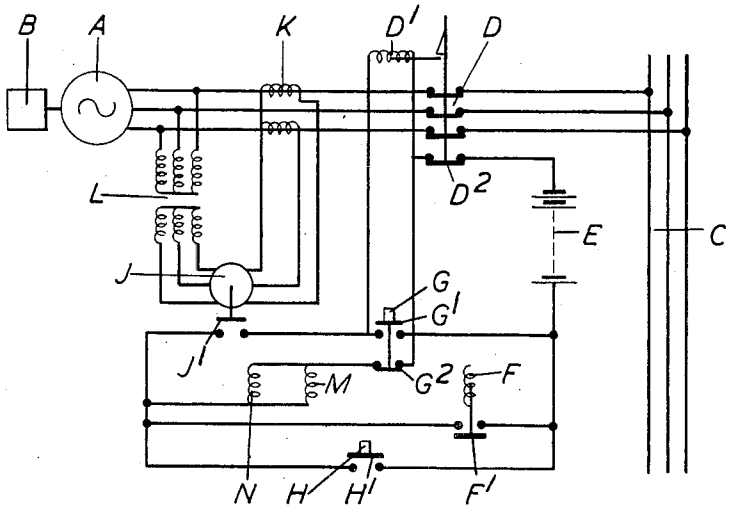
Nov. 10, 1964 B. WOOD 3,156,848

PROTECTIVE ARRANGEMENTS FOR PRIME MOVERS COUPLED TO ELECTRIC GENERATORS

Filed Oct. 2, 1959




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United States Patent Office 3,156,848 Patented Nov. 10, 1964



3,156,848

# PROTECTIVE ARRANGEMENTS FOR PRIME MOVERS COUPLED TO ELECTRIC GENERATORS

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Filed Oct. 2, 1959, Ser. No. 844,006
Claims priority, application Great Britain, Oct. 6, 1958, 31,805/58
2 Claims. (Cl. 317—19)

This invention relates to a protective arrangement for a prime mover, such for example as a steam or gas or hydraulic turbine or a reciprocating steam or internal combustion engine, driving an electric generator.

It is known to provide a mechanical shut-down knob, which is operated by hand in emergency (or otherwise) to cut off the supply of operating fluid or fuel to the prime mover. Thus, in the case of a steam turbine, it is customary to provide for the control of the steam supply a governor valve, often operated hydraulically from the governor, and usually also an emergency valve, which is normally latched in the open position, for example hydraulically, and in such case the mechanical shut-down knob may conveniently act to unlatch the emergency valve, for example by releasing the hydraulic pressure, and thereby to effect rapid closing of such valve, and at the same time to cause rapid closing of the governor valve by releasing the hydraulic pressure.

It is also known to provide a manually-operated electrical trip button to open the main electric circuit-breaker controlling the connection from the generator to the network or other electrical load. It is customary to arrange for such trip button also to cause the supply of operating fluid or fuel to the prime mover to be cut off, for example by combining together the electrical trip button and the mechanical shut-down knob.

It is also usual to provide an electric protective arrangement operative to trip the main circuit-breaker in the event of abnormal or faulty conditions arising in the generator or in the associated prime mover or in any auxiliary equipment provided or in the electrical load network. It has been found, however, that the governor valve and the emergency valve, as also other valves controlling the supply of operating fluid or fuel to the prime mover sometimes fail to close, when they are intended to close, and in such case the opening of the main circuit breaker without first ascertaining that the generator is not furnishing power may give rise to dangerous overspeeding and may thus be the cause of destructive accidents.

The present invention has for its object to provide an improved protective arrangement for the prime mover, whereby risk of such dangerous overspeeding is eliminated or minimized.

In the protective arrangement according to the present invention, a blocking contact is provided in an electrical circuit, through which trippling control means controls the tripping of the main circuit-breaker, such blocking contact normally acting to prevent the tripping control means from causing the circuit-breaker to be tripped, and a sensitive wattmetric relay responsive to the conditions in the connection between the generator and the load acts, when the power supply from the generator to the load has fallen below a predetermined value or has reversed, to operate the blocking contact and thereby to permit the circuit-breaker to be tripped by operation of the tripping control means. This arrangement ensures that the circuit-breaker will not be tripped, following operation of the tripping control means, so long as the generator is supplying significant power to the load.

Means are preferably provided for giving an alarm when tripping of the circuit-breaker has been initiated by the tripping control means but is prevented by the blocking contact.



The invention may be carried into practice in various ways, but the accompanying drawing illustrates by way of example a preferred practical protective arrangement according thereto.

In this arrangement an A.C. generator A is driven by a prime mover B, which may consist for example of a steam turbine provided in the well-known manner with a valve, operated through a hydraulic column by a governor responsive to the generator speed, for regulating the steam supply to the turbine, and with an emergency valve, which is normally latched in the open position by hydraulic pressure and whose function is to cut off the steam supply to the turbine in the event of over-speeding, and also with a hand-operated isolating valve, which provides an additional hand control of the steam supply, for use when required. A mechanical shut-down knob is often provided, which can be operated by hand in emergency to cause, by releasing the hydraulic pressure, rapid closing of the governor valve or the emergency valve or both. During operation of the turbine over long periods of time, however, these valves are apt to stick on occasions and thereby to fail to cut off the steam supply when called upon. Such failures may arise from various causes, including for example jamming of the valves by foreign matter or corrosion of or chemical deposit on the valve surfaces.

The generator A is connected to a three-phase electrical network C, or other load circuit, which it is to supply, through a main circuit-breaker D, shown in the closed position. The circuit-breaker D is provided in the usual manner with a trip coil $D^1$ energised from an auxiliary source of power, such for example as a battery E, which is connected to the trip coil $D^1$ through an auxiliary contact $D^2$ on the circuit-breaker. The contact $D^2$ is closed when the circuit-breaker is closed. The tripping of the circuit-breaker is controlled in the well-known manner by electric protective arrangements which are operative automatically and may be arranged in various ways in accordance with the circumstances of the particular installation to respond to any of a variety of abnormal conditions or faults in the generator A or in the steam turbine B or in associated equipment or in the load network C. Such protective arrangements, which may cause energisation of the trip coil $D^1$ either directly or through an auxiliary contactor, are not shown in detail in the drawing for the sake of clearness, but are represented diagrammatically by a relay F, whose contact $F^1$ directly controls the energizing circuit of the trip coil $D^1$.

The usual hand-controls are provided for closing and tripping the circuit-breaker D during normal operation, the tripping hand control being indicated at G. The contact $G^1$ of this tripping hand control G directly controls the energisation of the trip coil $D^1$ from the source E. In addition, a further hand-operated trip button H is provided, for emergency use, the contact $H^1$ of this trip button likewise controlling the energisation of the trip coil $D^1$. Such emergency trip button H may, if desired, be combined with the above-mentioned emergency shut-down knob controlling the steam supply to the turbine B, for simultaneous operation, or may be independent thereof.

With such known arrangement, it is important to ensure that the circuit-breaker D is not tripped when the steam supply valves to the turbine B are wide open (except deliberately for the purpose of testing, with suitable precautions), for this can give rise to dangerous overspeeding, with disastrous effects, if it should happen that the steam supply valves fail to close. The arrangement

according to the invention, now to be described, effectively eliminates this risk, by ensuring that the circuit-breaker cannot be tripped, unless the steam supply valves are in fact closed or nearly closed, thereby making it safe to trip the circuit-breaker.

For this purpose, a blocking contact is provided in series in the circuit, through which the protective relay F and the emergency trip button H control the energisation of the trip coil D. This blocking contact is closed only when it is safe to trip the circuit-breaker, and for this purpose is constituted by the contact $J^1$ of a sensitive wattmetric relay J, energised in any of the well-known ways in accordance with the current and voltage conditions on the connection between the generator A and the network C, for example (as shown) on the current side from current transformers K on two of the phases and on the voltage side from a three-phase voltage transformer L. The relay J is set to close its contact $J^1$ when the power flowing out from the generator A to the network C has fallen below a predetermined small value, or when the power reverses so that it is flowing into the generator from the network.

It will be noticed that in cases when, owing to incorrect operation or to failure of the valves to close, the circumstances are such that it would not be safe to trip the circuit-breaker D, the tripping of the circuit-breaker is temporarily prevented after the tripping operation has been initiated by operation of the emergency knob H or of the protective relay F. Whilst in general any delay in tripping after operation, say, of a protective relay is undesirable, it is believed that the risks run from such delay are much less than those which can arise from overspeeding. It should of course be made clear that the load will ordinarily fall off substantially instantaneously (and thus cause the blocking contact $J^1$ to close) following operation of the shut-down knob, so that the increase in time delay will usually be insignificant. It is, however, desirable to provide an alarm device operated by an alarm relay M, which is connected in parallel with the trip coil $D^1$ except that it is not controlled by the blocking contact $J^1$. Thus, the alarm will be given in all cases, in which the tripping of the circuit-breaker has been initiated but is delayed by the blocking contact $J^1$, and is arranged to continue until it has been attended to by manual shutting off of the steam supply to the turbine B.

Whilst it would be possible for the blocking contact $J^1$ also to control a tripping operation initiated under normal operating conditions by the tripping hand control G, this will not usually be desired and, as shown in the drawing, this hand control G controls the energisation of the trip coil $D^1$ independently of the blocking contact $J^1$. This hand control is also provided with a further contact $G^2$, which is normally closed and is in series with the alarm relay M, so that the alarm circuit is broken when the hand control G is operated to trip the circuit-breaker.

If desired, a further coil or relay N may be provided in parallel with the alarm relay M, this further relay N, when energised, acting to release the hydraulic pressure latching the emergency valve and the governor valve, thus making it possible for such valves to close independently of their



controlling devices. This unlatching coil N is also in circuit with the contact $G^2$ of the tripping hand control G, so that it will not be energised when such hand control G is operated.

It has been mentioned above that the electric protective arrangements for the network and generator may act on the trip coil D through an auxiliary contactor, instead of directly. In such case, if the emergency trip button H also acts through such contactor, the blocking contact $J^1$ may be in series either with the coil of the auxiliary contactor or with the trip coil circuit controlled by the auxiliary contactor, but if the emergency trip button H acts directly on the trip coil circuit and not through the auxiliary contactor, the blocking contact $J^1$ must be in the trip coil circuit.

It will be appreciated that the foregoing arrangement has been described by way of example and may be modified in various ways within the scope of the invention. Thus, the arrangement is not limited to use with a steam turbine as prime mover and is applicable also (with any necessary modifications) when other forms of prime mover are used, such for example as gas turbines or hydraulic turbines or reciprocating steam engines or internal combustion engines. Further, although described with reference to A.C. generators, it will be clear that the arrangement is equally applicable to D.C. generators.

What I claim as my invention and desire to secure by Letters Patent is:

1. A protective arrangement for a prime mover driving an electrical generator for supplying an electrical load through a main circuit-breaker, comprising an electrical circuit controlling the tripping of the main circuit-breaker, tripping control means acting when operated to control such circuit and thereby to effect tripping of the circuit-breaker, and means exercising an over-riding control for preventing the tripping control means from effecting tripping of the circuit-breaker whenever the generator is supplying substantial power through the circuit-breaker to the load, such over-riding control means including a blocking contact in the said electrical circuit normally rendering such circuit inoperative thereby to prevent tripping of the circuit-breaker, and a sensitive wattmetrical relay responsive to the power supply conditions in the electrical connection from the generator to the load and acting, when the power supply from the generator to the load has fallen below a predetermined small valve, to release the blocking contact and thereby to permit the tripping control means to effect tripping of the circuit-breaker.

2. A protective arrangement as claimed in claim 1, including means for giving an alarm when tripping of the main circuit-breaker has been initiated by the tripping control means but is prevented by the blocking contact.


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