United States Patent [19]
Reed

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[45] July 31, 1973

[54] HIGH-SPEED SWITCH DEVICE

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[73] Assignee: Hughes Aircraft Company, Culver City, Calif.

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[21] Appl. No.: 255,665

[52] U.S. Cl. .... 335/168, 200/153 H, 335/170, 335/174
[51] Int. Cl. H01h 9/20
[58] Field of Search .... 335/167, 168, 169, 335/170, 147, 21, 22, 16, 174; 317/11 C; 200/153 H

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3,657,607	4/1972	Knauer	317/11 C
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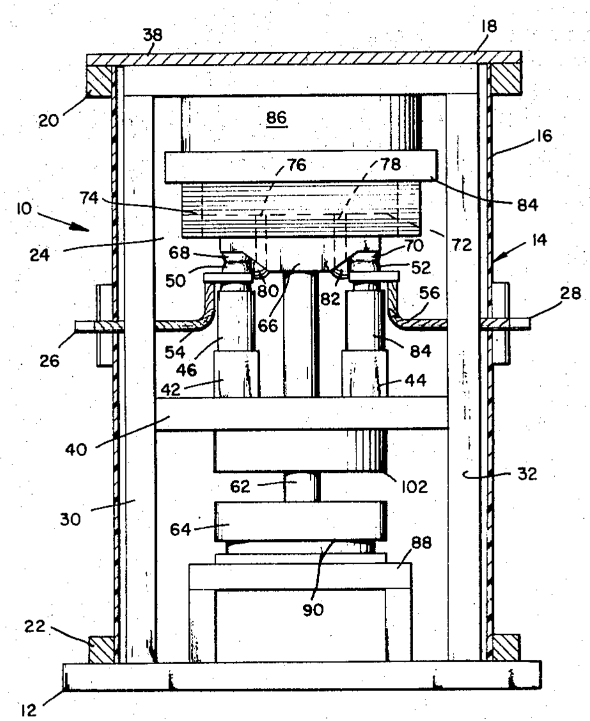
Primary Examiner—Harold Broome
Attorney—W. H. MacAllister, Jr. et al.

[57] ABSTRACT

High-speed switch device is capable of providing continuous current carrying capability with its contacts closed, and is capable of rapidly opening for current cessation therethrough. The device is particularly adapted for acting as a portion of a high voltage DC circuit breaker, so that the opening of the switch transfers current into an impedance increasing section of the circuit breaker.

17 Claims, 9 Drawing Figures



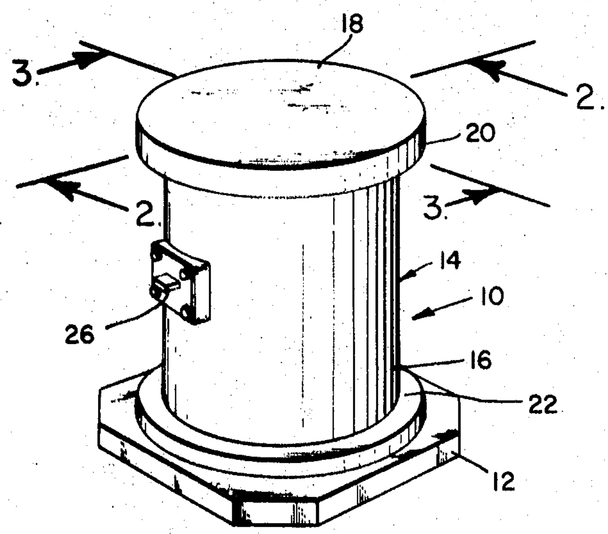

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Fig. 1.

Fig. 2.

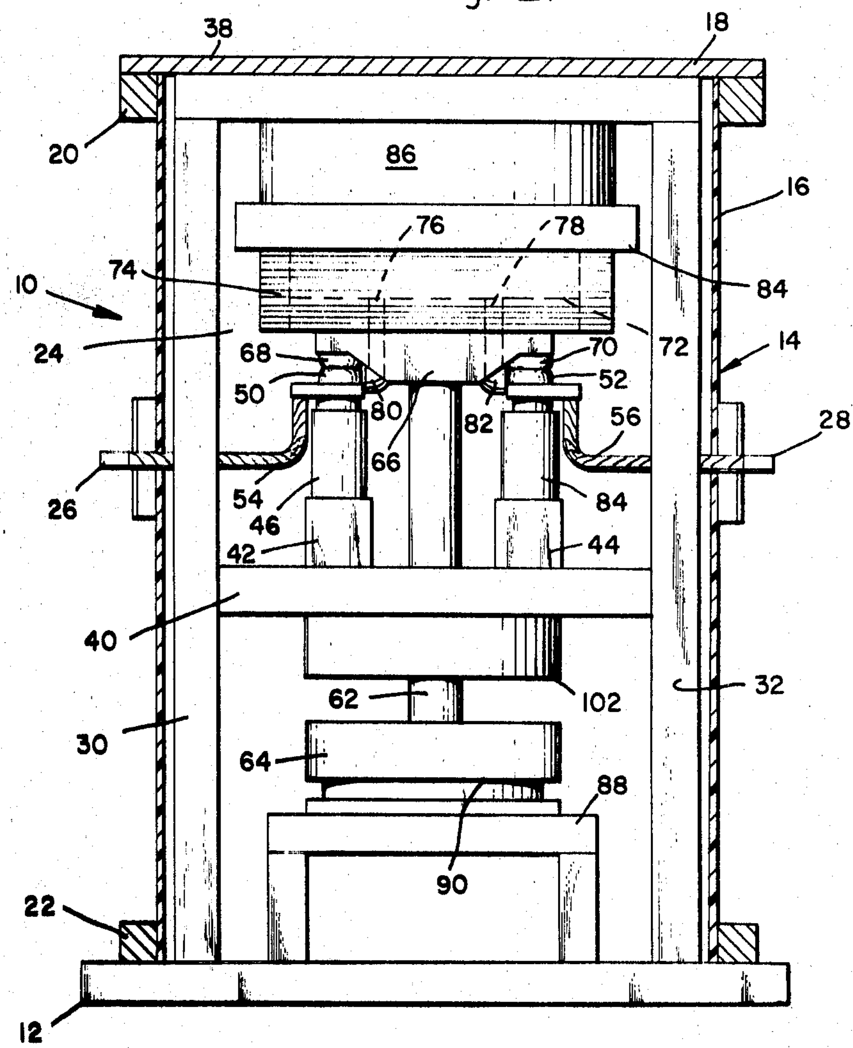
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Fig. 7.

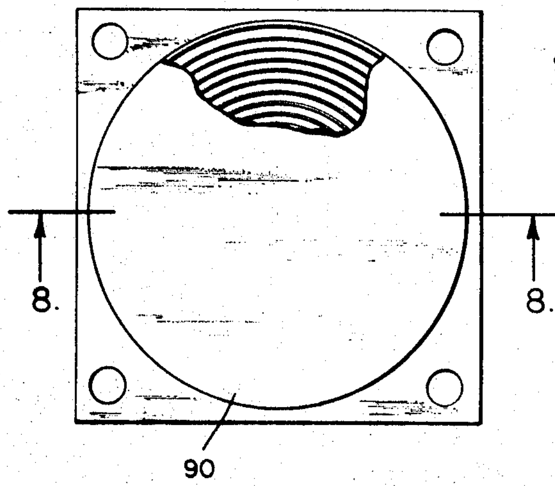


Fig. 8.

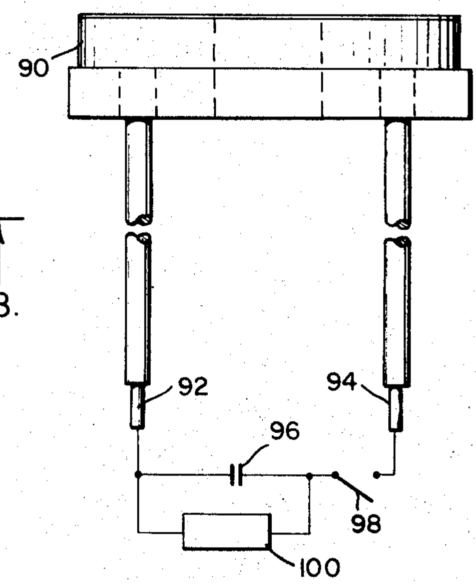
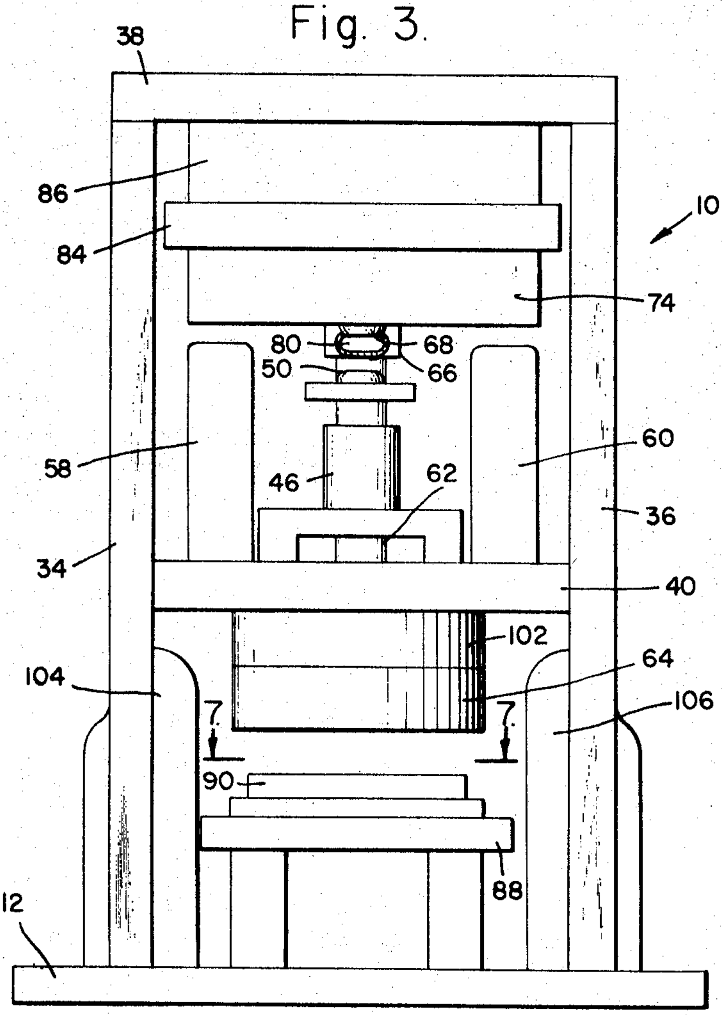


Fig. 3.



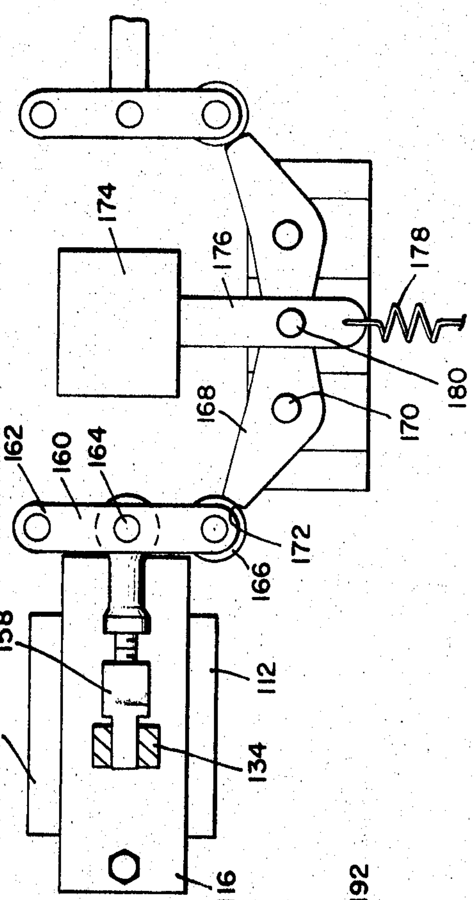


Fig. 6.

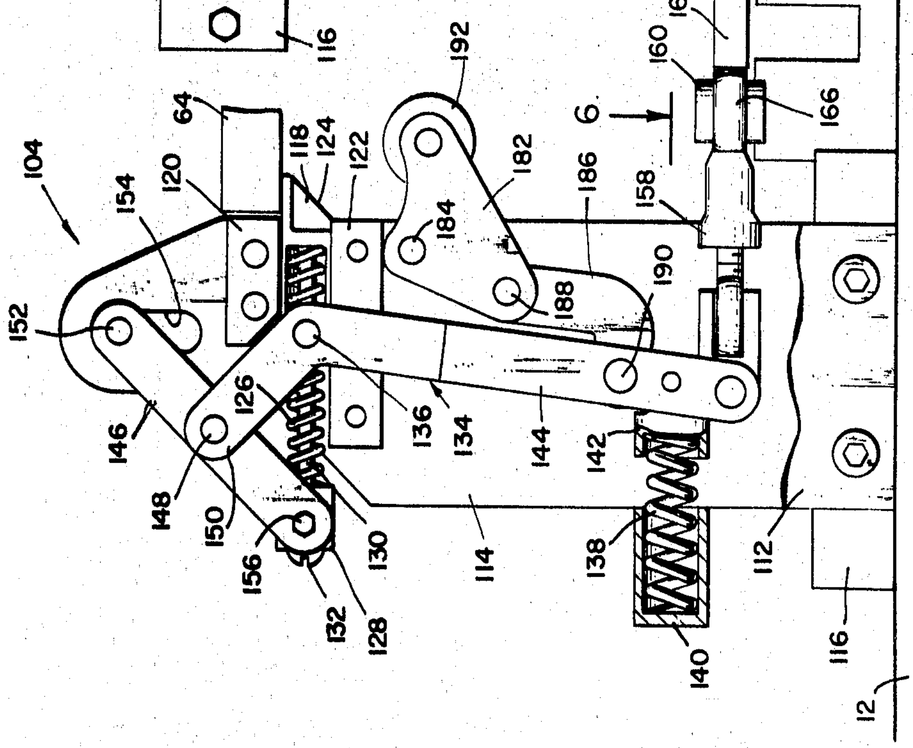
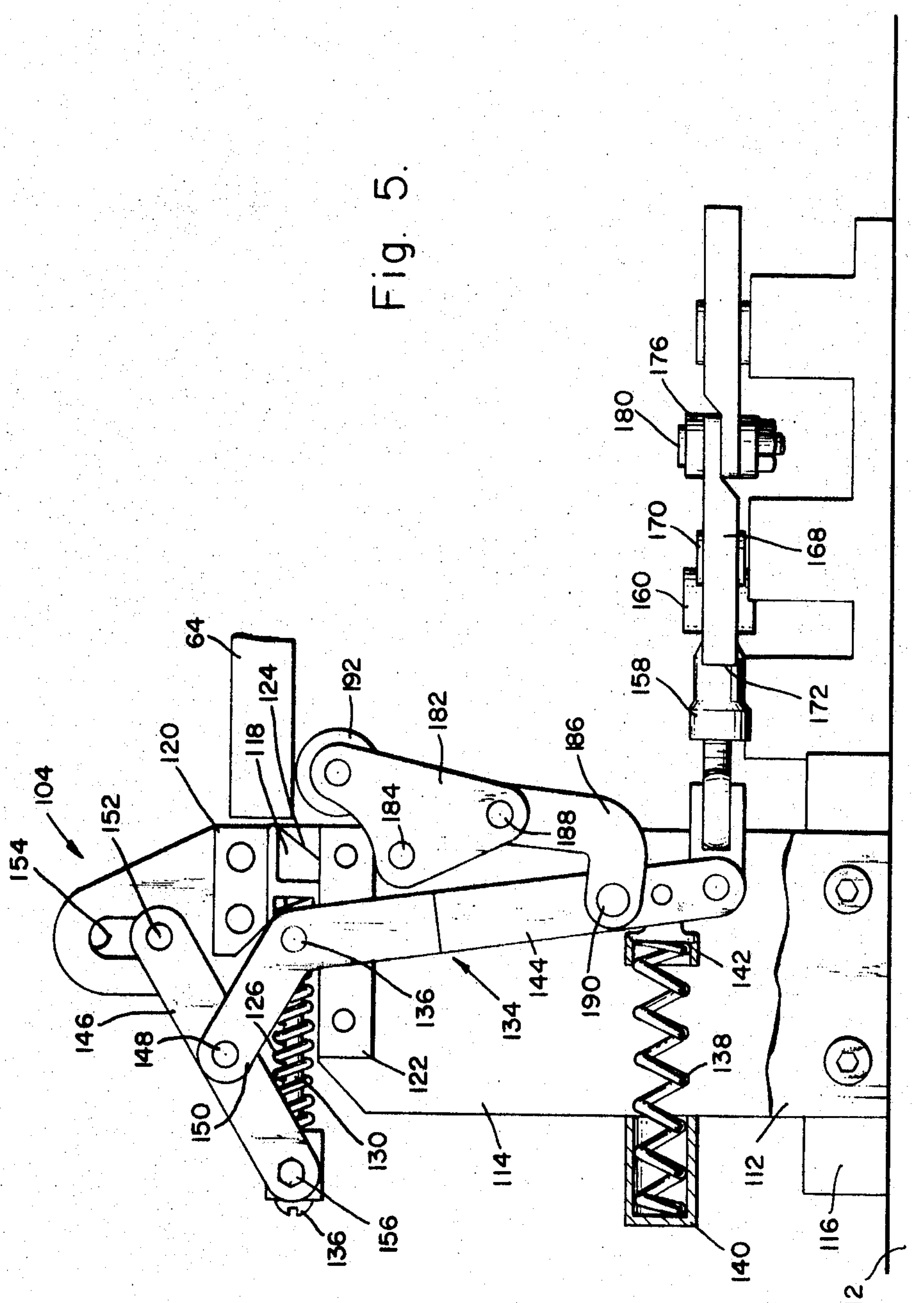


Fig. 4.


104
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120
118
124
64
192
182
184
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142
138
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114
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Fig. 5.

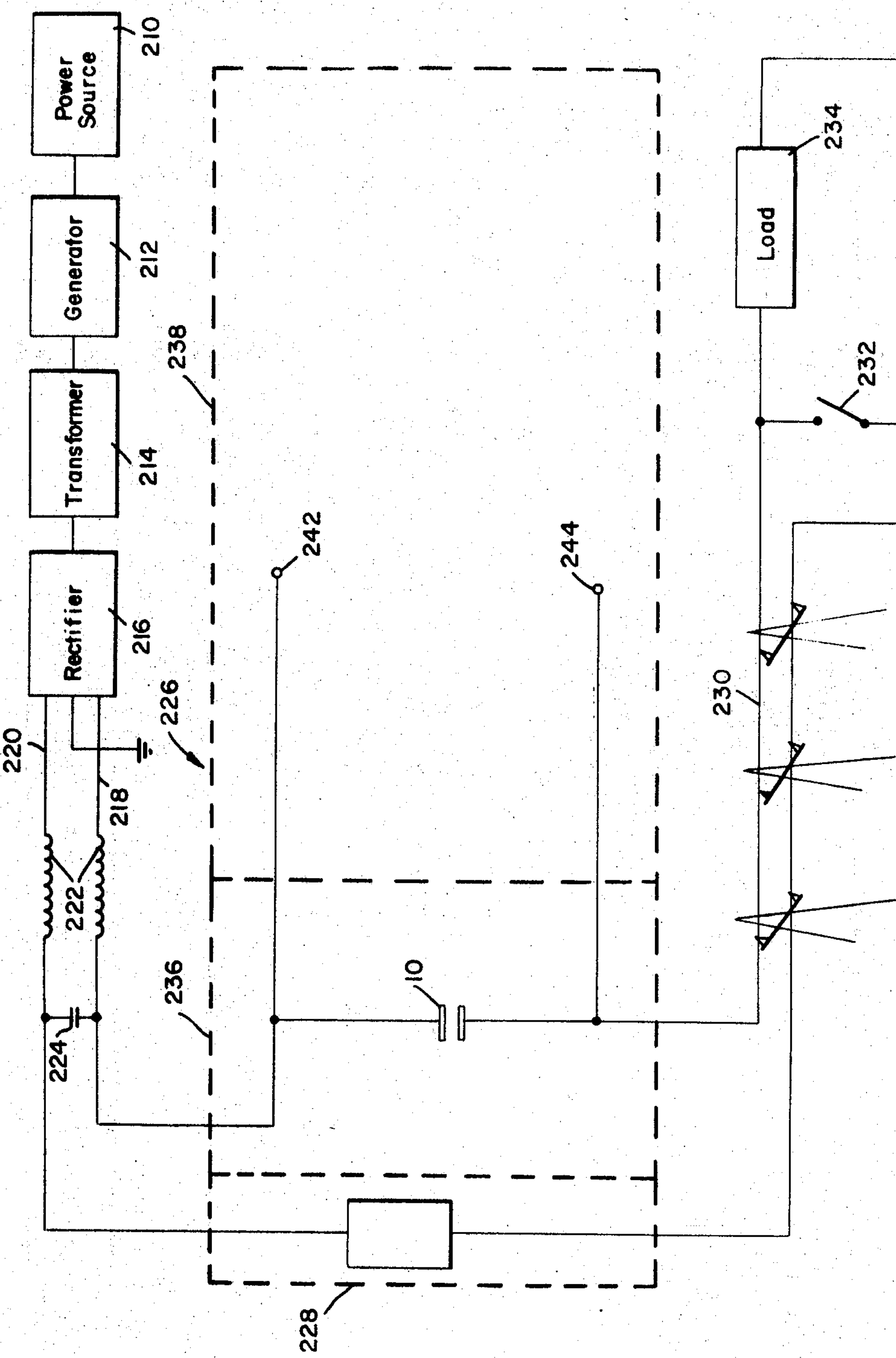
Power Source
210
Generator
212
Transformer
214
Rectifier
216
220
218
222
224
226
236
238
242
244
10
228
230
232
234
Load

Fig. 9.

HIGH-SPEED SWITCH DEVICE

BACKGROUND

This invention is directed to an electric switch device as particularly adapted to quickly open a DC circuit.

Switchgear apparatus which is used for the interruption, disconnection and isolation of main power circuits is usually required to carry normal continuous load current when in the closed position. Switchgear which is designed to interrupt either load or fault current will do so when the device is opened. Many types of such apparatus are designed to carry continuous load current and to achieve interruption by means of the same set of contacts. Other devices use one set of arcing contacts for interruption, and a second set of main contacts to carry continuous load current. This done to provide main contacts which are massive enough and made of the proper materials to carry continuous load current without producing too much heat, while the interrupting contacts are designed for efficient arc extinction and are made of arc-resistant materials which usually have a higher ohmic resistance which is not as suitable for main contacts.

A number of circuit breakers particularly adapted for the opening of high voltage DC circuits are known in the prior art. These circuit breakers require a switching device for carrying the normal continuous load current when in the closed position, and which is opened to transfer the load current to impedance increasing devices. For example, U.S. Pat. No. 3,534,226 has a switch 20 which is opened to transfer current into an impedance increasing section. Similarly, it shows additional embodiments having switches 52 and 84 respectively, for opening to transfer current into impedance increasing devices. Another example of this type of construction, switch **40** in U.S. Pat. No. 3,657,607 (Ser. No. 122,396, filed 3/9/71) carries the normal continuous load current, and is opened to transfer the current into an impedance increasing section. Another similar construction is found in U.S. Pat. No. 3,641,358 wherein switch 24 is opened to transfer the current into an impedance increasing section. U.S. Pat. No. 3,611,031 shows three switches 24, 26 and 28, which open to transfer the current to the impedance increasing section. Furthermore, U.S. Pat. No. 3,660,723 (Ser. No. 122,395, filed 3/9/71) has serial switches 56 and 58 which are opened to transfer the load current to the impedance increasing section.

The impedance increasing section itself of these patents conveniently employs a switch which has the capability of offswitching direct current while current is flowing therethrough. The devices shown in U.S. Pat. Nos. 3,558,960, 3,641,384, 3,638,061 and in FIG. 2 of U.S. Pat. No. 3,604,977 are examples of suitable devices for installation in such a circuit breaker to receive the current transferred from the switching device. By the particular nature of the crossed field device, it can carry current for only a limited period of time, so that it itself is not able to provide the continuous current capability which the circuit breaker requires.

Thus, the circuit breaker comprises a switch for carrying the normal continuous load current when it is in the closed position, and an impedance increasing circuit connected in parallel to the switch, for receiving the current when the switch opens. The impedance increasing circuit may include crossed field switch devices to aid in increasing the circuit breaker impedance to stop current flow. The switch of this invention finds particular suitability as the switch for carrying the normal continuous load current.

SUMMARY

In order to aid in the understanding of this invention it can be stated in essentially summary form that it is directed to a high-speed switching device. The switching device has electric contacts which are closed for normal current conduction, drive means for forcibly and quickly driving the contacts apart and puffer means for puffing gas into the arc space between the contacts.

It is thus an object of this invention to provide a high-speed switching device which is capable of quickly opening closed contacts and extinguishing the arc therebetween so that it can quickly offswitch current flowing therethrough. It is a further object to provide a switching device which when in its closed position can carry continuous load current of the circuit therethrough. It is another object to provide a switching device which can be employed in conjunction with a parallel impedance increasing the system so that when the switching device is opened, the current is transferred into the impedance increasing section.

It is yet another object to provide a switch device which, when opened, has the capability of withstanding circuit voltages and transient over voltages which occur in the circuit to which it is connected. It is yet another object to provide a switch device which can rapidly recover its dielectric strength, as soon as possible after opening of the switch and after arc quenching. It is a further object to provide a high-speed switch device which can be again closed so that it can again carry continuous load current and will be in full readiness for an ensuing interrupting, switch opening operation.

Other objects and advantages of this invention will become apparent from a study of the following portion of this specification, the claims and the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an isometric view of the high-speed switching device of this invention.

FIG. **2** is an enlarged vertical section taken generally along the line **2—2** of FIG. **1.**

FIG. **3** is a vertical section on the same scale as FIG. **2,** taken along the line **3—3** of FIG. **1,** with parts broken away.

FIG. **4** is the further enlarged side elevational view of one side of the latching mechanism, with parts broken away, shown in the latched position.

FIG. **5** is a view similar to FIG. **4,** showing the latch mechanism in the unlatched position.

FIG. **6** is a partial plan view of the latch releasing mechanism, as seen generally from along the line **6—6** of FIG. **4.**

FIG. **7** is an enlarged plan view, with parts broken away, of the drive magnet of the high-speed switching device of this invention, as seen generally along the line **7—7** of FIG. **3.**

FIG. **8** is a side-elevational view, with parts broken away, of the drive magnet of FIG. **7.**

FIG. **9** is a schematic circuit diagram showing an example of the use of the switching device.

DESCRIPTION

The high-speed switching device of this invention is generally indicated at **10** in FIGS. **1, 2** and **3.** It comprises a base plate **12** upon which the equipment is mounted, and against which cover **14** is flanged.

Cover **14** has an outer cylindrical shell **16** to which is secured top **18** by means of flange ring **20.** All parts of cover **14** are made of insulating material to inhibit arcing and leakage. Alternatively, it is a metal housing with insulating bushings. Cover **14** is removably held down to base plate **12** by means of flange ring **22** so that the cover can be removed for access to the equipment contained therein. Sealing is provided at all joints so that the gas in the interior space **24** can be controlled. Within present knowledge, the most satisfactory atmosphere is pressurized sulphur hexafluoride. This gas provides the benefits of excellent insulating value, rapid dielectric recovery and arc voltage generation, when it is supplied to the space between the opening contacts. Cover **14** is provided with exterior terminal connections **26** and **28**, for connection of switch into a circuit.

Interiorly of cover **14,** secured upon base plate **12,** are upright corner posts **30, 32 34** and **36.** These corner posts carry top cross piece **38** and intermediate cross piece **40.** The cross pieces serve as supports for portions of the switch equipment.

Intermediate cross piece **40** carries fixed contact supports **42** and **44,** upon which are mounted tubes **46** and **48.** Fixed contacts **50** and **52** are respectively slidably mounted in tubes **46** and **48,** and are arranged so that there is upward limit stop of the fixed contact with respect to their tubes. The upper limits stop is that occupied in FIG. 3. Springs in the bottom of the tubes, beneath the fixed contacts, urge the contacts upward toward the fixed stop position. Thus, the fixed contacts are resiliently mounted and can be pressed downward in the tubes from their upper position against the force of the contact springs. Cables **54** and **56** extend from the exterior electric connections **26** and **28** and are secured to their respective fixed contacts so that the fixed contacts are electrically connected exteriorly of the switching device.

Drive shaft **62** carries drive plate **64** in the lower end thereof. The upper end of drive shaft **62** carries crossbar **66,** which is of metal and carries contacts **68** and **70** adjacent its ends and facing downward. When the drive shaft is in the lower position, as shown in FIG. 2, the contacts **68** and **70** are respectively engaged against contacts **50** and **52.** The motion of drive shaft **62** is such that when it is in the lowered position, the springs under contacts **50** and **52** are somewhat compressed to maintain contact force. This condition is seen in FIG. 2. When the drive shaft **62** is raised to the position shown in FIG. 3, the contacts **68** and **70** are moved upward, out of contact with the fixed contacts **50** and **52.** For this reason, the contacts **68** and **70** are called moving contacts. The spacing, when the contacts are in a raised position, is such that a high voltage thereacross will not cause arcing. Arc resistance is enhanced by the atmosphere in interior space **24.**

Piston **72** is mounted on top of crossbar **66** and is driven by motion of drive shaft **62.** Piston **72** is in cylinder **74,** so that motion of the drive shaft **62** strokes the piston therein. Piston **72** carries ducts **76** and **78,** which extend downward from the space above the piston and terminate in outwardly directed nozzles **80** and **82,** respectively. These nozzles are directed outward, just below the moving contacts **68** and **70** so that gas is discharged into the interelectrode gap as the drive shaft **62** moves upward, carrying the pistons and moving contacts with it. This gas jet assists in arc quenching, raises the arc voltage and reduces the time in which holdoff voltage is achieved.

Cylinder **74** is carried on mounting plate **84,** which in turn is carried under top cross piece **38** on resilient shock absorber **86.** The shock absorber **86** aids in the deceleration of drive shaft **62,** and the parts carried thereon, when piston **72** bottoms in cylinder **74** and shaft **62** reaches the top of its stroke.

Drive of drive shaft **62** is accomplished by means of a magnetic repulsion drive motor. Table **88** is mounted above base plate **12,** and carries a magnetic coil **90** thereon. Magnetic coil **90** serves as the stator of the magnetic repulsion motor, while drive plate **64** serves as the moving armature. As is best seen in FIG. 7 and 8, magnetic coil **90** is wound in pancake form from a rectangularly shaped conductor, and terminates in connections **92** and **94.** Capacitor **96** and switch **98** are serially connected and are connected to the connectors **92** and **94.** Thus, upon closure of switch **98,** the capacitor **96** discharges through the coil **90.** Power supply **100** recharges the capacitor after switch **98** is opened. This structure forms an induced eddy current type of repulsion drive. It is known as a motor which can obtain very fast operation. The relationship between the capacitor size, charging voltage, coil inductance and mass of the moving drive plate **64** are related in T. F. Meagher's article "The Conversion of Electromagnetic Energy Into Shock Pulses," 18th Annual ISA Conference and Exhibit, Sept. 9–12, 1963, Chicago, Instrument Society of America, Preprint 49.4.63. It can be seen that quite heavy masses can be accelerated to high velocities, as required for this structure, by use of a capacitor bank of adequate size, charged to a high enough voltage. One of the limitations of this motor structure is the problem of how to make the moving structure sufficiently mechanically strong to withstand the high forces of acceleration. Shock absorber **86,** together with shock absorber **102,** decelerates the moving structure at the end of its stroke. Preferably these are in the form of resilient, rubber-like pads.

Since the greatest energy transfer in the moving parts occurs when the drive plate **64** is close to the coil **90,** it is necessary to hold the drive plate **64** against the coil until the discharge current of the capacitors through the coil has built up to a high value. This causes the drive plate **64** to move with a high acceleration when it is finally repulsed from coil **90.** As the drive plate **64** moves away, the repelling force decays very rapidly. The motivating force thus acts for a very short time, most likely in the range of 10 microseconds to one millisecond. The drive plate **64** then continues to move upward at its final velocity, which decreases due to resistance to its motion.

In order to obtain rapid contact separation time, the primary factor involved in the design is to keep the mass of the moving parts as low as possible while maintaining mechanical strength. The drive plate must be kept close to the coil conductors and the drive plate must be made of a high conductivity, non-magnetic, light weight metal for the disc. Copper provides a serious weight disadvantage, and thus a high strength aluminum alloy is preferred, even though this means a significant decrease in conductivity. Additionally, the drive plate must be sufficiently thick to prevent complete penetration by the magnetic field.

A shock absorber at the end of the stroke slows down the moving parts after they reach a certain point, and this dissipates as much energy as possible as the parts come to a stop. Thus only a fraction of the original kinetic energy is returned to the parts as they rebound off of the shock absorbers onto latches which hold them in the open position.

As seen in FIG. 3, latch towers **104** and **106** are positioned between the upright corner posts of the structure and adjacent the drive plate **64**. Two such latch towers are shown, and they contain identical latches. The latches have the function of holding drive plate **64** in the raised position, the position of FIG. 3, with the contacts open, to maintain the switch in the nonconductive position. The latches can be withdrawn, to release drive plate **64**, to permit the entire moving structure including moving contacts **68** and **70** to move downward to the switch closed position. The closure is accomplished by compressed compression springs in spring housings **58** and **60** engaging on the top of plate **64**.

As the moving structure moves downward under the influence of the closing springs, the latch mechanism is reset so that it is ready for the next cycle. The next cycle comprises energization of the magnetic repulsion motor to drive the moving structure upward.

Latch tower **104** is shown in the plate retentive position in FIG. 4 and is shown in the just unlatched position in FIG. 5. The mechanism of latch tower **104** is described in detail below, and latch tower **106** is symmetrically identical therewith. At least two latch towers are preferred, for balanced application of forces, but if desired, more than two latch towers can be employed for retaining drive plate **64** in its upper, latched position, so long as the latches are operated at the same time.

Referring to FIGS. 4 and 5 in more detail, latch tower **104** is formed of a near side plate **112** and far side plate **114**. They are separated by spacer **116**, to which they are secured, and spacer **116** serves as a means for securing the tower **104** down to base plate **12**. The upper portion of near side plate **112** is broken away so that the mechanism between the side plates can be seen.

Latch **118** is transversely slidable between guides **120** and **122** from the position where it extends out of the tower, as seen in FIG. 4, to a position where it is retracted away from engagement with drive plate **64**, as seen in FIG. 5. In the extended position of FIG. 4, it is positioned to retain drive plate **64** in the raised, latched position shown. The drive plate is sufficiently tall that when the drive plate is in its lower, released position, the latch engages the side of the drive plate.

Compression spring **126** is engaged against the back of latch **118** to urge it to the right. Yoke **128** is engaged by the other end of spring **126**. Tension member **130** is engaged in latch **118**, conveniently by screw threads for adjustment, and extends outward through a clearance hole in yoke **128**, and carries head **132** on the outer end of the yoke. By this construction, the latch **118** can move leftward with respect to yoke **128**, compressing spring **126**, but cannot move rightward with respect to the yoke from the relative position shown in FIGS. 4 and 5. Bell crank **134** is pivotally mounted to the near side plate of the latch tower on pivot shaft **136**. It is urged in the counterclockwise direction by compression spring **138** which is housed on one end in spring pocket **140** which is secured to the side plates of the latch tower and on the other end in spring pocket **142** which is pivotally mounted toward the lower end of lower arm **144** of bell crank **134**.

Lever **146** is pivoted at **148** to the upper arm **150** of bell crank **134**. Guide pin **152** extends transversely through the upper end of lever **146**, and engages in an upright guide slot **154** formed in the upper end of both of the side plates **112** and **114**. The other end of lever **146** carries pivot pin **156** which is engaged in yoke **128**.

Pivot pin **148** is constrained to arcuate motion about the axis of pivot shaft **136**, upon rotation of bell crank **134** on its pivot **136**. The upper end of lever **146** is constrained to vertical motion, by the engagement of its guide pin **152** in upright guide slot **154**. These two constraints of motion on the lever **146** cause the pivot pin **156** to move substantially in a straight, horizontal line, in line with the slot formed by guides **120** and **122** for the horizontal sliding motion of a latch **118**. Thus, this linkage is a straight line motion. In the position shown in FIG. 4, bell crank **134** is in its clockwise position, with spring **138** compressed, and latch **118** extended for support of the drive plate **64**. When bell crank **134** is released, permitting it to be driven in the counterclockwise direction by compression spring **138**, latch **118** is withdrawn from support, and the structure occupies the position shown in FIG. 5.

Referring to FIGS. 4, 5 and 6, the lower end of bell crank **134** is connected to link **158**, which is pivotally mounted on both ends, and may have a rotary joint or a linear adjustment in the center. Follower lever **160** is pivoted to the base on pin **162** and is pivoted to the end of link **158** by pin **164**. Follower roller **166** is rotatedly mounted on the free end of follower lever **160**.

Stop lever **168** is pivoted to the base on pin **170** and on its outer end is provided with stop surface **172**. Stop lever **168** can be pivoted in the counterclockwise direction as seen in FIG. 6, so that the stop surfaces swing out of the arcuate path of follower roller **166**, so that the stop surface does not act as a stop therefore.

Solenoid coil **174** embraces solenoid plunger **176**, and is shown in its outer, non-energized position in FIG. 6. Tension spring **178**, connected to the base and to solenoid plunger **176** holds the plunger to its maximum outer, stop position shown in FIG. 6. Pin **180** is engaged through solenoid plunger **176**, and into a suitable slot in stop lever **168**, so that when all the parts are in their stop position they are positioned as shown in FIG. 6. When solenoid coil **174** is energized, it pulls in plunger **176** to rotate stop lever **168** in the counterclockwise direction, so that stop surface **172** moves out of the way of follower roller **166**. Thereupon, bell crank **134** is free to rotate in the counterclockwise direction, being driven by compression spring **138**, from the position in FIG. 4 to the position in FIG. 5, thereby withdrawing the latch **118**. Thus, energization of solenoid coil **174** causes latch withdrawal. A symmetrical structure, partially shown in the right half of FIG. 6, operates the latch in latch tower **106** at the same time.

The released position is shown in FIG. 5. In this position drive plate **64** is released to descend under the drive force provided by springs in spring housings **58** and **60**, for the reclosure of the switch by permitting cross bar **66** to carry the moving contacts **68** and **70** downward into electrical and mechanical contact with the fixed contacts. FIG. 5 illustrates the just released condition with the drive plate **64** just below the upper lip of the just retracted latch **118.**

Reset lever **182** is pivoted on pin **184** to latch tower **104**, between the side plates thereof. It is connected by link **186** and by pivot pins **188** and **190** to lower arm **144.** The upper end of reset lever **182** carries follower roller **192**, which is positioned on the path of motion of drive plate **64** to be engaged by the drive plate. In the released position of latch **118**, follower roller **192** is in the raised position illustrated in the FIG. **5.** As drive plate **64** moves down, from the intermediate position of FIG. **5**, it engages follower roller **192** causing rotation of reset lever **182** in the clockwise direction, from the position of FIG. **5** to the position of FIG. **4.** The position of the pivot of follower roller **192**, and the position of pivot pins **184, 188** and **190** is such as to provide a substantial mechanical advantage for the compression of spring **138**, and overcome other resistive forces, as the drive plate **64** moves downward, and as the bell crank **134** moves to the cocked position of FIG. **4.** As it reaches its end position, the stop lever **168** swings into abutment position illustrated at FIG. **6**, to retain the latching equipment in the position illustrated in FIG. **4.** When motion has ceased, drive plate **64** is down on its magnet **90**, the contacts are closed and the latch equipment is in the position illustrated in FIG. **4**, except for the lower position of the drive plate **64.** Now, for the next opening of the high speed switch device, switch **98** is closed and the magnetic coil is energized, the drive plate **64** is driven upward, above latch **118** so that latch **118** springs out the drive plate rests on top of the latch **118**, as shown in FIG. **4.** As previously described, this upward motion of drive plate **64** quickly opens the contacts and blows gas across the opening contact surfaces. Thus, the cycle is completed.

The particular design characteristics described above and shown in the drawings result in a highspeed switch device of small physical structure for its offswitching capability, and one which produces a large direct current arc voltage drop. Due to the design of the gas flow discharge passages, and the manner in which highspeed gas flow is produced in the critical interelectrode area, cooling of the arc and arc extension results to produce an unusually high DC arc voltage drop. This is particularly useful when the current is being diverted from the opening switch device into a parallel path which incorporates a modern crossed field switch as described above. Modern crossed field switches have a voltage drop in the order of 1 kv when conducting high currents and thus, this switch device is particularly useful for producing the arc voltage drop necessary to transfer the current from the opening highspeed switch device to the crossed field switch which receives the current as a result of the offswitching of the highspeed switch device.

FIG. 7 illustrates a particular utility of the switching device **10.** The DC power which is to be offswitched by a circuit breaker, including the switching device **10** of this invention, is conventionally derived at power source **210** which delivers power to AC generator **212.** Generator **212** delivers its output to transformer **214** by which the voltage is raised to suitable transmission line voltage. From the transformer, the power is rectified by rectifier **216.** Rectifier **216** has positive and negative output lines **218** and **220** respectively. Inductances **222**, connected in the lines and capacitance **224**, connected between the lines, serve as conventional DC filtering and smoothing equipment. They are preferably connected at the output of the rectifier, as shown. In certain circumstances, the reactance of the transmission system may be sufficient to provide adequate smoothing for economic power transmission.

Circuit breaker **226** is serially connected in line **218** between the rectifier **216** and transmission system **230**, while an identical circuit breaker **228** is connected in line **220** therebetween. Bipolar circuit breakers are thus provided, because of the high voltages in the exemplary embodiment of employment of the circuit breaker. In lower voltage systems, only one circuit breaker might be necessary.

In high voltage DC systems, it is customary to have a line potential such that one line is above ground potential, while the other is below. This equalizes the amount of transmission line insulation between the two lines and ground. Either one of the lines, through the transmission system or at the load, may fault to each other, as by exemplary fault switch **232**, or can fault to ground. Thus, independent line protection is necessary, as by breakers **226** and **228.**

Each of the circuit breakers, of which circuit breaker **226** is exemplary, comprises line switch means **236** and impedance-increasing means **238.** Line switch means **236** comprises switch **10** which is serially-connected in power line **218** between rectifier **216** and the load **234.** Switch **10** is of such nature that, as it opens, sufficient voltage drop is generated thereacross to transfer the current from the low impedance path through normally closed switch **10** into the impedance-increasing means **238.**

As discussed above, various impedance-increasing means can be connected to terminals **242** and **244.** Examples are shown in U.S. Pat. Nos. 3,534,226, 3,641,358, 3,611,031 and others mentioned above.

This invention having been described as preferred embodiment, it is clear that it is susceptible to numerous modifications and embodiments within the ability of those skilled in the art and without the exercise of the inventive faculty. Accordingly, the scope of this invention is defined by the scope of the following claims.

What is claimed is:

1. A high speed switching device comprising:

a frame;

a relatively fixed electric contact secured to said frame;

a movable electric contact movably mounted with respect to said frame and movable into and away from mechanical contact with said fixed contact;

connection means connected to both said fixed and said movable contacts for electrical connection thereto so that electric continuity through said connection means is interrupted by moving said movable contact away from said fixed contact;

drive means connected to said movable contact for driving said movable contact away from said fixed contact to an open position of said switching device, a drive plate mounted to move with said movable contact;

latch means for holding said movable contact in its open position to maintain said switching device in a condition of nonconductivity therethrough, said latch means including an engagement surface movable with said movable contact and a latch engageable on said engagement surface to hold said movable contact in position, trigger means connected to said latch for releasing said latch from holding position, and reset means engageable by said drive plate and connected to said latch for urging said latch toward holding position when said drive plate actuates said reset means.

2. The switching device of claim **1** wherein said drive means comprises an electrically conductive drive plate and an electromagnetic coil adjacent said drive plate, so that when current is passed through said coil, magnetic repulsion forces are generated between said drive plate and said coil to repel said drive plate with respect to said coil to move said movable contact away from said fixed contact.

3. The switching device of claim **2** wherein said movable contact is mounted upon a drive shaft, and said drive plate is mounted on said drive shaft so that motion of said drive plate away from said magnetic coil causes said drive shaft to move said movable contact away from said fixed contact.

4. The high speed switching device of claim **1** wherein there are first and second relatively fixed contacts in said switching device, and first and second movable contacts therein, such first and second movable contacts being mounted upon a cross bar and being electrically connected, said connection means being connected to said first and second fixed contacts, so that upon movement of said movable contacts away from said fixed contacts, two gaps are opened.

5. The switching device of claim **4** wherein said drive means comprises an electrically conductive drive plate and an electromagnetic coil adjacent said drive plate, so that when current is passed through said coil, magnetic repulsion forces are generated between said drive plate and said coil to repel said drive plate with respect to said coil to open said contact gaps.

6. The switching device of claim **5** wherein said movable contact is mounted upon a drive shaft, and said drive plate is mounted on said drive shaft so that motion of said drive plate away from said magnetic coil causes said drive shaft to move said movable contacts away from said fixed contacts.

7. The high speed switching device of claim **1** wherein said device has a base, and said relatively stationary contact is mounted with respect to said base, and said movable contact is movable with respect to said base, said latch being mounted on said base, said engagement surface moving with said movable contact and positioned to be engaged by said latch when said movable contact is away from said stationary contact to maintain said switching device in the nonconductive condition.

8. The switching device of claim **7** wherein said reset means includes a latch lever connected to said latch, said latch lever being connected to withdraw said latch away from said engagement surface to permit said movable contact to move into engagement with said stationary contact to permit closing of said switching device.

9. The switching device of claim **8** wherein said latch lever has a spring connected thereto urging said latch lever in the latch withdrawal direction, said trigger means including a movable stop lever positioned to prevent motion of said latch lever in the latch withdrawal direction, said stop lever being movable to a disengaged position wherein said latch lever is permitted to move and withdraw said latch.

10. The switching device of claim **8** wherein said reset means includes a reset lever connected to said latch lever, said reset lever moving said latch lever from a latch withdrawn position to a latch extended position against force of said latch lever spring.

11. The switching device of claim **10** wherein said reset lever is positioned to be engaged by the drive means so that as said drive means for said movable contact moves from its contact open position to its contact closed position, said reset lever is moved to cause resetting of said latch lever.

12. The switching device in claim **11** wherein said stop lever is urged into latch lever retaining position when said latch lever is moved to its latch extended position.

13. The high speed switching device of claim **12** wherein there are first and second relatively fixed contacts in said switching device, and first and second movable contacts therein, such first and second movable contacts being mounted upon a cross bar and being electrically connected, said connection means being connected to said first and second fixed contacts, so that upon movement of said movable contacts away from said fixed contacts, two gaps are opened.

14. The switching device of claim **13** wherein said drive means comprises an electrically conductive drive plate and an electromagnetic coil adjacent said drive plate, so that when current is passed through said coil, magnetic repulsion forces are generated between said drive plate and said coil to repel said drive plate with respect to said coil to open said contact gaps.

15. The switching device of claim **14** wherein said movable contact is mounted upon a drive shaft, and said drive plate is mounted on said drive shaft so that motion of said drive plate away from said magnetic coil causes said drive shaft to move said movable contacts away from said fixed contacts.

16. The switching device of claim **1** wherein such switching device is connected in parallel with impedance increasing means so that when said switching device is open the circuit path is through impedance increasing means.

17. The switching device of claim **16** wherein said impedance increasing means is on a path having a crossed field switching device therein parallel to said switching device so that when said switching device is closed, the principal current passes therethrough, and when said switching device is opened the principal current passes through said crossed field switching device.

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