REMOTE CONTROL OF STANDBY ENGINE GENERATOR SETS OVER A MICROWAVE SYSTEM

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Experience in actual operation of microwave relay systems throughout the country has shown that involuntary outages have been caused principally by failure of the input power to the microwave equipment. Where substantially continuous service is required of the microwave system the common practice is to have emergency standby power available. This emergency power is supplied by an emergency generator set at the microwave station site. Failure of the normal input power supply initiates starting the engine generator set to supply a particular microwave station with power. This paper describes the units used to improve reliability of engine generators in microwave applications.

Combustion engines have been developed to the point where they are dependable with one important exception. For various reasons, after long periods of idleness, the engine does not start readily. Gasoline engines do not start easily because of evaporation, gumming, and loss of volatility of the fuel. The lubricating oil congeals and the ignition system absorbs moisture and becomes leaky electrically during long periods of idleness. Also, over extended periods of non-operation, gasoline engines are plagued with acid action due to chemical combination of the fuel, combustion products and condensed water.

Diesel engines suffer from loss of fuel due to leakage in the fuel distributor and injectors during periods of idleness. Low temperature is perhaps one of the most serious conditions affecting the starting of diesels.

Liquid petroleum engines on the other hand are not affected seriously by changes in the condition of the fuel due to idleness, but, like the gasoline engine, they have an electrical ignition system and are thus subject to the moisture problem.

To insure greater reliability of the microwave system the answer to the above problems arising out of non-continuous operation of the engine generator sets is to periodically start the engine as a preventive maintenance procedure. It may be determined by experiment how often an engine must be started and how long it must be run to condition it properly for reliability of starting under emergency conditions. At a particular location, such factors as temperature, altitude, and humidity affect the intervals of time allowable between test runs. Under normal conditions, starting and operating the engine generator for twenty minutes every two weeks is sufficient to insure its reliability when needed by the microwave system. Conditions at a particular geographical location may require that the interval between test runs be less than two weeks. Allowing the engine to run twenty minutes each time it is started is considered sufficient to condition the engine for an emergency start or another test start within the specified time.

At isolated microwave stations test starting and operation of engine generators becomes a costly maintenance procedure if done manually on the site by operating personnel. On an extensive microwave system it is possible that the services of one man might be required full time to test run the engine generators in the system. To eliminate this fixed cost and to provide the system dispatcher with a convenient means of remotely starting the engine generators, a control scheme as shown in Fig. 1 was developed. Operating personnel at attended point T have control over engine generators at unattended points R_1, R_2, etc. The engine generator at R_1 or R_2 may be started at will any time from T by selecting the engine with a selector switch and pushing a start button. More than one engine generator may be tested simultaneously.

The microwave alarm system is arranged to report back to point T within one minute after engine generator is operating. Each fifteen minute interval thereafter a report is received at point T on the alarm system indicating operation of the engine generator. An automatic timer at the engine-generator location shuts down the engine after a predetermined running time. The final report of the alarm system indicates that the engine has been shut down.

The transfer circuits at R_1 and R_2 are arranged so that the engine generator actually takes over the microwave equipment load on a test run after the engine generator set has come up to proper operating speed. Synchronizing the engine generator with the 60 cycle line frequency is eliminated by using a DPDT relay. Under this arrangement power to the microwave equipment is momentarily interrupted during the transfer time of the relay. In practice this power interruption is not serious where 100 per cent continuous service is not required.

A simplified diagram of the engine generator control scheme is shown in Fig. 2. At controlling station T a tone transmitter is keyed according to a time division code. The 1 rpm motor which drives a set of connected brushes around a printed circuit commutator is normally at rest with the brushes located as shown in Fig. 2. The engine selector switch is turned to the desired position and the start switch is depressed. The 1 rpm timing motor locks itself in to turn 1 revolution and then stops. The driven brush rig first contacts a synchronizing segment to transmit an initial tone which starts the 1 rpm timer motors at all engine control receivers. The brushes at all receivers and at the transmitter travel around the commutator in phase contacting each segment in turn. The engine to be started is selected by the second transmitted tone during the sequence as determined by the position of the selector switch. A third transmitted tone actuates a relay at the engine control receiver to start the engine.

All receivers are tuned to a common frequency which is the output frequency of the tone transmitter. Each receiver has its code lead wired to a particular segment of the printed circuit commutator.

The keyer relay in the receiver operates each time a tone signal is received. The circuit to the code signal relays is completed through the keyer relay contacts and through the brushes to a particular segment. If the tone is received on the segment to which the code signal relays are wired, a circuit is set up to cause starting of the engine generator when keyer relay closes on segment 11. Thus a particular receiver responds to its code and all other receivers are excluded. The final relay at the output of the selected receiver controls the starting sequence of the particular engine generator.

It can be seen from Fig. 2 that a maximum of ten engine generators can be selected and started using this simple system. This effectively serves the system for which it was designed.

The maximum of eleven segments is a physical limitation and not an arbitrary one. Considering that some tolerance must be included in the angular velocity of the two independently supplied synchronous motors the segments and spaces between segments on the commutator are made progressively longer. If a 5 per cent power frequency deviation is allowed between transmitter and receiver, the maximum number of segments possible around the commutator is eleven. The number of segments may be increased if constant speed motors are used.

Worthy of note is the fact that the alarm system, used to report operation of the engine generator and other off normal functions to an attended point, is essentially the same device as the remote control units. The alarm system uses the same oscillator and transmitter, the same receiver and printed circuit commutator as the remote control system. The two circuits differ only in relay configuration which in turn is determined by the function the device is designed to perform. Considered together, the control function and reporting function constitute a loop circuit. This loop circuit concept is fundamental where an operation is performed from some remote point and where, simultaneously, a positive indication must be received at the originating point that the operation has actually taken place. The system described is readily adaptable to control and "answer back" applications.

The remote control of engine generators in microwave systems described above is but one specific use of many possible applications for this type of circuit.

For example, telemetering a number of quantities over one channel is possible by use of this time division selector method. Where non-continuous indicating or recording is practicable the telemetered quantities could be transmitted through this time-divided system and be read or recorded at the receiving point one at a time. Common or separate indicators would be used depending on the type of service required.

A minimum of telemetering equipment is necessary in that one only physical telemetering transmitter-receiver-indicator system can be utilized for a number of similar measurements at one location. In this application one commutator would be located between the input sources and the one telemeter transmitter and the other commutator would be located between the telemeter receiver output and the indicating or recording device. Rotating velocity of the brushes would be governed by the ballistics of the indicators or recorders at the receiving end.

Another example of possible future use of this type of selector device is its application to supervisory control functions. Although the above engine-generator control application is essentially a simplified supervisory control system, the device is capable of further expansion. By using a binary code system it is evident that the system could be arranged to provide a number of control functions at any one of a number of different locations. Interrogation of faults at remote points is still another application of the system. This latter use has already reached the design stage.

Where channel space is crowded, and where numerous control functions must be provided at low cost, the above described time division scheme offers a simple and effective solution.

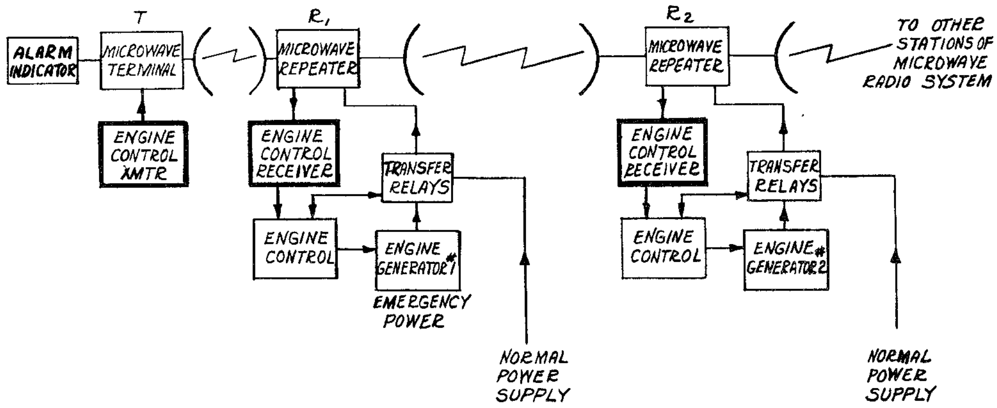

Fig. 1 - Block diagram of typical system using remote engine generator control. Units described in this paper shown in heavy outline.

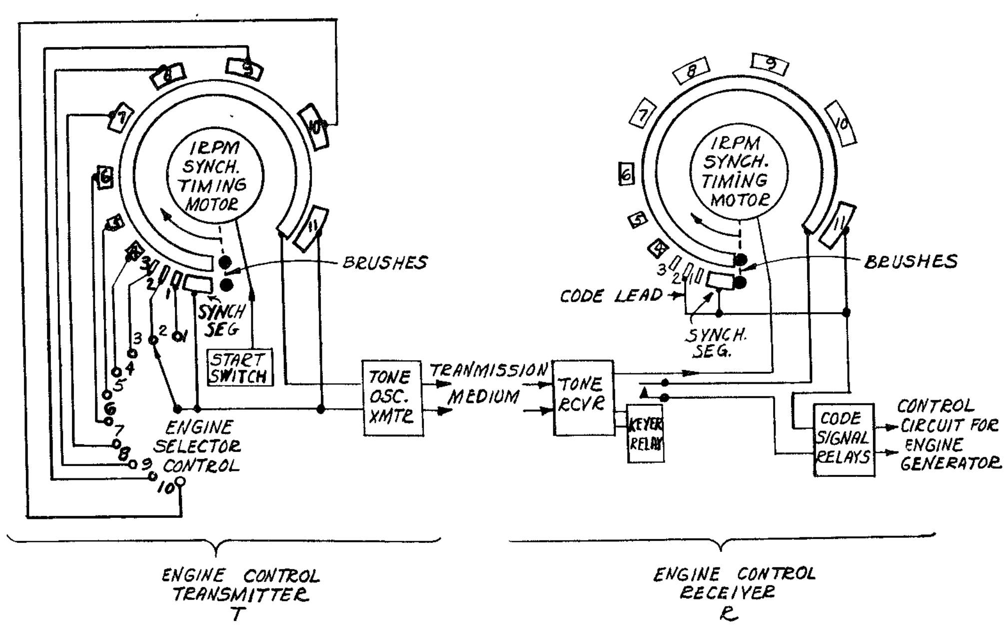

Fig. 2 - Simplified diagram of engine generator remote control scheme.