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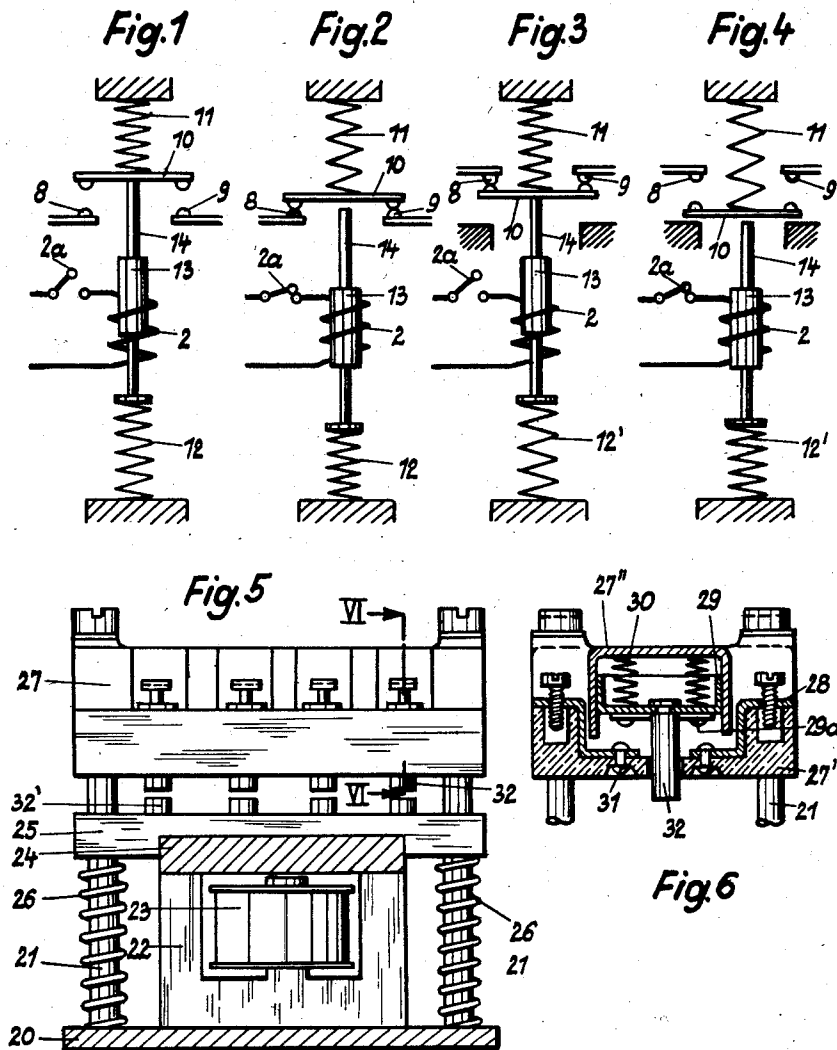
F. BAUER

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ELECTROMAGNETICALLY OPERATED CONTACTOR

Filed Jan. 29, 1957

2 Sheets-Sheet 1



Inventor: FRANZ BAUER

by *A. John Michel*
ATTORNEY

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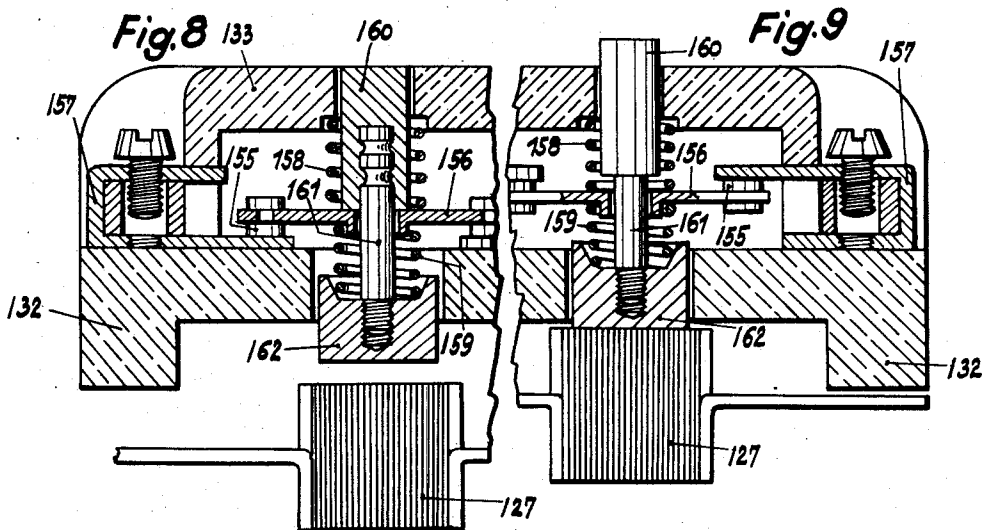
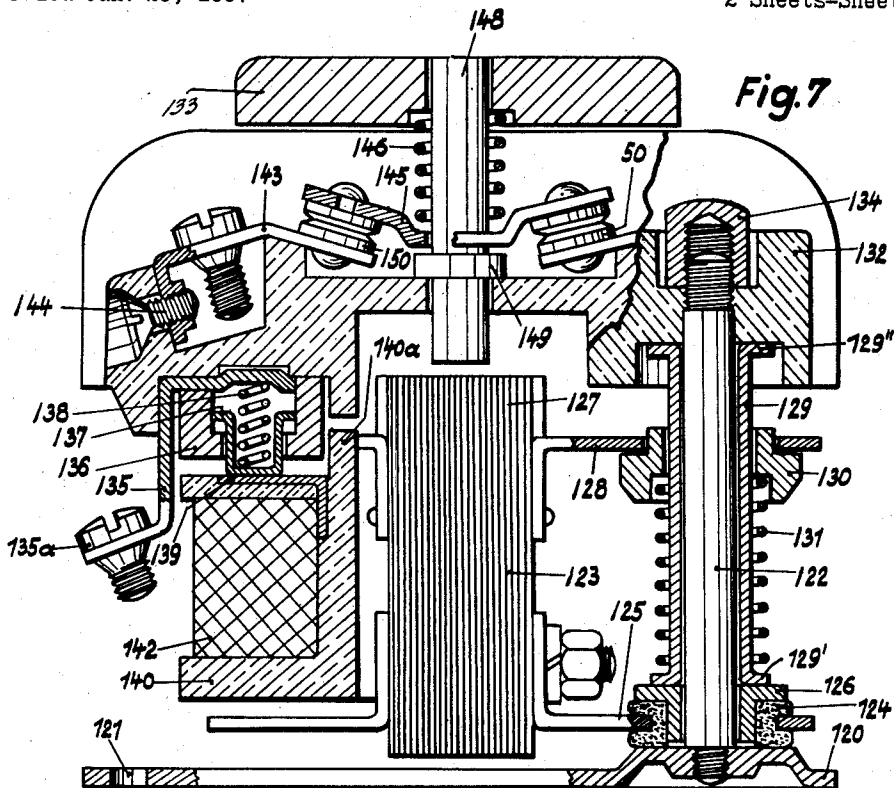
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Inventor: FRANZ BAUER

by A. John Michel

ATTORNEY

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ELECTROMAGNETICALLY OPERATED CONTACTOR

Franz Bauer, Vienna, Austria, assignor to Hubert Naimer, Vienna, Austria

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4 Claims. (Cl. 200—87)

The present invention relates to electrical switches, and more particularly to electromagnetically operated contactors.

Switching devices of this type are operable by remote control with a freely retractile force by means of an electromagnet actuated by an auxiliary circuit. Such remote control contactors can close and open a main or work circuit by respectively opening and closing the auxiliary circuit.

It is the principal project of this invention to construct such switching devices in smaller dimensions for a given switching capacity without impairing and possibly with an increase in the useful life of the device.

It is another object of the invention to construct switching devices of a great range of capacities by assembling standardized elements of a few standard sizes.

I have accomplished the above and other objects with a contactor whose contact or switching element is permanently loaded by a switching force. The term "switching force" is used to indicate a force which permanently aims at the actuation of a switching motion or which, if effective without a counter-force, produces a given switching position. This switching force, which normally is a retractile force, is usually exerted by a spring.

In accordance with the invention, a contactor of this type comprises a preferably mechanical counter-force acting upon the switching element when the electromagnet is not energized. This force is exerted by a spring or any suitable mechanical means, such as counter-weights and the like, such means being carried by an element independent of the switching element and exerting a counter-force greater than the first-named switching force. The differential force created by the first-named switching force and the counter-force forms a second switching force which is nullified by the energized electromagnet when the contactor is operated, whereby the switching element, which is only in pressure-transfer relation with the electromagnet will be separated from the electromagnet during its energization and the switching element will effect opening and closing of the circuit exclusively under the direct influence of the first or second switching forces. Furthermore, the switching element or contact of the main circuit as well as its terminals and the means constituting the switching forces are assembled in a demountable unit.

Thus, I have combined a novel and improved actuation of the switching element or contact with a switch whose structure permits it to be mounted as a unit which can be easily detached since it is only in pressure transfer relationship with the electromagnetic actuating means. When required, the unit can be interchanged without difficulty for a unit of different dimensions.

A contactor according to the invention has considerable advantages in regard to its production and mounting. It also permits considerably improved hum damping. Its switching force arrangement decreases the contact chatter, defines the force accurately and permits exact adjustment of the contact stroke, all of which protects

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the contacts against undue wear and thus prolongs the useful life of the contactor.

The above and other objects, advantages and features will be more fully described in the following detailed description of certain preferred embodiments of the invention, taken in conjunction with the drawing wherein

Figs. 1 and 2 schematically illustrate the construction and operation of a contactor according to one embodiment of the invention;

Figs. 3 and 4 schematically illustrate another embodiment;

Fig. 5 is a side view of a contactor constructed in accordance with the invention;

Fig. 6 is a section along line VI—VI of Fig. 5;

Fig. 7 is a vertical section through another contactor according to the invention, the left half of the figure constituting a central section while the right half is a section along two guide bolts arranged in the four outer corners;

Fig. 8 is a section through an upper portion of the contactor with auxiliary switching contact which is a working contact when the coil is energized; and

Fig. 9 is a similar section showing an auxiliary rest contact when the coil is de-energized.

While at least one switching motion of the switching element or contact has been effected under the direct influence of the electromagnet in known contactors, the switching force of my contactors is accurately defined and is completely separated and independent from the magnetic force. The main circuit controlled by the contactor of my invention is opened and closed by a force other than the magnetic force so that the movable switching force actuating means may be mechanically separated from the movable electromagnetic means.

This principle is schematically shown in Figs. 1—4. The switching element or contact bridge 10 is permanently biased by compression spring 11 to exert a first switching force whereby the contact 10 is urged against terminals 8 and 9 of electrical conductors forming part of the main or working circuit to be controlled by the contactor. The counter-force is exerted by compression springs 12 and 12', respectively. Obviously, the springs could be replaced by weights or like means.

Figs. 1 and 2 illustrate an open-circuit contactor, Fig. 1 showing the position when the core 13 is not energized and Fig. 2 showing the position with an energized magnetic core. The first switching force closes the working circuit and the second switching force (difference between the forces of springs 11 and 12) opens it, depending on which force is effective. The electromagnet serves to neutralize one or the other force while remaining mechanically completely separated from the contact bridge in either switching motion.

Figs. 3 and 4 show a closed-circuit contactor generally similar to the above-described switching device, Fig. 3 illustrating the non-energized core and Fig. 4 the position with an energized core. In this instance, the first switching force opens the circuit and the second switching force closes it.

In the open-circuit contactor of Figs. 1 and 2, the circuit 8, 9 will be closed when current is delivered to coil 2 to energize core 13. When switch 2a is open and the core is accordingly de-energized (see Fig. 1), the force exerted by spring 12 exceeds that of spring 11. This causes rod 14, which is rigidly connected to the core, to lift contact bridge 10 off terminals 8, 9, the armature and its rod working merely as pressure-transfer means between spring 12 and the contact.

When contact 2a is closed to deliver current to coil 2 and energize core 13 (see Fig. 2), the electromagnetic force exerted by the core overcomes the force of spring 12. The force of spring 11 is thereby freed to exert its

pressure upon contact 10 since the core is merely in pressure-transfer relationship with the contact but not rigidly connected thereto. The switching force exerted by spring 11 will accordingly press the contact against the circuit terminals and close the circuit.

When the core is de-energized again, it loses its magnetic force, spring 12 becomes effective again and lifts the contact off the terminals since its force is stronger than the force of spring 11. Thus, the second switching force, which is the difference between the forces of spring 12 and 11, opens the circuit.

In this manner, the switching motion is effected only by the springs or equivalent mechanical means. The electromagnet 2, 13 never actuates the contact bridge directly.

The closed-circuit contactor of Figs. 3 and 4 operates similarly, like elements carrying the same reference numerals. In Fig. 3, where the core is de-energized, the force of spring 12' exceeds the force of spring 11, thus preventing spring 11 from lifting the contact off terminals 8, 9 to open the circuit. The contact bridge 10 keeps the circuit closed under the bias of the force constituted by the difference between the force of spring 12' minus the force of spring 11.

When the core is energized (Fig. 4), the force of spring 12' is neutralized and spring 11 alone becomes effective to press the contact bridge away from the circuit terminals whereby the circuit is opened.

Upon again de-energizing the core, the force of spring 12' will be fully effective again to overcome the weaker force of spring 11 and to close the circuit.

Thus, it will be obvious that the open-circuit and closed-circuit contactors operate essentially in the same manner, both being actuated only by mechanical forces while the electromagnet never directly actuates the contact.

Figs. 5 and 6 illustrate an embodiment of a contactor according to the invention. The contactor of Fig. 5 is an open-circuit switch for a four-conductor circuit, Fig. 6 illustrating the switching unit proper.

Referring to Fig. 5 there is shown a base plate 20 from which two guide pillars 21 project upwardly. The base plate supports the shielded electromagnet 22 with coil 23 and armature 24. The armature carries the sliding element 25 which is movably mounted on the guide pillars against the action of compression springs 26. Box 27 containing several switch units is mounted at the upper ends of guide pillars 21. As shown in Fig. 6, each unit comprises a lower casing portion 27' which carries the circuit terminals 28 and a contact bridge 29 which is guided in the upper casing portion 27''. The pressure springs 30 are biased to urge the contact bridge with its contacts 29a against the contacts 31 of the circuit terminals and thus to close the circuit. Each contact bridge has mounted thereon a plunger 32 arranged to cooperate with a corresponding stop 32' mounted on sliding element 25.

Fig. 5 shows the armature 24 in its lowest position which it attains upon energization of coil 23. Since this is an open-circuit contactor, sliding element 25 is urged upwardly under the load of springs 26 when the electromagnet is de-energized, whereby stops 32' will lift plungers 32 and will detach contacts 29a and 31, as shown in Fig. 6. In the rest position, therefore, the circuit is open. When the magnet is energized, sliding element 25 will be forced downwardly against the pressure of springs 26, making it possible for springs 30 to press the contact bridge 29 downwardly and establish contact between 29a and 31 to close the circuit.

Box 27 forms a demountable unit which contains all switching elements and may be removed from the guide pillars 21 and replaced by a different unit. The electromagnetically controlled sliding element 25 is not rigidly connected with plungers 32 but merely in pressure-transfer relationship therewith. The electromagnet cannot exert any pulling force on plungers 32. Furthermore, box 27 contains also the springs which exert the above-de-

scribed mechanical switching force. Thus, it will be noted that the switching force means may consist of several parts.

Another embodiment of the invention is illustrated in Fig. 7. The switching device is mounted on base plate 120 having bores 121 to bolt or otherwise fix the device to a support, for instance the floor. Four upright bolts 122 are threadedly mounted in the four corners of the rectangular base plate and serve to support the centrally arranged magnetic core 123. The core is carried by angle pieces 125 which are mounted in rubber grommets 124 surrounding bushings 126. The movable armature 127 is provided with laterally extending rims 128 which cooperate with sliding bushing 130 mounted on sleeve 129. As clearly shown, all of these support elements are glidably mountable on the upright bolts.

Compression springs 131 are biased to urge bushings 130 and, accordingly, armature 127 upwardly when the electromagnetic core is de-energized. The lower flange 129' of sleeve 129 abuts bushing 126 while its upper flange 129'' supports the lower portion 132 of the switch head which is covered by closure 133. Portions 132 and 133 are preferably made of molded plastic material. The switch head contains all contactor elements and forms a demountable unit which can be easily detached from the base by removing the nuts 134 which are threadedly connected to the upper ends of bolts 122. The electrical conductors 135 are also fixedly connected to the switch head by means of insulating body 136 which is threadedly mounted on lower portion 132 of the switch head. The contact 137 is slidably mounted in a bore in insulating body 136 and is biased downwardly by compression spring 138 mounted between conductors 135 and contact 137 which engages coil terminals 139. The coil support body 140 is mounted freely on fixed core 123 and is centered by the insulating body 136 which cooperates with an upwardly extending lip 140a of the coil support body. In this manner, the armature 127 has free play. Springs 138 press the two contacts 137 against the terminals 139 of the coil, thereby pressing the coil body 140 with coil 142 against core 123. At the same time, they establish an electrical connection between the coil terminals and electrical connectors 135 which carry connections 135a.

The operation of the main contacts of the contactor in switch head 132 is clearly shown in Fig. 7. Fixed contacts 143 are mounted in lower portion 132 of the head by means of screws 144. The movable contact bridge 145 rests on the fixed contacts under the pressure of spring 146 which delivers the switching force corresponding to the force of spring 11 in Figs. 1-4. The contact bridge is glidably mounted on plunger 148 which is journaled in closure 133. Fig. 7 illustrates the position of the switch during energization of the electromagnet when armature 127 is depressed against the pressure of springs 131 and spring 146 is free to press the contact bridge downwardly into contact with contacts 150 of fixed contacts 143. When the current is cut off from coil 142, springs 131 press bushings 130 engaging armature rims 128 upwardly. Accordingly, the face of the armature will move plunger 148 upwardly and the annulus 149 of the plunger will lift contact bridge 145 off fixed contacts 150, compressing spring 146.

Figs. 8 and 9 show auxiliary circuits which are also mounted in the unit 132, 133. As illustrated, the arrangement may be changed from an open-circuit (Fig. 8) to a closed-circuit switch (Fig. 9) merely by inverting the contact 157.

Fig. 8 shows an open-circuit auxiliary switch having an auxiliary contact bridge 156 with contacts 155, similar to the main contact bridge 145 described in connection with Fig. 7. Spring 158 is equivalent in function to spring 146 to exert a switching force on contact bridge 156. The function of spring 159 is made evident in Fig. 9 where the open-circuit contactor has been converted

into a closed-circuit switch by inverting the fixed contact 157.

As shown in Fig. 8, the armature 127, when pressed upwardly by springs 131, also operates an auxiliary contactor plunger which consists of plastic plug 160 having molded thereto a metal rod 161 which threadedly carries the insulating portion 162. The auxiliary plunger is journaled in switch head portions 132 and 133 and its metal rod 161 carries the contact bridge 156. The force of spring 159 exceeds that of spring 158 whereby the contact bridge is normally pressed against insulating plug 160. Spring 158 is biased to press the contact bridge and the plunger downwardly and thus to close the open circuit (Fig. 8) or open the closed circuit (Fig. 9). When the magnet is de-energized, the armature 127 will force the plunger and the contact bridge upwardly under the pressure of spring 158 in the case of the open-circuit contactor of Fig. 8.

In the case of a closed closed-circuit arrangement, however, as shown in Fig. 9, the contact bridge will engage the fixed contact 57 before the armature has reached its uppermost rest position so that the plunger 160, 161, 162, which continues to be pressed upwardly, will compress the spring 159 while contact bridge 156 glides on metal rod 161. Thus, in the case of the open-circuit contactor of Fig. 8, the spring 158 constitutes the switching force when the electromagnet is energized. When the magnet is de-energized, the force of spring 158 is over-compensated by that of springs 131. On the other hand, the force of spring 158 opens the circuit when the magnet is energized in the structure of Fig. 9 while springs 131 must first overcome the bias of spring 158 and then that of spring 159 when the magnet is de-energized (position shown in Fig. 9) whereby a switching force is created which is constituted by the difference between the force of spring 159 minus the force of spring 158.

As is shown in Fig. 7, the flanged sleeve 129 forms a unit with spring 131 and sliding bushing 130 to prevent an undesirable expansion of spring 131. This facilitates the simple and speedy assembly and demounting of the contactor unit. The coil connection assembly serves the same purpose by automatically centering the coil body and keeping it under pressure, being at the same time fixedly connected with the demountable switch head by means of insulating body 136.

The advantages of the contactor according to the present invention will be obvious from the above description of certain now preferred embodiments thereof. Thus, the contact is not established by the magnet but the magnet is used merely to neutralize or nullify the force of strong springs which normally effect the switching movement. The plunger actuating the contact bridge is thereby deprived of support, which is of importance particularly in main contacts subjected to constant use. The movable mass of the actual contacts can be held low even with large switching capacities so that there will be considerable freedom from impact even through sufficient contact pressure is assured. Furthermore, a clearly defined contact force is established at each contact. Another advantage is the smaller contact stroke obtainable with my contactors since the stroke need be only long enough to separate the contacts from each other. This stroke can be easily adjusted by intermediary elements

positioned between the base and the switch head. Since the switching device is a separate unit which is completely separate from the electrical control means, i.e. the electromagnet, mounting and replacement are considerably facilitated, which becomes particularly important when repairs are needed. The control magnet forms a separate unit and permits excellent damping of the hum vibrations because the fixed coil can easily be arranged to damp the hum while the freely floating armature can position itself in the most favorable position in relation to the fixed portion of the electromagnet.

While the invention has been described in connection with certain preferred embodiments, it will be obvious that many modifications of a structural nature are possible in regard, for instance, to the form of the armatures, the spring or weight means for exerting the switching force, the number of contacts, etc., without departing from the spirit and scope of the invention as defined in the appended claims.

This is a continuation-in-part of Serial No. 415,294, filed March 10, 1954.

What I claim is:

1. A contactor for opening and closing an electrical circuit, comprising a contact arranged to open and close the electrical circuit, a first mechanical pressure means permanently biasing said contact in one direction, a second means permanently biasing said contact in the opposite direction, a support member independent of said contact for said second means, the bias of the second means being greater than that of the first means to form a differential force, an electromagnet comprising an energizing coil and an energizable core, pressure-transfer means arranged between the core and the contact to eliminate the differential force upon energization of the coil, the pressure-transfer means and the contact being separated from each other during said energization and the opening and closing of the electrical circuit by the contact being effected only by said first mechanical means, and said contact and the first mechanical means being mounted in a demountable unit.

2. The contactor unit of claim 1, wherein said unit is axially spaced from said energizing coil.

3. The contactor unit of claim 2, comprising a support base for the electromagnet and support means on said base for mounting the unit.

4. The contactor unit of claim 1, wherein the contact in the demountable unit consists of at least two contact elements and one contact bridge, said first mechanical pressure means biasing the contact bridge, and a housing enclosing said contact and contact bridge biasing means to form therewith a replaceable switch unit.

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