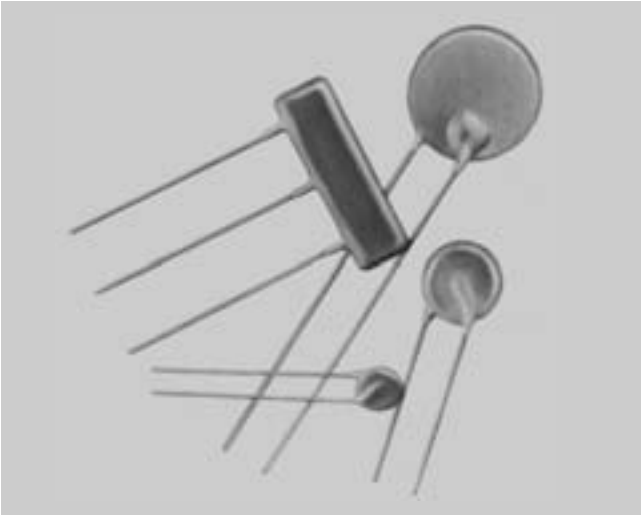
Publication Number IS 402 Republished October 2003

Information Sheet for Pyro E MI Wiring Cables - Surge Generation and Control

It is common knowledge that inductive circuits can produce surge voltages greatly exceeding the line voltage when the current flowing in them is suddenly interrupted and that under adverse conditions these surges can be sufficient to cause a breakdown in various circuit components. This phenomenon is recognised in the 16th Edition of the IEE Wiring Regulations BS 7671 and it is the designers'/installers' responsibility to ensure compatibility - See section 331-01 of the Regulations. When such circuits are wired with, say PVC cable, the cable has normally sufficient reserve of voltage withstand to ensure that damage falls first on other components in the system. Thus, unexplained breakdowns in such components as electric motors, chokes, resistors, transformers, switches and contactors are by no means unknown, although it is common to attribute them vaguely to overloading or to accept them without explanation.

The factors influencing the generation of surges of a dangerous magnitude are many and complex; the point in the current cycle at which switching occurs, the exact moment of separation of the contact points and the presence of stray damping and other losses in the circuit are but a few of the contributory factors. Thus, many pieces of equipment which are theoretically capable of producing troublesome surges do so in practice only very occasionally. Exhaustive tests have shown that a representative sample of switching operations must consist of at least several thousand cycles to obtain truly meaningful results. For this reason many pieces of equipment which are potentially capable of causing trouble will actually run for many years, possibly the entire life of the installation, without encountering the conditions which could cause failure.

The installation most likely to give trouble are those which are most frequently switched. Examples are air-conditioning installations, refrigeration systems and others where equipment is cycled every few minutes. Some circuits, controlled for example by thermostats, may, through 'chatter', switch very frequently indeed. In such installations a considerable number of switching cycles may occur over a period of a few months, more than might occur in the whole lifetime of many other installations.



When MI cable is used it may sometimes happen, although this is not necessarily always the case, that the cable itself is the circuit component with the lowest surge voltage withstand. In such cases a cable failure may result and, although data which has been collected as a routine over the years shows that such failures are rare, however, each incident causes annoyance and inconvenience to the user.

The best cure would be to suppress voltage surges at source and it seems likely that public influences and regulations will move progressively in this direction. Some manufacturers of equipment are reluctant to incur the very small additional cost in time and money of including the necessary suppressors in their equipment and prefer to take no action in the matter, leaving all other circuit components to take their chance with surges which may amount in many kilovolts. To use high-voltage cable for every metre of adequate insulation against such excess voltages would be an impractical and unrealistic way out of the problem. Hence in the present state of affairs it is left to the user, often without proper guidance, to take the appropriate action.

Pyro E cables offer the safest, most durable and neatest wiring cable system yet devised, and these cables, together with other more expensive circuit components, can be simply and inexpensively protected from surges by the use of standard surge suppressors.

MAIN SOURCES OF TROUBLE

Long experience has shown that trouble arises primarily from certain well defined types of equipment. These are:-

1 3-Phase Motors

Advancing technology in motor design, the use of higher flux densities leading to smaller physical size and trends towards standardisation of manufacture have posed new problems in relation to surges. Experience indicates that single phase, delta connected 3-phase or star-connected motors above 3hp can be left out of consideration as generators of dangerous surges. However, star-connected motors of smaller sizes (particularly in the fractional horse power range) may easily give rise to switching surges of dangerous magnitude. Note that in this context it is unsafe to consider only the switch-off operation, as even when the circuit is ostensibly being switched on, a momentary switch-off may occur due to contact bounce.

As an example the graph below shows the typical frequency of surges of various magnitudes produced by a 3-phase, 415v, 1hp star-connected motor before and after the fitting of a simple surge suppressor.

After a suppressor was fitted, no surge above 1,100v was recorded, a level well within the withstand capability of all the circuit components including the MI cable. Surge suppressors are therefore a reliable way of overcoming the problem.

2 Contactors

The hold-on coil in a contactor is a likely source of voltage surges. This is particularly the case where remote switching is employed and in such cases it is the remote control cable which is exposed to the risk. On a 3-phase circuits the coil is often connected between phases and a suppressor rated at 415volts is required.

3 Fluorescent Lamp Ballast Units

In practice, very few instances of breakdown of MI cable in fluorescent light circuits have been recorded, certainly not enough to make it necessary to recommend that surge suppressors should always be fitted.

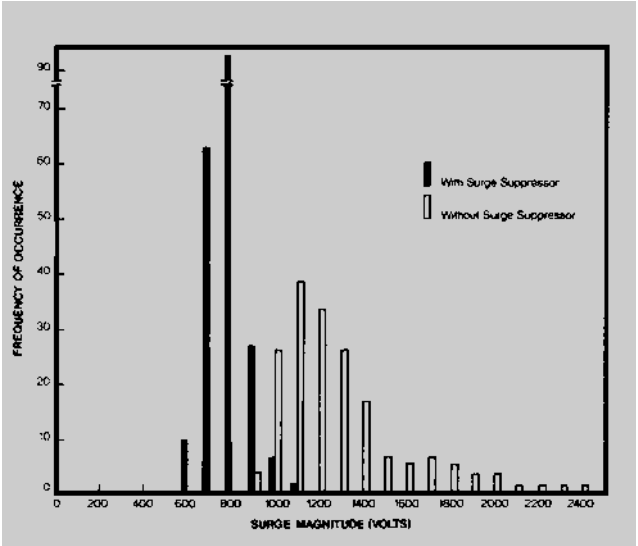
The choke, which is a component of almost all fluorescent light ballast units, can produce high voltage surges. In many fittings these are absorbed by the parallel-connected power factor correction capacitors and no surge suppressors are required. However, certain types, including some double lamp fittings, do not incorporate a power factor correction capacitor and there appears to be an increasing use of a series-connected capacitor in the control circuit. In other installations a single bank of power factor correction capacitors is used in conjunction with a number of remotely situated fluorescent lighting fittings.

In the types of fittings which do not incorporate a power factor correction capacitor, or have the capacitor connected in series, the voltage surges generated within the striking circuits are not necessarily confined to the fittings. They may be of such a magnitude as to cause an insulation breakdown or a flash-over in the external switch gear. The switch gap itself is very often the minimum path across which an arc dissipates the surge. Hence the type of switch used can influence the level of the surge produced.

On the type of installation in which the control gear (the choke, starter etc.) is situated remote from the associated discharge lamp it is not possible to give protection to the connecting cable and accessories and it is therefore essential that the cables and accessories in this part of the circuit be chosen for their ability to withstand the high striking voltages necessary for lamp ignition.

In recent years a number of low energy lamps have been introduced. These are small diameter fluorescent tubes and are usually bent into a 'U', 'Double D' or 'Double U' making very compact units frequently used as a direct replacement for tungsten lamps.

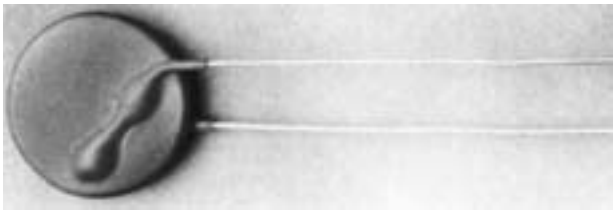
Most of these low energy lamps **do not** incorporate a power factor correction capacitor and when switched, can generate high transient voltages in the same way as those types of conventional fluorescent fitting which are not fitted with parallel- connected capacitors.



THREE STANDARD SUPPRESSORS ARE AVAILABLE

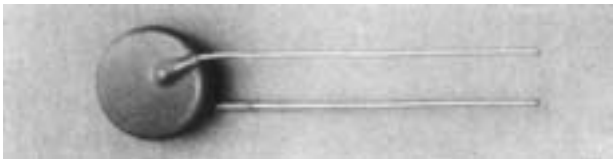
ORDER REF RRN1

A heavy duty single phase suppressor consisting of a single voltage dependent resistor, three of which can be used star-connected for motors up to 6hp. These suppressors are suitable for use up to 250 volts. The star point should be earthed.



ORDER REF RRN2 AND RRN4

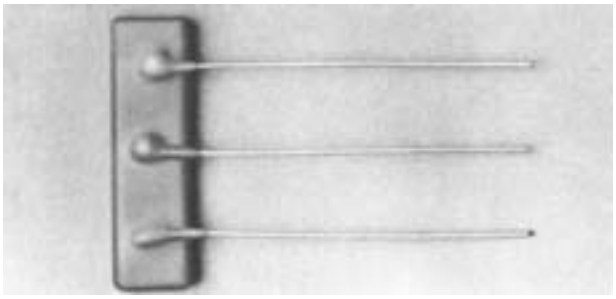
These are both 2 wire suppressors consisting of a single voltage dependent resistor.
The RRN2 is suitable for use up to 415 volts to suppress the surges generated by contactor coils and should be connected across the coil terminals.
The RRN4 is suitable for use up to 240 volts to suppress the surges generated by fluorescent fittings including 'low energy' lamps. It should be connected directly across the input terminals of the lamp control gear.



ORDER REF RRN3

A three-phase suppressor, consisting of an array of voltage dependent resistors, particularly for use with fractional horsepower star connected motors. The three tails should be connected one to each phase (if possible at the motor terminals).

This suppressor is suitable for motors up to and including 1hp, on 415 volts-nominal.



The type of suppressors listed and illustrated are available from Tyco Thermal Controls UK Limited. If the type of installation is different to one of the above categories further information can be obtained from our Washington address.

OPERATING CONDITIONS

The maximum and minimum temperature limits of these devices are 85^{o}C and -20^{o}C respectively. Their rating is based on an ambient temperature of 20^{o}C but is not significantly affected by ambient variations in the range -29^{o}C to +40^{o}C.
For ambient temperatures outside the above range please contact our Washington address.

RECOMMENDATIONS

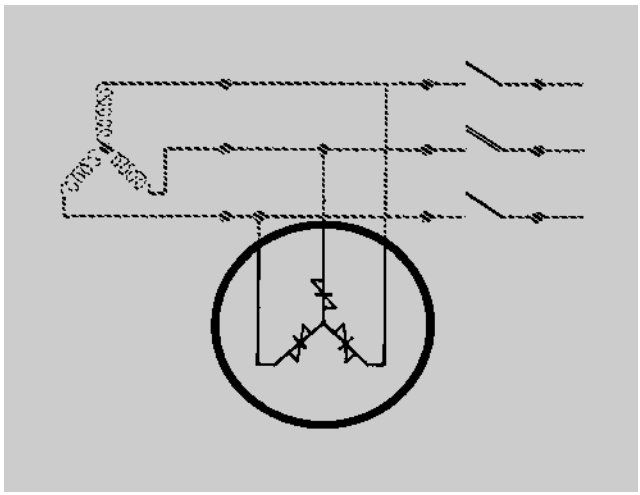
1. Initial Installation

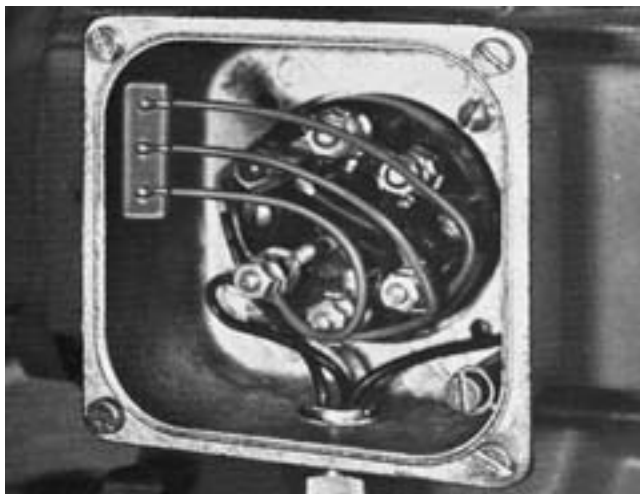
Perhaps the most widespread misconception regarding surge suppression is that it is an expensive additional operation. On the contrary, in the areas that have been highlighted, a small outlay in time and material is sufficient to give that essential factor of safety, not only to the cable, but to the electrical installation as a whole.

2. Existing Installation

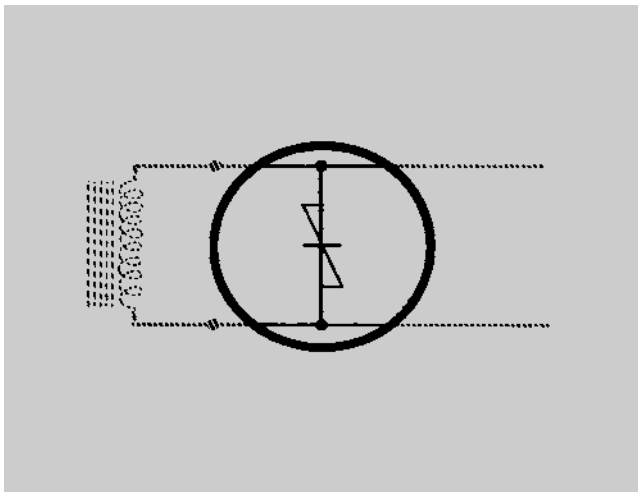
Mineral insulated cable has the unique ability to recover from a flashover. Some rare cases have occurred when numerous surge strikes on the same cable have reduced the insulation's withstand against overvoltage and resulted in fuse failure. Under normal operating conditions the cable still continues to work satisfactorily, but it may be desirable to fit one of the above suppressors to protect the cable against further surge voltages.

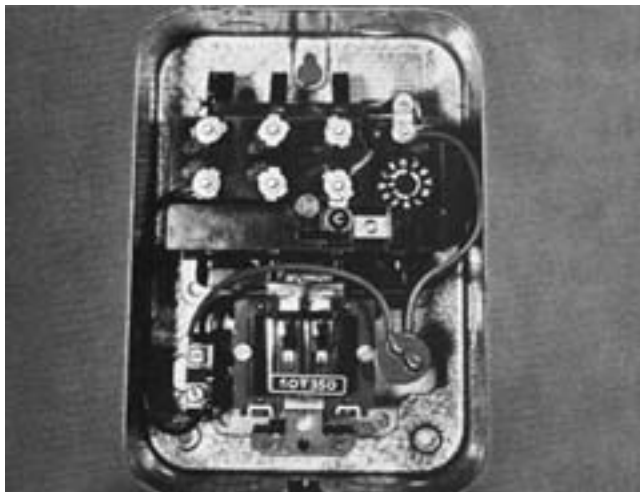
Before fitting the suppressor, the condition of the cable should be ascertained by testing the insulation resistance at 500 volts and 1000 volts and comparing the two readings. A much lower reading at 1000 volts will indicate that the voltage withstand of the cable has been permanently reduced and that it cannot be protected from further voltage surges by one of the above suppressors.



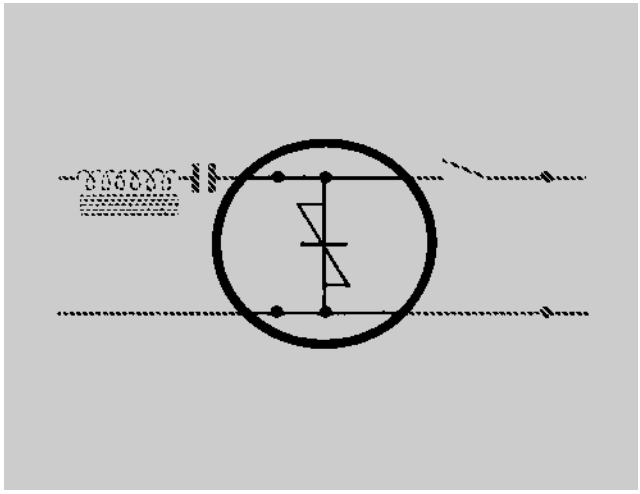


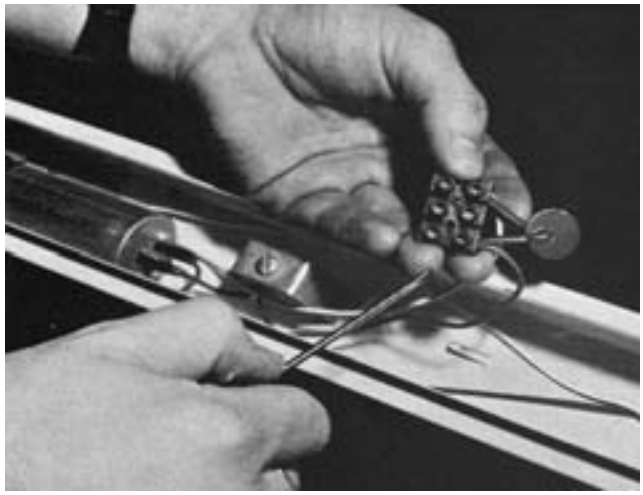
THREE PHASE STAR-CONNECTED SURGE SUPPRESSOR CONNECTED INTO A MOTOR TERMINAL CONNECTING BOX.





SINGE PHASE SURGE SUPPRESSOR CONNECTED ACROSS CONTACTOR COIL TERMINALS.





SINGLE PHASE SURGE SUPPRESSOR CONNECTED ACROSS THE SUPPLY TERMINALS OF A FLUORESCENT LIGHTING FITTING.

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Publication Number IS 402
Republished October 2003

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