon, said chuck having a face forming a seat for the work piece, principal work holding

means comprising an electro-magnet carried by the chuck and which draws the work piece firmly against said face, a plurality of contact blocks formed with beveled faces which contact the edges of the work piece at a plurality of spaced points to aid in properly positioning the work piece and to secure it against sidewise movement while the operation is being performed thereon, and bendable arms supported at one end thereof by the chuck, one of the contact blocks being secured at the opposite end of each arm, the face of the chuck having sufficient clearance for the blocks to move in the direction of said face when the beveled faces of the blocks contact said edges and the free ends of the arms move in a direction normal to the face of the chuck under a bending stress.

8. A chuck for supporting a work piece while an operation is performed thereon, said chuck having a face forming a seat for the work piece and work holding means comprising a permanent magnet carried by the chuck, a plurality of contact blocks arranged to contact the edges of the work piece at a plurality of spaced points to aid in properly positioning the work piece and to secure it against sidewise movement while the operation is being performed thereon and bendable arms supported at one end thereof by the chuck, one of the contact blocks being secured at the opposite end of each arm and having a beveled face which contacts a section of said edges, the free ends of the arms being movable under a bending stress in the direction normal to the face of the chuck when the edges of the work piece are contacted by said beveled faces.

9. A chuck for supporting a work piece while an operation is performed thereon, said chuck having a face forming a seat for the work piece, vacuum work holding means wherein the major holding force is essentially normal to said face, the chuck having a plurality of ports leading to the face and a source of negative pressure connected with the ports, a plurality of contact blocks formed with beveled faces which contact the edges of the work piece at a plurality of spaced points to aid in properly positioning the work piece and to secure it against sidewise movement while the operation is being performed thereon, and bendable arms supported at one end thereof by the chuck, one of the contact blocks being secured at the opposite end of each arm, the face of the chuck having sufficient clearance for the blocks and arms to retract in the direction of said face when the beveled faces of the blocks contact said edges and the free ends of the arms move in a direction normal to the face of the chuck under a bending stress.

10. A chuck for supporting a ring-like work piece while an operation is performed thereon, said chuck having an annular face forming a seat for the work piece, and electrostatic work holding means carried by said chuck and wherein the holding force is essentially normal to said face, a plurality of contact blocks arranged to contact the edges of the work piece at a plurality of spaced points to aid in properly positioning the work piece and to secure it against sidewise movement while the operation is being performed thereon and bendable arms supported at one end thereof by the chuck, one of the contact blocks being secured at the opposite end of each arm and having a beveled face which contacts a section of said edges, the free ends of the arms being movable under a bending stress in a direction normal to the face of the chuck when the edges of the work piece are contacted by said beveled faces, the body of the chuck having sufficient clearance to allow said bending movement.

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