The present invention relates to a transfer switch mechanism and more particularly to a mechanism for automatically transferring an electrical load from a preferred power source to an emergency power source when the preferred power source fails.

An object of the present invention is to provide an improved transfer switch for A.C. or D.C. systems which functions to transfer an electrical load from a preferred power source to an emergency power source when normal voltage fails or is significantly reduced below accepted limits and then to restore the load to its original preferred source automatically when the preferred power source is restored to a desired level.

Another object of the present invention is to provide a transfer switch mechanism of the type described which is rugged in design and is reliable in operation.

It is also an object of the present invention to provide a design which is capable of embodying transfer mechanisms having high in-rush and thermal capacities and in which arcing may be minimized. A further object of the present invention is to provide a mechanism which is adapted to either motor or manual operation.

Switching time in transfer switches of the type described is critical in many applications where continuity of power is essential. The transfer of power from a preferred to an emergency source must be substantially instantaneous, not only to minimize power interruption but also to minimize damage to the contacts in that the mechanism due to arcing which occurs in slow transfer mechanisms. It is therefore also an object of this invention to provide high speed transfer mechanism wherein switching may be effected between a high power preferred source and an emergency high power source in less than 3 cycles in a 60 cycle system.

A further object of this invention is to provide a transfer mechanism wherein closed contacts are positively locked closed to prevent inadvertent opening due to strong stray magnetic fields which occasionally have a tendency to open such contacts.

A further object of the invention is to provide a transfer mechanism wherein the preferred and emergency power source terminals are arranged in tandem in such a manner as to prevent inadvertent short circuiting from one power source to the other, and wherein the contact mechanism cannot lock inadvertently into a neutral position.

A further object of the present invention is to provide a transfer mechanism wherein an improved switching mechanism of the type described wherein the switching mechanisms for transferring an electrical load from a preferred power supply to an emergency power supply or vice versa is arranged in tandem pairs, with each tandem mechanism interlocked to prevent the switching mechanisms in the tandem pair from assuming either closed or open positions. Also provided is a structure wherein mechanically interlocked tandem pairs of switching mechanisms are actuated by a power source symmetrical with the tandem pairs. Such arrangement includes a gear motor functioning through a crank and interlocked link arrangement to actuate the switching mechanisms of the tandem pairs in phase opposition. The crank and link arrangement is designed in conjunction with the switching mechanism to preload the switching mechanism through a spring link means whereby spring elements within each of the switch mechanism functions when actuated to cooperatively move the contact arms with a positive force for cooperative movement is in part attained through the mechanical interlock of the contact arms in the tandem pairs.

These objects and advantages of the present invention will be more clearly understood when considered in conjunction with the accompanying drawings, in which:

FIG. 1 is a plan view of a preferred embodiment of the present invention illustrating a 3-pole switch, FIGS. 2 and 3 represent schematic elevations of the switch shown in FIG. 1 respectively in two different positions of operation; and FIG. 4 is a schematic view of the circuitry associated with the mechanism.

While the present invention will be described in conjunction with a 3-pole switch, it should be understood that the principles herein disclosed are applicable to single or other multiple pole switches. The construction is also susceptible to various modifications, adaptations and other uses. Moreover, it may be actuated manually or automatically as described. In its preferred form the present invention is useful for transferring a load from a normal or preferred powered source to an emergency source automatically, on the occasion of a partial or complete failure of the preferred power source and an automatic return to the preferred power source to its desired level.

Referring to FIG. 1 there is illustrated a transfer switch mechanism which may be mounted on a suitable switchboard 12, having associated circuitry, described later in connection with FIG. 4, for operating the transfer switch mechanism of the present invention. In the embodiment illustrated three circuit breakers or switching mechanisms 13, 14 and 15, each having terminals 13A, 14A and 15A for connection to normal or preferred powered sources are secured to the switchboard 12. Circuit breakers or switch mechanisms 16, 17 and 18 each having terminals 16A, 17A and 18A for connections to an emergency power sources are also secured to the switchboard 12. The individual circuit breakers in the first group of switch mechanisms are arranged in parallel or tandem with individual circuit breakers in the second group of switch mechanisms. Thus circuit breakers 13 and 16; 14 and 17; and 15 and 18; are arranged in parallel or tandem pairs.

These circuit breakers are preferably constructed with an over-center spring actuated toggle action best illustrated schematically in FIGS. 2 and 3. The construction of these circuit breakers, which will be described generally in connection with the circuit breaker 14 which applies to each of the circuit breaker mechanisms, is one which is presently commercially available. These circuit breakers each are provided with contact terminals 14A adapted to receive a power supply load. This terminal 14A is electrically connected to a fixed contact 14B. A contact arm 20 is pivotally supported at one end 21 to allow the movable contact 22 to pivot into and out of engagement with the fixed contact 24. The contact arm 20 is actuated through a toggle mechanism 28. This toggle mechanism comprises links 26 and 27 pivotally interengaged at adjacent ends 29. One end of the toggle mechanism 28 is pivotally interengaged with the contact arm 20 intermediate its ends at 30, and the other end of the toggle mechanism is pivotally secured to a fixed member 31. In actual commercial embodiments the member
The circuit breaker mechanism 14 has been described in schematic terms, it should be understood that elaborations of these constructions are contemplated and in fact are available in commercially manufactured structures at this time.

A more detailed arrangement of an actual commercially available circuit mechanism is illustrated in FIG. 1. As illustrated, such additional features as a De-Ion arc quencher 45 may be used. This De-Ion arc quencher consists of parallel steel plates partially surrounding the contacts and enclosed by a fibre wrapper or ceramic support. This quencher is used to draw the arc from the contacts into the plates as the contacts are open or closed. These plates function to disperse the arcs and reduce heat, thereby rapidly removing ions from the area and improving the build-up time of the dielectric between the contacts. In addition, constructions are available in which double toggles and spring links are used for more rapid actuation. However, in each of the preferred embodiments it is important to use a circuit breaker embodying the center spring actuated mechanism of the type herein described.

The preferred power supply is normally connected to the output or load terminals 50, 51 and 52. Output or load terminal 50 is connected by bus bars 53 and 54 respectively to circuit breakers 13 and 16. Load terminal 51 is connected respectively by bus bars 55 and 57 to circuit breakers 14 and 17, while load terminal 52 is connected by bus bars 58 and 59 respectively to circuit breakers 15 and 18.

Each of the circuit breakers in each of the respective groups are tied to the other circuit breakers in their group by suitable means for synchronous operation. Such means may comprise a cross tie bar 69, 61, which may be suitably mounted by brackets to the contact arms 20. Thus each contact arm 20 in the first group of circuit breakers 13, 14 and 15 are actuated simultaneously by cross tie bar 69, and circuit breakers 16, 17 and 18 in the second group are simultaneously actuated by bar 61.

The first group of circuit breakers 13, 14 and 15 are mechanically interlocked to the second group circuit breakers 16, 17 and 18 so that they work in opposition. That is, when the first group of circuit breakers 13, 14 and 15 are opened thereby disconnecting the load from the preferred power source, the second group of circuit breakers 16, 17 and 18 are closing, and thereby connecting the load to the secondary or emergency power supply. These two groups of circuit breakers are mechanically interlocked by at least one tie rod 70. The tie rod 70 is pivotally interengaged at its ends 71 and 72 with rigid projections 74 and 75 respectively to the arms 20 of a circuit breaker in each group. In a preferred embodiment of a three-pole transfer mechanism, mechanical interlocks or tie rods 70 are provided on each of the outer pair of circuit breakers in the group of three. It has been found that this symmetrical arrangement of the interlocking arrangement as provided an improved and more balanced arrangement.

The first and second groups of circuit breakers are automatically operated by means of a motor mechanism generally illustrated at 80. This mechanism has a shaft 81 rotatable in one direction which shaft carries a crank 82. The crank 82 is pivotally connected rodd 83 and 84 pivotally secured to it. The end of the connecting rod 83 is pivotally connected to lever 34 of the circuit breaker 14, while the end of the connecting rod 84 is pivotally connected at 87 to the lever 34 of the circuit breaker 17. As illustrated in this preferred embodiment the connecting rods in a double throw three pole system are symmetrical with respect to the rods 70. They also function in part as a mechanical interlock.

The motor 80 preferably comprises a unidirectional high torque motor having a single speed reduction means which reduces its speed at the output shaft 90 to a speed of the order of 180 rpm with the worm coupled directly to the crank shaft of the motor and the gear to the crank arm. The motor also has a pair of limit switches 90, 91 incorporated into its housing to permit incremental successive rotations of 180° with the motor power controlled by these switches.

Referring now to the mechanical arrangement of FIGS. 2 and 3, the motor mechanism 80 is actuated incrementally to cause the crank arm 82 to move 180° on each actuation. Thus, the crank arm 82 moves from a position wherein its end 82a (FIG. 2) will move from one stable position shown in FIG. 2 to a position 180° out of the phase with that position shown in FIG. 2. When actuated the motor will cause the links 83 and 84 to pivot the levers 34 on the opposite circuit breakers. Because the circuit breakers of each group are tied together, all levers 34 in each group will move simultaneously. Because of the spring links 39, the crank 82 will move over an angle of 90° during which time the toggle mechanism 28 will remain stationary. However, during this time, the spring links 39 preload the toggle mechanism so that when the crank is rotated to just beyond 90°, the levers 34 assume an over center position and the kinetic energy in the spring links 39 cause a rapid change over of the contact arms 20 from one stable position such as shown in FIG. 2 to the other stable position shown in FIG. 3. By proper selection of the spring links 39 and other parameters, the switch-over generated by the kinetic energy of the springs will cause the contact arms to close more rapidly than possible under the influence of the motor 80. In the switched position the toggle mechanism positively locks the closed contact such as illustrated in FIG. 3 at the right with a knee locking action.

One limit switch 91 controls the normal position and the other switch 90 controls the emergency position. These switches are operatively mounted on and controlled by the motor shaft. To transfer from a normal load condition as illustrated in FIG. 4 to an emergency position the motor 80 is actuated to rotate its shaft 180°. This occurs when there is a failure or partial failure of power from the normal source shown in FIG. 2 to a position in the normal power lines 93, 94, drops. This deenergizes coil 95 of the normal power control relay A causing contacts 96 to open and 97 to close. Emergency power control relay G is also closed if the emergency power source is high enough above a selected minimum level, as for example 90%, to maintain coil 98 energized. Under these conditions energy will pass through lines 99, contacts 98, line 100, contact 97 and line 101 to terminals 3 of the motor. Since limit switch 91 is normally closed the motor will actuate through 180° when the motor itself opens switch 91 and closes switch 90.

When the power in the normal circuit returns, coil 95
5 is reenergized causing contacts 96 to close and contacts 97 to open. When contacts 97 open the motor cannot be energized through the motor contact 1, line 105, contact 96 and 93 on reestablishment of normal power. This causes the motor 80 to rotate a second 180° until switch 90 is opened and switch 91 is closed.

As previously indicated the main switch contacts are connected to the operating mechanism through a spring loaded device that preloads through the first 90 degrees of travel and then allows the main contacts to transfer at high speed ahead of the motor operated mechanism. If by chance, the motor is jogged to a position just beyond 90 degrees, sufficient to transfer the circuit breaker but not sufficient to operate the limit switch, and if the power from the source to which the circuit breaker has just transferred fails, the mechanism would assume a neutral position electrically and could not be transferred to the other position until the limit switch contacts have transferred. To prevent this an electrical interlock circuit is provided with auxiliary contacts 110, 111 connected to the bars 60, 61 of the circuit breakers with switch 110 normally open and switch 111 normally closed. When the limit switch contacts in such a neutral position after the circuit breakers have transferred, in order to retransfer the first position, the motor mechanism is energized through the control relay (A) and through the electrical interlock contacts 110 and 111 to complete the previous cycle and allow for transfer in the other direction if power is available from that source.

What is claimed is:

1. In a transfer mechanism for transferring a load between first and second power supplies, first and second switch mechanisms respectively operable, a second switch mechanism means for synchronously actuating said first and second switch mechanisms each comprising a unidirectional motor with limit switch means adapted to deenergize said motor on rotation of its shaft over a preselected arc of rotation and after a time interval during which the bistable conditions of said switch mechanisms may be changed.

2. A transfer switch mechanism means for synchronously actuating said first and second switch mechanisms provided.

3. A mechanism as set forth in claim 6 wherein three pairs of switch mechanisms are provided and said pairs are symmetrically arranged with respect to said actuating means.

4. A transfer switch mechanism means having a first contact arm and said second switch mechanism having a second contact arm, a tie rod pivotably interconnected with said first and second contact arms for normally maintaining said arms in an asymmetrical bistable condition, and, said means for synchronously actuating said first and second spring means to said selected positions at a first rate of speed which is slower than the rate at which said spring means changes said conditions beyond said selected positions.

5. A transfer switch mechanism for transferring a load from a first to a second power supply comprising, first and second switch mechanisms each having bistable conditions with first and second spring means for preloading said mechanisms without changing said conditions and for contacting to change said conditions on continued loading beyond selected positions, a rigid tie rod pivotably interconnected with said first and second switch mechanisms for normally maintaining said mechanisms in asymmetrical bistable conditions, means for synchronously actuating said first and second spring means comprising a unidirectional motor with limit switch means adapted to deenergize said motor on rotation of its shaft over a preselected arc of rotation and after a time interval during which the bistable conditions of said switch mechanisms may be changed.

6. A mechanism as set forth in claim 6 wherein three pairs of switch mechanisms are provided and said pairs are symmetrically arranged with respect to said actuating means.
switch mechanisms and said tie rod is connected to one end pair of said switch mechanisms.

8. A mechanism as set forth in claim 7 wherein a second tie rod is connected at its end to the other end pair of said switch mechanisms whereby said rods are symmetrically and parallelly arranged in respect to said connecting rods.

9. A transfer switch mechanism in accordance with claim 5 and further comprising an electrical circuit with limit switch means for de-energizing said motor means on rotation of its shaft over a preselected arc of rotation after a time interval during which the bistable conditions of said switch mechanism are changed.

10. A transfer switch mechanism in accordance with claim 9 wherein said electrical circuit comprises means for sensing a partial failure of said first power supply and for simultaneously actuating said motor means to transfer from a first bistable condition to a second bistable condition and for sensing reestablishment of said first power supply to actuate said motor means to return said switch mechanisms to said one bistable condition.

11. A transfer switch mechanism in accordance with claim 10 wherein said electrical circuit further comprises means for preventing said mechanism from assuming an electrically neutral position.

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