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ELECTROMAGNETIC DEVICE AND PARTS THEREFOR

Filed Aug. 20, 1962

3 Sheets-Sheet 2

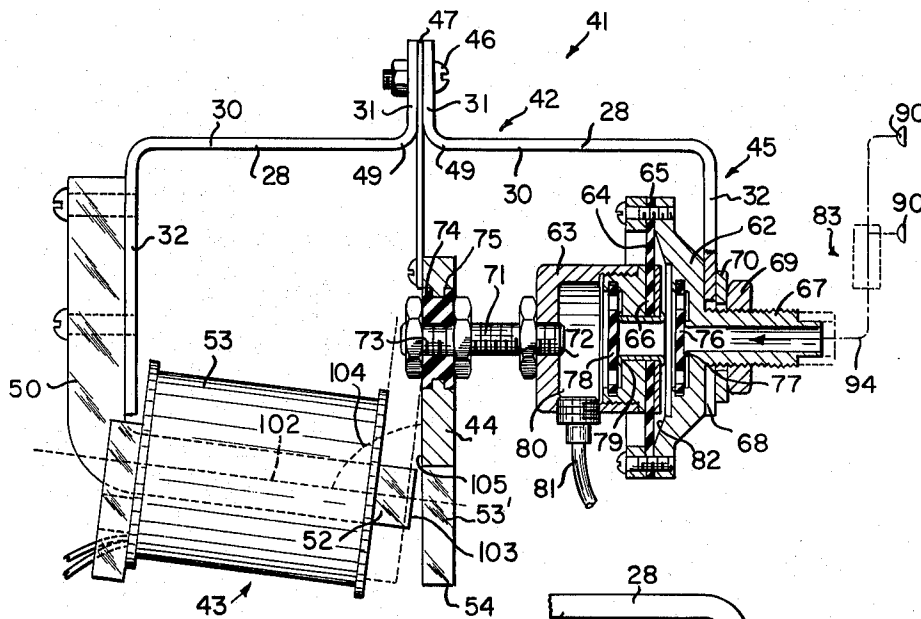


FIG-7

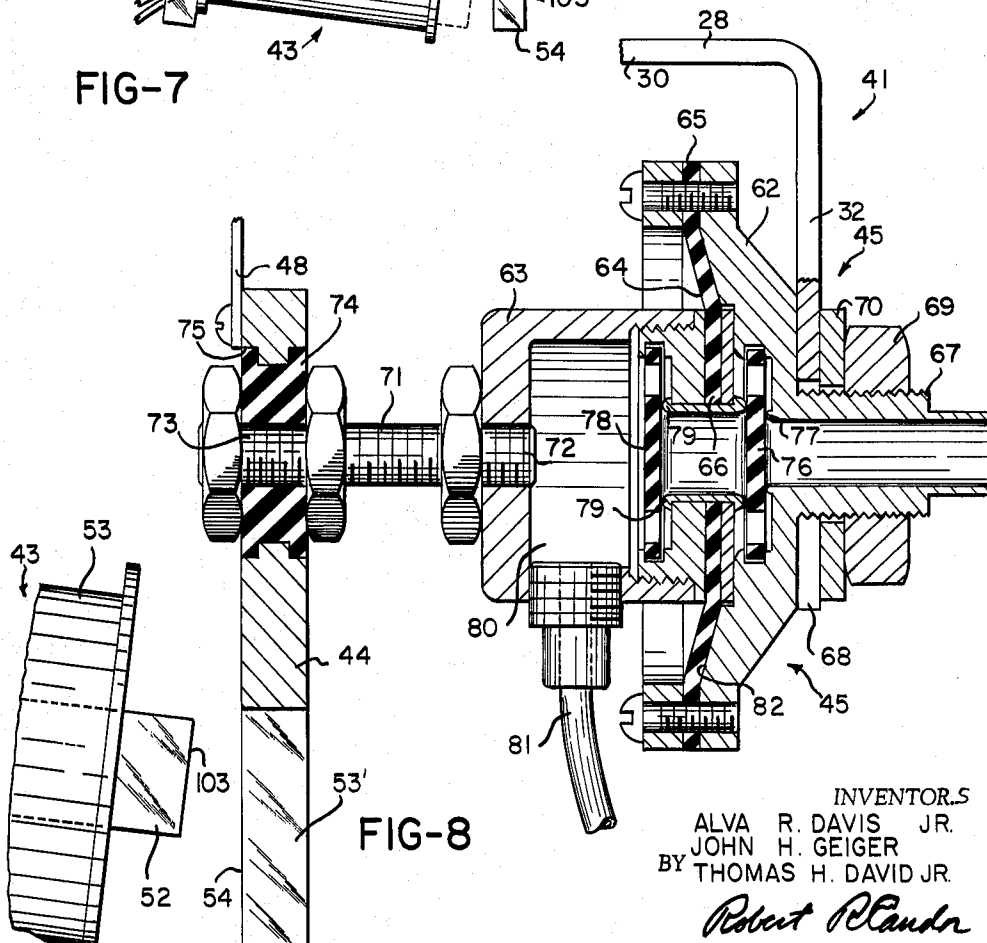


FIG-8

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3 Sheets-Sheet 3

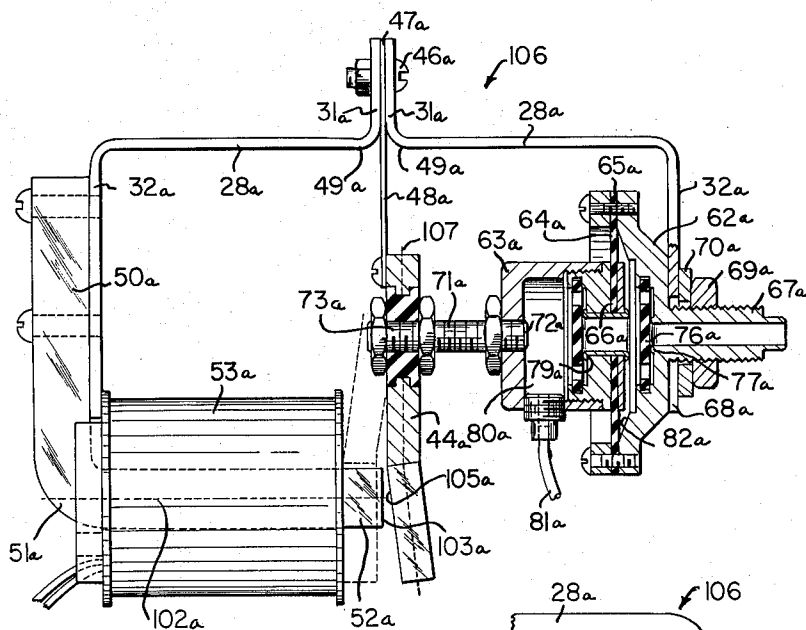


FIG-13

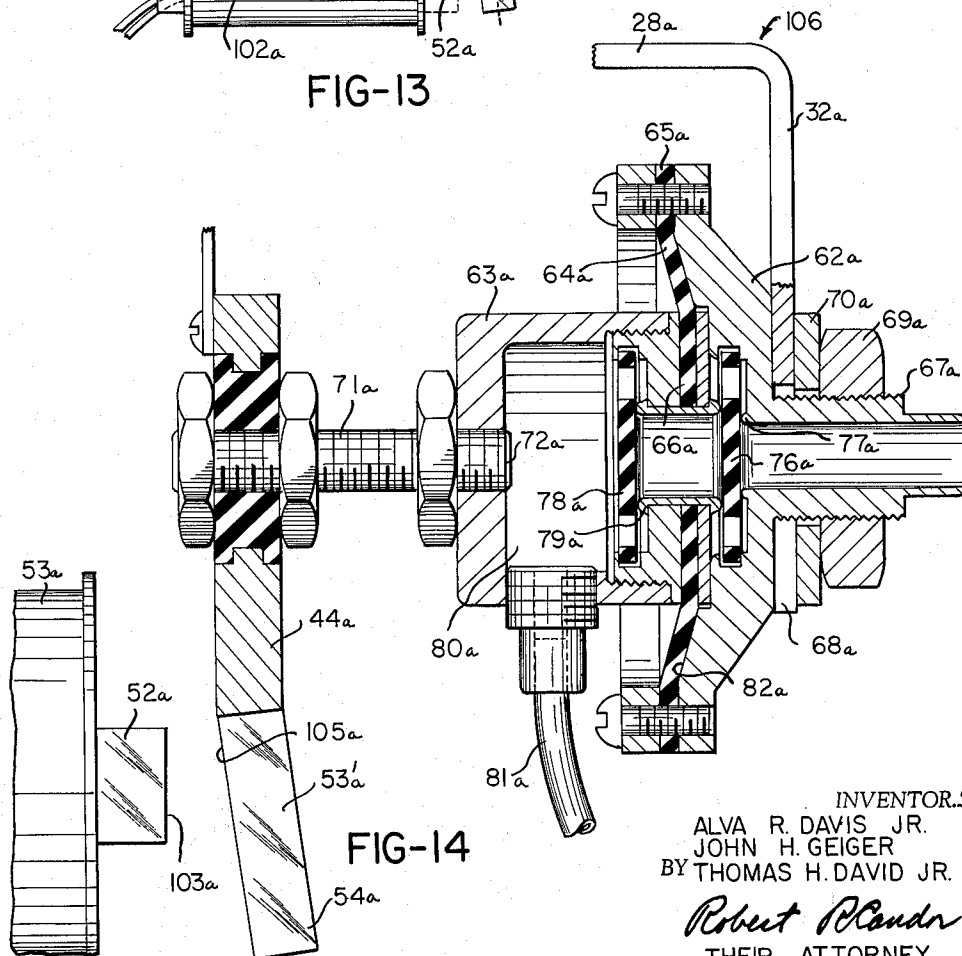


FIG-14

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3,242,355

ELECTROMAGNETIC DEVICE AND PARTS THEREFOR

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Filed Aug. 20, 1962, Ser. No. 217,857
9 Claims. (Cl. 310—21)

This invention relates to an improved electromagnetic device and to improved parts for such a device or the like.

In one embodiment of this invention, the electromagnetic device comprises an electromagnetic vibrator motor adapted for driving a diaphragm type fluid pump.

The various features of this invention are particularly adaptable for being utilized in combination with the diaphragm type fluid pump set forth in the copending United States patent application, Serial No. 149,990, filed November 3, 1961, now abandoned.

More specifically, the features of this invention are particularly adaptable when the fluid pump is used to produce a vacuum for a vacuum program system which requires a substantially constant source of vacuum at a substantially regulated vacuum pressure and which also requires a variable capacity in the vacuum pump so that the vacuum pump can effectively maintain the desired vacuum with automatically reduced volumetric capacity when no substantial volume of air movement is required in the system, the pump automatically increasing its volumetric capacity when a substantial amount of air or fluid is to be removed from the program system.

While the electromagnetic devices of this invention have many improved features over the devices set forth in the above-mentioned copending patent application, one such feature is to provide a smooth transition of the device as the fluid pump operates between full-flow and substantially no-flow positions thereof.

Accordingly, it is an object of this invention to provide an improved electromagnetic device or the like having one or more of the novel features of this invention set forth above or hereinafter shown or described.

Another object of this invention is to provide improved parts for such an electromagnetic device or the like.

Other objects, uses and advantages of this invention are apparent from a reading of this description which proceeds with reference to the accompanying drawings forming a part thereof and wherein:

FIGURE 1 is a side view of the electromagnetic device fully disclosed in the above-mentioned copending patent application.

FIGURE 2 is an end view of the device illustrated in FIGURE 1 and is taken in the direction of the line 2—2 of FIGURE 1.

FIGURE 3 is a bottom view of the device illustrated in FIGURE 1 and is taken in the direction of the line 3—3 of FIGURE 1.

FIGURE 4 is a side view of one of the improved electromagnetic devices of this invention.

FIGURE 5 is an end view of the device illustrated in FIGURE 4 and is taken in the direction of the line 5—5 of FIGURE 4.

FIGURE 6 is a bottom view of the device illustrated in FIGURE 4 and is taken in the direction of the line 6—6 of FIGURE 4.

FIGURE 7 is an enlarged view of the device illustrated in FIGURE 4 and illustrates various parts thereof in cross-section.

FIGURE 8 is an enlarged fragmentary view similar to FIGURE 7 and illustrates the fluid pump in a no-flow position thereof.

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FIGURE 9 is a schematic view illustrating one method of wiring the electromagnetic vibrator motor of the device of this invention.

FIGURE 10 is a fragmentary, cross-sectional view of another embodiment of the exhaust housing of the fluid pump of this invention.

FIGURE 11 is a schematic view illustrating one application of the electromagnetic device of this invention.

FIGURE 12 is a top view of a portion of the structure illustrated in FIGURE 11.

FIGURE 13 is a view similar to FIGURE 7 and illustrates another embodiment of this invention.

FIGURE 14 is a view similar to FIGURE 8 illustrating the device of FIGURE 13 in the no-flow position thereof.

While the various features of this invention are hereinafter described and illustrated as being particularly adaptable for use with a fluid pump or the like, it is to be understood that the various features of this invention can be utilized singly or in various combinations thereof to control other operating devices as desired.

Therefore, this invention is not to be limited to only the embodiments illustrated in the drawings, because the drawings merely illustrate one of the wide variety of uses of this invention.

Referring now to FIGURES 1—3, an electromagnetic device is generally indicated by the reference numeral 20 and comprises the subject matter of the aforementioned copending patent application.

In general, the electromagnetic device 20 includes a frame means 21 carrying an electromagnetic vibrator motor 22, a magnetic armature 23 and a diaphragm type fluid pump 24.

The frame means 21 includes a substantially rigid L-shaped frame member 25 carrying a U-shaped laminated core means 26 on the arm 27 thereof and being interconnected to a resilient frame member 28 at the arm 29 thereof.

The resilient frame member 28 has a substantially straight body portion 30 provided with oppositely directed end portions 31 and 32, the end portion 32 suitably mounting the diaphragm type fluid pump 24 and the end portion 31 thereof cooperating with the arm 29 of the rigid frame member 25 to sandwich a pair of pivot members 33 therebetween.

A leaf spring 34 has one opposed end 35 thereof secured between the pivot members 33 and the other opposed end 36 thereof secured to the armature 23, the armature 23 being operatively interconnected to the diaphragm type fluid pump 24 in a manner more fully set forth hereinafter and fully disclosed in the aforementioned copending application.

As illustrated in FIGURE 3, the core means 26 of the electromagnetic vibrator motor 22 has a pair of legs 37 provided with pole or core faces 38 adapted to be received in substantially rectangular holes 39 formed in the armature 23 when the armature 23 is pulled into overlapping relation with the core means 26 in opposition to the force of the leaf spring 34 tending to maintain the armature 23 in the neutral position illustrated in FIGURE 1.

The vibrator motor 23 includes an electrical coil 40 disposed about one of the legs 37 of the core means 26 whereby it can be seen that the centerline of the resulting vibrator motor assembly 22 is disposed out-of-line with a plane passing through the centerline of the frame means 21, the centerline of the armature 23 and the centerline of the diaphragm type fluid pump 24.

Because of this offset relation of the vibrator motor 22 relative to the centerlines of the frame means 21, armature 23, and fluid pump 24, unequal electromagnetic forces,

provided by the legs 37 of the core means 26, tend to cause mechanical interference between the armature 23 and the core means 26 when the armature 23 is moved in an arcuate path over the core means 26.

Accordingly, the holes 39 in the armature 23 must be made oversize to prevent such mechanical interference and thereby sacrifices operating efficiency.

Further, the frame member 25 must be a relatively large and rigid member to also prevent such mechanical interference whereby the overall cost of the device 20 is relatively high compared to its output.

Therefore, it has been found by the teachings of this invention that an electromagnetic vibrator motor can be so designed that its configuration and electromagnetic driving forces are symmetrical about the centerline of the diaphragm type fluid pump and vibrator motor assembly whereby unequal electromagnetic forces are minimized and the vibrator motor structure can be simplified without encountering many of the mechanical interference problems of the electromagnetic device 20.

In particular, the frame member 25 of the electromagnetic device 20 had to be rigid to eliminate flexing action caused by the off-center nature of the electromagnetic driving force produced by the coil 40 or the unequal forces which are produced by differences in the air gaps between the legs 37 of the core means 26 and the rectangular openings 39 in the armature. Otherwise, if the base 25 is made flexible, mechanical striking and interference will result between the armature 23 and the core means 26 under certain modes of pump operation.

Therefore, an improved electromagnetic device is provided by this invention to overcome the above disadvantages of the electromagnetic device 20 and is generally indicated by the reference numeral 41 in FIGURES 4, 5 and 6.

The electromagnetic device 41 comprises a frame means 42 carrying an electromagnetic vibrator motor 43, a magnetic armature 44 and a diaphragm type fluid pump 45 identical to the fluid pump 24 previously described and hereinafter set forth in detail.

The frame means 42 is defined by a pair of resilient frame members 28 previously described and having the end portions 31 thereof secured together by a nut and bolt arrangement 46 and sandwiching one end 47 of a leaf spring 48 therebetween, the arcuate portions 49 between body portions 30 of the frame members 28 and the end portions 31 thereof providing pivot points for the leaf spring 48 and thereby eliminating the need of the pivot members 33 of the construction 20 previously described.

It has been found that the arcuate portions 49 of the frame members 28 are desirable to avoid excessive stresses in the leaf spring 48 near the point of clamping the same.

The end portion 32 of the right hand frame member 28 carries the diaphragm type fluid pump 45 in substantially the same manner that the frame member 28 of the device 20 carries the fluid pump 24.

The other end portion 32 of the left hand frame member 28 of the device 41 is secured to one leg 50 of an L-shaped member 51 having the other leg 52 thereof extending toward the armature 44.

An electrical coil 53 is disposed about the arm 52 of the L-shaped member 51 whereby the arm 52 provides the core means for the electromagnetic vibrator motor means 43 of the device 41, the free end of the core means 52 projecting beyond the coil 53 and being adapted to be received in a rectangular slot 53' formed in the armature 44 and interrupting the end 54 thereof as illustrated in FIGURE 5.

It has been found that by forming the simple open ended slot 53' in the armature 44 of the device 41, instead of a rectangular hole similar to the holes 39 in the armature 23 of the device 20, the slot 53' will provide substantially as great an electromagnetic force to drive the fluid pump 45 as no particular advantage is derived from surrounding the core means 52 by means of a rectangular

hole because suitable clearance must be maintained between the armature 44 and the core means 52 to avoid striking therebetween.

Further, the open ended slot 53' in the armature 44 permits easier assembly and adjustment procedures than does the rectangular holes 39 in the armature 23 of the device 20.

It has been determined that a laminated core means for the device 41 is not essential to satisfactory operation, and the core member 51 of this invention may be made of hot or cold rolled bar stock, angle iron, or the like cut to width or any other means which will provide a ferro-magnetic core material suitable for the intended purpose.

As illustrated in the drawings, the electromagnetic vibrator motor 43 of this invention includes three terminals, 55, 56, and 57, FIGURE 9, with the terminals 55 and 56 being adapted to be interconnected by suitable leads to a source of alternating current 58.

The terminals 55 and 57 are respectively connected to the coil 53 by leads 59 and 60 while a diode 61 is disposed between the terminals 56 and 57.

In this manner, the diode 61 provides half-wave alternating current to the coil 53 to reduce the maximum losses from eddy currents and hysteresis effects to less than half of what would be experienced with full wave electrical input.

Thus, non-laminated core means can be used for the electromagnetic vibrator motor 43 of this invention without excessive temperature rise of the coil 53 and other parts of the assembly during operation thereof.

Therefore, it can be seen that not only is the frame means 42 of the device 41 of this invention substantially simpler than the frame means 21 of the device 20, but also the centerlines of the vibrator motor 43, the frame means 42, the armature 44 and the diaphragm type fluid pump 45 are disposed in a common plane whereby the electromagnetic driving forces are symmetrical about the centerline of the pump 24, frame means 42 and armature 54 to minimize unequal electromagnetic forces as provided by the device 20.

In this manner, the device 41 of this invention is less expensive to manufacture than the device 20 and easier to assemble and repair.

The details of the diaphragm type fluid pump 45 of the device 41 will now be described and reference is made to FIGURES 7 and 8.

As illustrated in FIGURES 7 and 8, the diaphragm type fluid pump 45 comprises a pair of housings 62 and 63 respectively interconnected together by a flexible diaphragm 64 having its outer periphery 65 secured to the housing 62 and its inner periphery 66 secured to the housing 63.

The housing 62 has an externally threaded inlet tubular extension 67 passing through a slot 68 formed in the end portion 32 of the right hand frame member 28, the housing 62 being secured to the end portion 32 of the frame member 28 by a nut 69 and washer 70 disposed on the tubular extension 67.

The housing 63 is interconnected to the armature 44 by a threaded stem member 71 having one end 72 threaded in a suitable aperture in the housing 63 and the other end 73 thereof passing through a resilient grommet 74 press-fitted in an aperture 75 formed in the armature 44.

In this manner, the shaft 71 and housing 63 can oscillate along a substantially straight horizontal axis while the armature 44 oscillates through a substantially arcuate axis.

The housing 62 carries a flexible inlet valve member 76 normally seated against an annular valve seat 77 formed at the inner end of the tubular extension 67.

The housing 63 carries a flexible exhaust valve member 78 normally seated against an annular valve seat 79.

When the housing 63 moves to the left upon attraction of the armature 44 by the motor 43 to the position

illustrated in dotted lines in FIGURE 7, the diaphragm 66 is pulled therewith and increases the volumetric capacity between the valve members 76 and 78 to provide a vacuum therebetween which tends to move the valve member 76 away from the valve seat 77 and draws fluid from the inlet extension 67 into the space between the valve members 76 and 78.

When the armature 44 is moved back from the dotted position illustrated in FIGURE 7 to full line position illustrated in FIGURE 7 by the force of the leaf spring 48, the fluid trapped between the valve members 76 and 78 forces the exhaust valve member 78 away from the valve seat 79 to permit the fluid trapped between the valve members 78 and 76 to escape to an exhaust chamber 80 leading to an outlet conduit 81.

When the fluid being pumped in the above manner is air or the like, the portion of the housing 63 forming the exhaust chamber can be formed of porous material as illustrated in FIGURE 10 whereby the exhaust conduit 81 can be eliminated.

Therefore, it can be seen that by oscillating the housing 63 relative to the housing 62 by the electromagnetic motor 43, the fluid pump 45 is adapted to remove air or fluid from a device interconnected to the inlet conduit 67 thereof.

As the fluid pump 45 progressively removes the fluid from the device interconnected to the inlet 67, the pressure differential on opposite sides of the diaphragm 64 progressively increases whereby the diaphragm 64 progressively moves inwardly from the outer periphery 65 toward the inner periphery 66 thereof against a frusto-conical surface 82 of the housing 62 from the position illustrated in FIGURE 7 to the position illustrated in FIGURE 8 where substantially no-flow is produced through the fluid pump 45 even though the housing 63 is oscillating relative to the housing 62.

When the fluid pump 45 assumes the position illustrated in FIGURE 8, it can be seen that the center of oscillation of the armature 44 is moved away from the core means 52 of the vibrator motor 43 whereby the air gap between the armature 44 and the core means 52 is increased to reduce the magnitude of movement of housing 63 relative to the housing 62.

Therefore, it can be seen that the fluid pump 45 progressively decreases its capacity as the vacuum condition of the operating device increases so that the fluid pump 45 is adapted to be interconnected to a vacuum operated device and maintain a vacuum therein while the pump 45 is operating at a no-flow position as illustrated in FIGURE 8.

Such a change in the volumetric capacity of the fluid pump 45 is particularly useful when it is required to rapidly remove air from a vacuum operated device and, thereafter, maintain the vacuum at the vacuum operated device.

However, when a greater fluid flow is required to be removed from the device interconnected to the inlet means 67 of the fluid pump 45, the reduced pressure differential across the diaphragm 64 automatically allows the diaphragm 64 to have a greater working area because it operates further away from the conical surface 82 of the housing 62.

Also, the diaphragm 64 has a more leftward center of oscillation with a reduced average air gap between the armature 44 and the core means 52 which results in a greater or stronger electromagnetic force and a larger pump stroke.

In this manner, the relationship of the conical surface 82 of the housing 62 with respect to the diaphragm 64 provides automatic reduction of pump stroke after the desired vacuum or pressure differential has been obtained by the contact of a portion of the diaphragm 64 with the conical surface 82. However, when air in larger volume is desired to be removed from the system, when the vacuum has been partially reduced in the system, the

diaphragm 64 operates further from the conical surface 82 of the housing 62 to provide a larger effective diaphragm area and also a longer stroke of the diaphragm 64 to produce a greater volumetric pumping capacity in the pump 45.

For further details of the structure and operation of the pump 45 of this invention, reference is made to the aforementioned copending patent application.

While the electromagnetic device 41 can be utilized in any desired system, one such application is illustrated in FIGURES 11 and 12 wherein a program system 83 is shown and includes a card or film 84 that passes over a block or reading head 85 with a smooth reading surface 86.

The reading head 85 has one or more discharge passageways 87 with discharge ports 88 at the reading surface 86. The discharge passageways 87 are respectively connected by resilient plastic pipes 89, if desired, with one or more vacuum motors or actuators 90 which operate various levers, switches, and the like of a machine, such as a washing machine or the like.

The reading head 85 also has one or more intake passageways 91 which has intake or suction ports 92 at the reading surface 86. The passageways 91 may merge into a common suction passageway or manifold 93 which is connected by a resilient plastic pipe 94, if desired, to the intake 67 of the diaphragm type fluid pump 45 as disclosed in FIGURES 7 and 8.

The card or film 84 may have a plurality of indentations or closed inverted channels 95 which bridge two or more ports such as ports 88 and 92 as illustrated in FIGURES 11 and 12. The margins of the indentations 95 form a seal with the reading surface 86 and form a fluid connection between the respective vacuum actuator 90 and the source of vacuum or fluid pump 45.

The indentations 95 in each of the rows 96 and 97 are sufficiently close to maintain a substantially constant bridging action between the ports 88 and 92 as the indentations 95 pass over the ports 88 and 92. This is accomplished by making the space between the indentations 95 of the particular row 96 or 97 narrower than the diameter of the ports, if desired.

When a particular vacuum actuator 90 has been energized by being subjected to a vacuum to pull on its respective diaphragm 98, such actuator 90 may be deenergized by breaking the vacuum in its respective passageway 87 to allow its diaphragm 98 to be pulled out by combined atmospheric and spring action or the like. The vacuum may be broken by causing a hole 99 in the film 84 to pass over the respective port 88. This permits atmospheric air to enter the respective passageway 87 to allow the respective diaphragm 98 to move outwardly.

Ordinarily, the corresponding suction port 92, opposite the hole 99, is not uncovered so that the film 84 prevents the breaking of the vacuum in the passageway or manifold 93 which is connected to the vacuum pump 45.

Because of the relatively small size of the vacuum chambers in the actuators 90 and of the respective passageways 87 only a small volume of air or fluid is introduced in the system through the hole 99. In view of this, the pump 45 ordinarily has long periods of time when it operates to maintain a vacuum without pumping any material amount of air or fluid. Thus, the ability of the diaphragm 64 to reduce its effective pumping area by contact with the concave wall 82 of the housing 62 permits the pump 45 to operate with a very small power consumption.

However, when a new actuator 90 is interconnected to the pump 45 by the film 84 in the above manner, the diaphragm 64 moves away from the conical surface 82 of the housing 62 to permit a longer pump stroke to quickly reduce the volume of air in the actuator 90 whereby the pump 45 returns to the no-flow position illustrated in FIGURE 8.

Because of this change from no-flow condition of the pump 45 to the full-flow or partial flow of the pump 45 as illustrated in FIGURE 7, some means must be provided to produce the desired pressure limiting characteristics of the pump output as well as a smooth transition from no-flow to full-flow conditions.

One such means for accomplishing the above function of the electromagnetic device 20 illustrated in FIGURES 1-3, was to angle or taper the pole or core faces 38 of the legs 37 of the core means 26 at 100 and 101 approximately 10 to 15 degrees to produce the desired pressure limiting characteristics of the pump output as well as a smooth transition from no-flow to full-flow conditions of the pump 24.

However, it has been found by the teachings of this invention that comparable results are achieved by the use of a core means with a square cut end and having the core axis located at a suitable angle with respect to the armature to provide an effect similar to tapering the pole faces 38 of the device 20.

In particular, it can be seen in FIGURES 7 and 8 that the core means 52 of the electromagnetic vibrator motor 43 has a longitudinal axis 102 disposed substantially perpendicular to the square cut flat pole or core face 103 of the core means 52 and disposed at an acute angle 104 relative to the adjacent face 105 of the armature 44 when the armature 44 is disposed in the neutral position, as illustrated in FIGURE 7.

It has been found that the angular relationship between the armature 44 and the core means 52 may be used to establish the operating characteristics of the pump assembly of the electromagnetic device 41 in a two-fold manner.

First, such angular relationship may be used to limit the maximum operating pressure.

For example, with the pump 45 operating under minimum air flow, or no air flow conditions, under which maximum pressure differential occurs across the diaphragm 64, the resilient, flexible diaphragm 64 will tend to be forced inwardly toward or against the conical surface 82 of the housing 62, initially, nearest the outer periphery 65 thereof and then progressively toward the inner periphery 66 thereof.

The effect of this movement of the diaphragm 64 against the conical surface 82 of the housing 62 is as follows:

(1) The working area of the diaphragm 64 is reduced as the force of the air on the diaphragm 64 counteracts the electromagnetic force driving the pump 45, (2) The center of oscillation of both the diaphragm 64 and the armature 44 is moved away from the core face 103 of the core means 52, and (3) The changing armature position results in an increase in the average air gap (the magnitude of which is determined by the angularity of the core face 103 with respect to the armature 44), resulting in a reduction in the electromagnetic force of attraction.

Secondly, the angular relationship between the core means 52 and the armature 44 may be used to establish the flow versus pressure characteristics.

In general, the flatter the core face 103 which the armature 44 "sees," the more abrupt is the transition from no-flow or partial flow to conditions of higher flow. With the core face angle increased, a smoother transition will result. Thus, to a great extent, the shape of the curve of flow versus pressure is tailored.

This angular relationship between the core means 52 and the armature 44 can be accomplished in various manners.

In particular, in the embodiments illustrated in FIGURES 7 and 8, the arms 50 and 52 of the L-shaped member 51 are disposed at an obtuse angle relative to each other rather than at right angles relative to each other, whereby the core axis 102 of the core means 52 of the electromagnetic vibrator motor 43 is disposed at an acute

angle 104 relative to the longitudinal axis or face 105 of the armature 44.

Alternately, the armature 44 could be provided with an initial bend relative to the core axis 102 of the core means 52 to accomplish the above features of producing the desired pressure limiting characteristics of the pump output as well as a smooth transition from no-flow to full-flow conditions of the pump 45.

In particular, reference is made to FIGURES 13 and 14 wherein another electromagnetic device 106 of this invention is generally indicated by the reference numeral 106 and has parts thereof substantially identical to the device 41 previously described.

Therefore, the parts of the device 106 which are substantially identical to like parts of the device 41 are indicated by like reference numerals followed by the reference letter "a."

However, no detailed description is given the particular parts of the device 106 of this invention, and, therefore, various reference numerals are utilized in FIGURES 13 and 14 which will not be specifically described. However, by referring to the like reference numeral in the figures disclosing the device 41, a description of the desired part of the device 106 can be made by referring to that part in regard to the device 41 as set forth above.

As illustrated in FIGURES 13 and 14, the arms 50a and 52a of the L-shaped member 51a are disposed at right angles relative to each other, whereby the core axis 102a of the core means 52a is disposed substantially perpendicular to the flat square cut core face 103a of the core means 52a and is disposed substantially perpendicular to the leaf spring 48a carrying the armature 44a.

However, the armature 44a has its longitudinal axis 107 bent in the desired location to dispose the face 105a thereof of adjacent the core face 103a at an acute angle relative thereto.

Thus, it can be seen that the device 106 accomplishes the above novel features of the devices 41 by merely bending the end of the armature 44a away from the core face 103a so that the core face 103a magnetically "sees" an angle to the armature 44a.

The angle of bend of the armature 44a and the point at which the bend is made can be determined by the operating characteristics desired.

Therefore, it can be seen that this invention not only provides an improved electromagnetic device which is relatively simple to manufacture and assemble, but also the device of this invention has means to produce the desired pressure limiting characteristics of a pump output or the like, as well as a smooth transition from no-flow to full-flow conditions of the pump thereof.

While the form of the invention now preferred has been disclosed as required by the statutes, other forms may be used, all coming within the scope of the claims which follow.

What is claimed is:

1. In combination, a frame means, an electromagnetic motor carried by said frame means and having an impulse frequency, said motor having core means provided with a core axis and a core face, and a magnetic armature carried by said frame means and movable substantially along said core axis, said armature having a face disposed adjacent said core face and normally disposed angularly relative thereto, said armature having a free end interrupted by a slot whereby said armature has a U-shaped end that overlaps said core means with said core means passing through said slot when said armature is moved relative to said core means.

2. A combination as set forth in claim 1 wherein said armature has a straight longitudinal axis and said core axis is angled relative thereto at an angle other than a right angle.

3. A combination as set forth in claim 1 wherein said armature has a longitudinal axis that is bent to provide the angular relation between said faces.

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4. In combination, a frame means, an electromagnetic motor carried by said frame means and having an impulse frequency, said motor having core means provided with a core axis and a flat core face disposed perpendicularly to said core axis, and a magnetic armature carried by said frame means and movable substantially along said core axis, said armature having a face disposed adjacent said core face and normally disposed angularly relative thereto, said armature having a free end interrupted by a slot whereby said armature has a U-shaped end that overlaps said core means with said core means passing through said slot when said armature is moved relative to said core means.

5. A combination as set forth in claim 4 wherein said armature has a straight longitudinal axis and said core axis is angled relative thereto at an angle other than a right angle.

6. A combination as set forth in claim 4 wherein said armature has a longitudinal axis that is bent to provide the angular relation between said faces.

7. In combination, a frame means, an electromagnetic motor carried by said frame means and having an impulse frequency, said motor having core means provided with a core axis and a core face, a leaf spring having one opposed end thereof secured to said frame means, and a magnetic armature secured to the other end of said leaf spring and movable substantially along said core

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axis, said armature having a face disposed adjacent said core face and normally disposed angularly relative thereto, said armature having a free end interrupted by a slot whereby said armature has a U-shaped end that overlaps said core means with said core means passing through said slot when said armature is moved relative to said core means.

8. A combination as set forth in claim 7 wherein said core means is solid.

9. A combination as set forth in claim 7 wherein said core means comprises a substantially L-shaped member.

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