Sept 17, 1957 M. RIGERT ET AL 2,806,926

ELECTRIC CONTACT

Filed June 29, 1955

Fig. 1

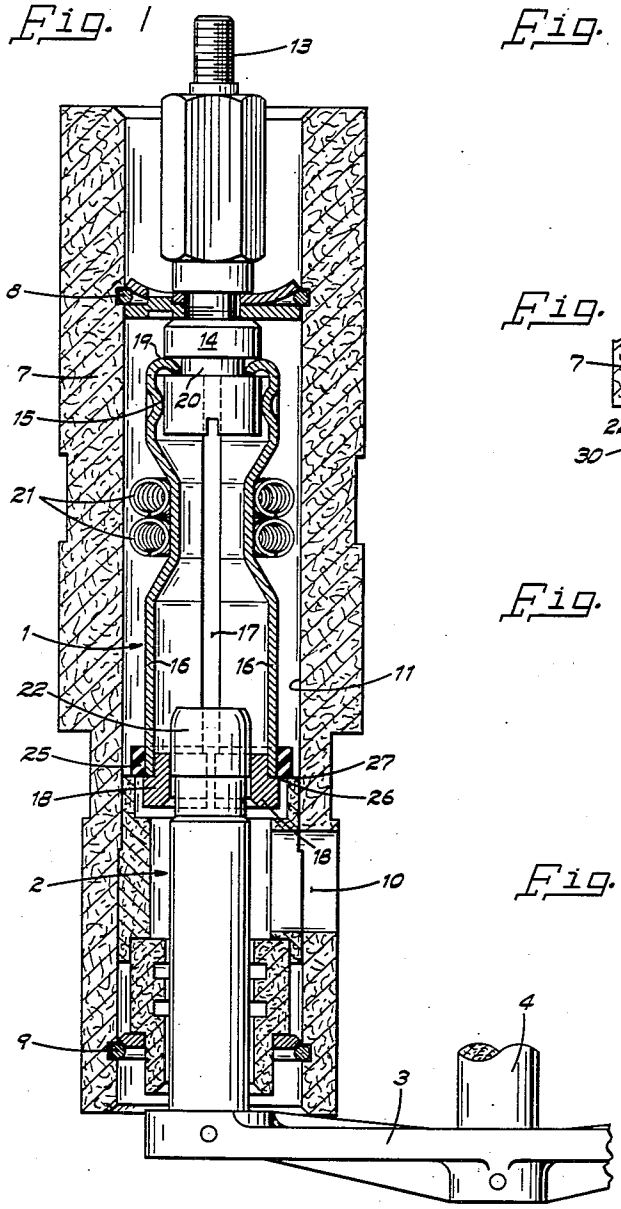


Fig. 3

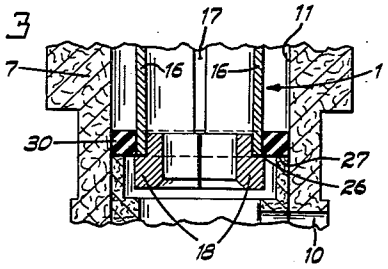


Fig. 4

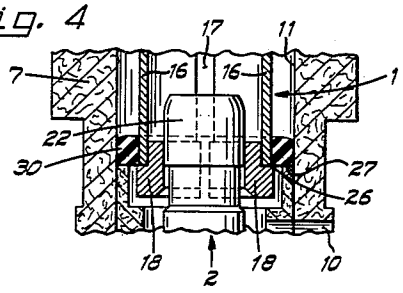


Fig. 5

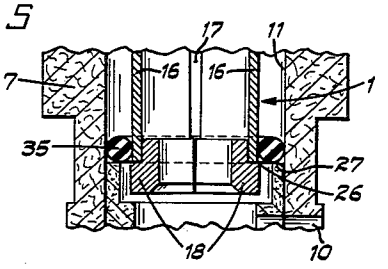


Fig. 6

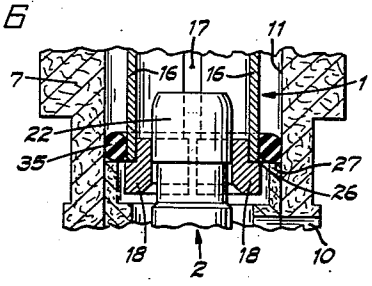
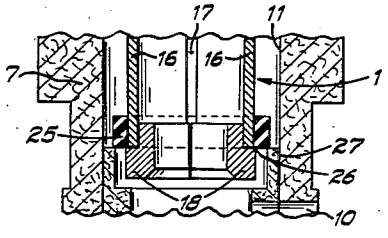


Fig. 2



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ELECTRIC CONTACT

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Application June 29, 1955, Serial No. 518,744

5 Claims. (Cl. 200—166)

This invention relates to electric circuit breakers and more particularly to contacts adaptable for installation in breakers having high current interrupting capacity.

Closing the movable contact of a high capacity circuit breaker into or against the stationary contact is an operation which normally takes place with extreme rapidity. Upon this event, the movable contact not only electrically engages the stationary contact but the kinetic energy of the former is transferred to the latter with a sharp impact. Since the collision with the stationary contact is somewhat elastic, it follows that the stationary contact will be deflected from its normal position of engagement with the movable contact and that subsequently, the contact pressure creating springs will restore the stationary contact to engagement with the movable contact.

In reality, the stationary contact is caused to vibrate periodically in a natural frequency of vibration somewhat indeterminate but governed largely by the mass of the contacts and the constant of the pressure creating springs. In high capacity breakers, this vibration, which is in fact a minute opening and closing of the circuit through short amplitude swings, is especially deleterious because it causes arcing which rapidly erodes the contacts and shortens their lives.

It is a primary object of the instant invention to overcome the aforementioned vibration problem, together with its consequent arcing, by providing the relatively stationary electric contact with vibration damping means.

It is a further object of this invention to provide simple and compact vibration damping means which are easily incorporable in existing contact structures without extensive modification thereof.

A general object is to provide a novel and more efficient electric contact: Other more specific objects will appear from time to time throughout the specification.

Referring to the single sheet drawing in conjunction with which the invention will be described in detail:

Fig. 1 is a sectional elevational view of a contact assembly embodying the invention, the contact being in closed circuit position;

Fig. 2 is a fragmentary view of the contact assembly shown in Fig. 1 as the same appears in open circuit position;

Fig. 3 is a fragmentary view of the stationary contact illustrated in Fig. 1 but with a modified form of vibration damping means;

Fig. 4 represents the contact assembly of Fig. 3 in closed circuit position;

Fig. 5 is a fragmentary view of the stationary contact showing an alternative form of the vibration damping means; and

Fig. 6 shows the contact assembly of Fig. 5 in closed circuit position.

For illustration of a particular circuit interrupter to which the anti-vibration contact forming the subject of the forthcoming description may be applied, reference may be had to the copending application of W. R. Harry entitled Circuit Interrupter, Serial No. 141,336, filed

January 30, 1950, and assigned to the same assignee as the instant invention.

For the sake of brevity, only the improved contact structure per se will be described herein. Referring to Fig. 1, the contact assembly comprises a stationary contact **1** arranged to coact with a coaxially movable contact designated generally by the reference numeral **2**. Movable contact **2** is pinned to a bridging cross head **3** which may carry a like movable contact on its opposite end (not shown). Cross head **3** is supported by an insulating rod **4** which is adapted to execute a reciprocatory movement, thus causing contact **2** to telescope into and out of electrical engagement with stationary contact **1**.

An insulating tube **7** houses the contact assembly which is restrained therein by any suitable means such as snap rings **8** and **9**. Customarily, housing **7** is immersed in a dielectric liquid such as oil filling the circuit interrupter tank (not shown). Thus, when movable contact **2** is rapidly disengaged from stationary contact **1**, some of the dielectric liquid is vaporized due to heat associated with the electric arc thus established, and the resulting gases are relieved through a radially extending aperture **10**.

The path of current flow through the contact assembly is evident from Fig. 1, it being from wire connecting stud **13**, contact supporting terminal **14**, stationary contact **1**, movable contact **2** and to a similar adjacent contact structure through conductive cross head **3**.

Stationary contact **1** comprises a plurality of fingers **16** spaced from each other by slots **17** and arranged to define a substantially cylindrical resilient enclosure. One end of each finger **16** is provided with arc resistant tips **18**, preferably of copper tungsten alloy. Axially opposed ends of each finger are conformed into a hook-like arcuate guide edge **19** which bears in an annular channel **20** in the contact supporting terminal **14**. A pair of contact pressure creating closed coil springs **21** surround the pivotal fingers **16** intermediate arcing tips **18** and guide edges **19**. Obviously, the tension in springs **21** causes arcing tips **18** to bear in compressive relation upon the contact head **22** of the movable contact **2**. When the movable contact **2** is withdrawn from arcing tips **18** by reason of cross head **3** being vertically reciprocated (see Figs. 2, 3, and 5) fingers **16** are collapsed radially inwardly toward each other an amount dependent upon the width of slot **17** until adjacent ends of arcing tips **18** abut each other. An annular axial protuberance **15** bearing on supporting terminal **14** constitutes a fulcrum on which fingers **16** flex or pivot radially in order to establish an entrance for receiving movable contact head **22** against the force of springs **21**.

From the structure and operation described thus far it should be evident that execution of a rapid vertical reciprocatory motion by insulating rod **4** would cause contact head **22** to strike arcing tips **18** with considerable impact. Because it is necessary for movable contacts **1** to be inherently flexible in order that movable contact **2** be admissible therebetween, it is further evident that the impact of the collision will result in a vibratory motion being set up in movable contact fingers **16**. The nature of this vibration is governed by well known physical principles and depends primarily upon the mass of movable contact **2**, its velocity, the mass of stationary contact **1**, and the constants and characteristics of the springs **21**. In reality, this vibratory movement amounts to a making and breaking of the electric circuit which it is desired to establish between contact head **22** and arcing tips **18** when the circuit breaker is closing in. Of course, after a suitable time lapse following closure of the breaker the energy of the impact incidental to closing will decline to zero, being dissipated by the vibratory action of stationary contact fingers **16**. In heavy current circuits, however, the heat developed by such vibration, even though it is of

relatively short duration, is sufficient to cause inordinate pitting or erosion of the contacts. The instant invention is directed to minimizing the effects stated above by incorporation in the contact structure of a novel damper or vibrational energy absorbing element preferably in the form of a ring of dielectric impervious rubber or other resilient material.

In Figs. 1 and 2 the resilient damping ring is designated by the reference numeral **25** and is shown surrounding stationary contact fingers **16** concentrically thereof in tension and radially spaced from the interior wall **11** of insulating tube **7**. The ring is supported on a shoulder **26** on arcing tips **18** and a fixed shoulder **27** of insulating material. In the respective figures, rings **25**, **30** and **35** are each displaced axially from the free ends of arcing tips **18** so that the heat generated by arcing incident to separation of contact head **22** will not effect them adversely.

The effect of incorporating the resilient ring **25** is to dampen the natural period of vibration of the contact assembly when compared with the natural frequency of the same assembly if rubber ring **25** were omitted. It is evident that the effect of the stiffness of the spring **21** is augmented when the springs are moved axially closer to ring **25**. Correspondingly, the amplitude of vibration of the movable contact fingers **16** is greatly reduced by rubber ring **25** because of the greater effectiveness of the latter resulting from its being placed more remote from the pivot point **15** on the individual fingers **16**. Thus, it is seen that the metallic springs **21** and resilient ring **25** constitutes the combination of a vibratory spring having an energy absorbing spring damper in parallel therewith both acting on a single mass so that the amplitude and frequency of vibration of the mass is damped appreciably although the total force required to close the contacts is increased only slightly.

While it is not here intended to go into a complete discussion of the properties of all resilient materials which could be used to accomplish the purpose of ring **25**, it may be noted that rubber or synthetic rubber like materials which are unaffected by the dielectric fluid performed the damping function particularly efficaciously. This is so in part because of the inherent energy absorbing capabilities of rubber like materials. Reference to the hysteresis curves of such materials will demonstrate that the area included in the hysteresis loop of rubber is relatively large as compared with that of other resilient metallic materials, and consequently, this area being a representation of the work performed, the internal work is relatively large. Not only is the hysteresis loop of rubber like materials large, but within a certain practical range the area and the energy absorbed increases according to rapidity of application of the load. Thus, in circuit breakers where a movable contact strikes and comes to rest in a stationary contact during a small fraction of a cycle, the shock of closure is particularly enormous and it is advantageous to have as part of the contact assembly a high energy obsorbing material such as rubber which increases its capacity to absorb energy when it is needed most and exerts a lesser effect during slow closures. Moreover, an important characteristic of the rubber like material is that it absorbs much of the energy it receives under impact and manifests it in the form of heat; whereas, a metallic spring returns almost all the energy which it receives in the form of an opposite mechanical force. Hence, the advantage accompanying use of a rubber like mass as a damping means is apparent.

Fig. 3 shows a fragmentary section of the contact structure illustrated in Fig. 1 modified by inclusion of an alternative form of the resilient vibration damping ring designated by the reference numeral **30**. Note in this figure that when contact head **22** is withdrawn from stationary contact **1** that ring **30** assumes a square cross section and that it fully bridges the space between fingers **16** and the interior wall **11** of insulating tube **7**. Fig. 4 demonstrates the deformation of rubber ring **30** resulting from entry of contact head **22** between arcing tips **18**. By comparison with Fig. 1, where the rubber damping ring is placed in tension by closing of the contact, it will be noted in Fig. 4 that the loading of rubber ring **30** is purely compressive in nature because of the ring being closely confined by the wall **11** and outer periphery of fingers **16**. Moreover, it is to be noted that even though fingers **16** have swung radially outward compressing ring **30**, that the ring has substantially the same area as represented in Fig. 3. The fact that the total cross sectional area and the total volume of the rubber like material remain substantially constant when it is subjected to compressive loading accounts to a large extent for the rubber high energy absorbing characteristics. In fact, it is known that rubber is capable of absorbing approximately four times more energy per cubic inch than metal such as steel, when energy is expressed in inch pounds. Thus, from purely volumetric considerations, it is seen that there is considerable advantage in using the rubber like material as a damping means in preference to another metallic spring.

Figs. 5 and 6 illustrate an alternative form of the resilient damping ring designated by the reference numeral **35**. Here it is to be noted that ring **35** is round in cross section when not loaded compressively as in Fig. 5 and that it is elliptical in cross section when compressively loaded by entry of contact head **22** as in Fig. 6. The preceding discussion with reference to Figs. 3 and 4 pertains with equal force to the construction of Figs. 5 and 6. However, since the volume of rubber is less in the embodiment of Figs. 5 and 6, ring **35** may be assumed to have characteristics different from the rings illustrated in the preceding figures.

It will be appreciated that the various embodiments of the invention are merely illustrative and that greater specificity regarding the configuration of the damping ring is difficult in view of the large number of variables affecting a vibrating mechanical system. As implied above, these factors include the constants of the associated coil springs, the mass of the stationary contact, and the velocity of the impact occurring when the movable contact engages the arcing tips. Accordingly, it should be a relatively easy matter, using the basic ideas disclosed hereinabove, to attain exactly the right amount of damping desired for any particular circuit breaker contact of the type analogous to that described herein.

While preferred forms of the invention have been illustrated, it should be understood that the invention is not limited to the specific details of construction and arrangement thereof herein illustrated but that the general principles disclosed herein are subject to modification and adaptation by those versed in the art to various other contacts, for example, butt type or knife type, without departing from the scope of the instant invention.

We claim:

1. An electric contact assembly including a stationary contact element and an axially movable contact element adapted to electrically engage each other with sharp impact, one of said contact elements comprising a plurality of fingers juxtaposed to each other in circular arrangement and having pivot ends and free ends for receiving the other contact element therebetween, a metallic coil spring surrounding said fingers intermediate said ends and biasing them radially inwardly toward each other, a resilient rubber-like ring surrounding said fingers near their free ends around the zone of interengagement between contact elements and axially remote from said metallic spring, whereby the periodic vibration of said fingers and metallic spring resulting from said impact are damped by said rubber-like ring.

2. An electric contact assembly including a stationary contact element and an axially movable contact element adapted to electrically engage each other with sharp impact, an insulating tube housing said contact elements, said stationary contact comprising a plurality of fingers juxtaposed to each other in circular arrangement and each having a pivot end and free end disposed to receive

said movable contact element therebetween, a contact pressure metallic coil spring surrounding said fingers intermediate their ends wherein vibrations are established by engagement of said elements, and a resilient rubber-like ring surrounding said fingers near their free ends around the zone of contact interengagement and in compressive relation with the interior of said tube axially remote from said metallic spring, whereby the periodic vibrational energy of said metallic spring and fingers is absorbed by said reslient ring.

3. The invention according to claim 2 wherein the resilient rubber-like ring is rectangular in cross section.

4. The invention according to claim 2 wherein the resilient rubber-like ring is round in cross-section.

5. The invention according to claim 2 wherein the resilient rubber-like ring is square in cross section.

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