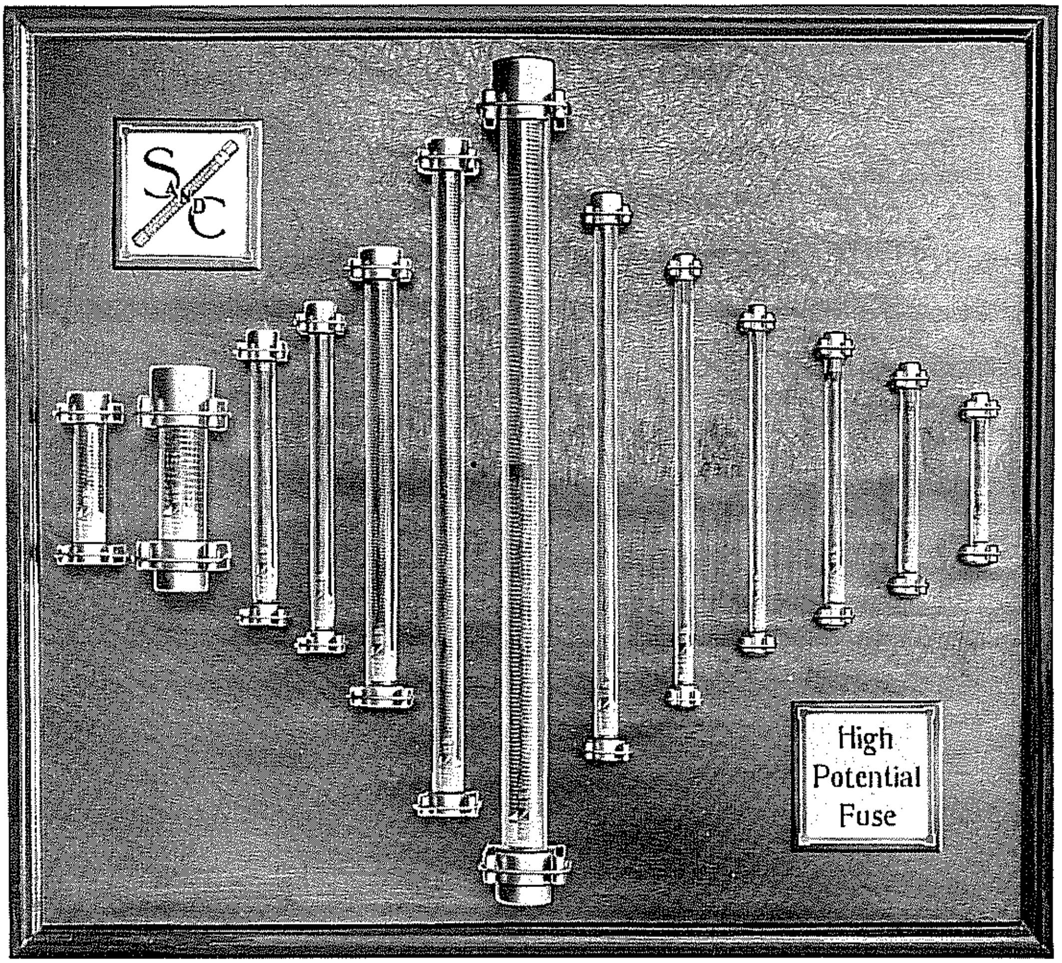
The S&C HIGH POTENTIAL FUSE

SCHWEITZER S&C CONRAD INC.



The S & C Fuse

2,200 to 132,000 Volts

½ to 400 Amperes

The Standard of High Voltage Fuse Protection not only in the United States but all over The World.

SCHWEITZER & CONRAD, INC.
4435 RAVENSWOOD AVENUE CHICAGO, ILLINOIS U.S.A.

Bulletin 200A

The S&C Fuse

And Its Relation to Electric Power Systems

Electric Power Systems

The extension and interconnection of high voltage power systems have contributed largely to national prosperity by making available an abundance of electricity for power, lighting, and heating purposes in all communities, even those situated great distances from generating stations.

These interconnections have effected considerable savings in generation and distribution costs, by obtaining the advantages accruing from diversity of loads and making possible the construction of large and efficient generating stations at locations where electric production costs are a minimum.

A Problem in the Transmission and Distribution of Power

Continuous, uninterrupted service on these transmission and distribution systems is, however, more difficult to maintain because the failure of any transformer will cause a service interruption to other parts of the system unless means are provided for the rapid and effective isolation of the defective transformer.

A transformer failure may result from an overload, a short circuit, or a voltage surge, and its rapid and effective isolation necessitates the application of protective equipment which will successfully interrupt both overload and short-circuit currents.

The Disconnecting of Defective Equipment

The automatic isolation of defective equipment is accomplished either by oil circuit breakers or fuses. Oil circuit breakers, on account of their high initial cost and the large installation space required, are, in numerous cases, not justified from an economic standpoint, and for this reason fuses—and particularly the S & C Fuse—have found an ever-increasing field of usefulness.

High Voltage Arcs

Interrupting a high voltage circuit under load is certain to be accompanied by an arc which must be disposed of in some manner before it reaches destructive proportions.

A brief consideration of the characteristics of a high voltage arc will show the fundamental features which high voltage circuit interrupting equipment must possess in order to clear the circuit during both overload and short circuit conditions.

Fig. 1 shows in graphic form the relation existing between the line voltage, the current, and the arc voltage, during the opening but before the final clearing of a high voltage *non-inductive* circuit.

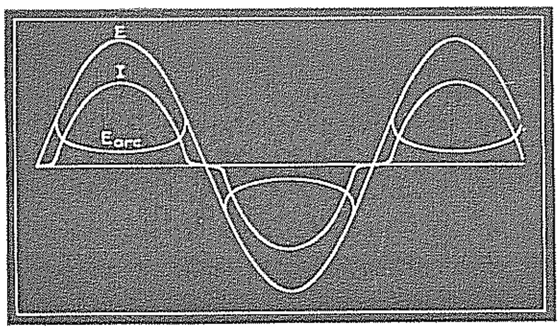


Fig. 1—Non-Inductive Circuit. E-Line Voltage; I-Current; E_{arc}-Arc Voltage

Immediately upon the opening of the circuit, a voltage appears across the gaseous gap (*i. e.* the arc voltage) which is in phase with the current. During the latter portion of each half cycle the arc becomes unstable and its resistance increases rapidly, causing the current to diminish to zero a small interval of time before the line voltage becomes zero. The arc is re-established during the following one-half cycle, as shown in Fig. 1, unless a gap has been established having a flash-over value greater than the highest instantaneous value of the line voltage.

The S&C Fuse

And the Requirements for Interrupting High Voltage Circuits

Fig. 2 shows in graphic form the relation existing between the line voltage, the current, and the arc voltage during the opening but before the final clearing of a high voltage

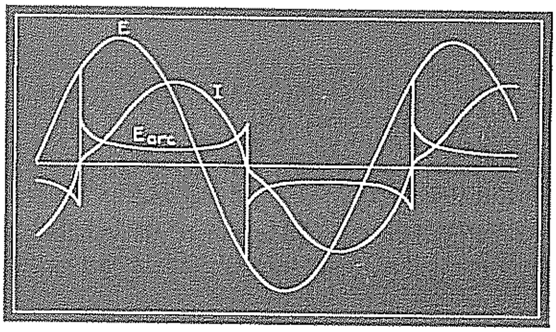


Fig. 2—Inductive Circuit—60° displacement between current and voltage. E-Line Voltage; I-Current; E_{arc}-Arc Voltage

inductive circuit. This graph shows that there is always a voltage available for the instantaneous re-establishment of the arc at the instant the current is zero. The voltage which causes the re-establishment of the arc increases with the inductance in the circuit, and becomes a maximum when a 90° phase displacement exists between the line voltage and the current. *Inductance, therefore, greatly increases the difficulty of interrupting the circuit.*

Fundamental Requirements for the Interruption of a High Voltage Circuit

From Figures 1 and 2 it is evident that a fundamental requirement for the successful interruption of a high voltage circuit is the establishment, at the proper instant, of a positive gap, over which the arc cannot be re-established. It will also be apparent that such a gap must be established in a minimum of time to prevent destruction of the circuit interrupting equipment due to the thermal effect of the arc.

An arc in reality is a conductor, which automatically adjusts its cross section so as to maintain a constant current density. An arc may develop considerable physical proportions during a short-circuit, and this necessitates some reliable means for rapidly quenching the arc. Immediately following the interrupting of a short-circuit in modern systems, the system voltage often reaches several times its normal value due to the sudden release of the stored energy of the system, which phenomenon increases the chances for the failure of the circuit-interrupting equipment.

Methods Employed for Interrupting High Voltage Circuits

Several methods for interrupting high voltage circuits have been applied by manufacturers. In expulsion fuses, for instance, sufficient vaporization of the fuse element must take place to expel conducting vapors and metals from the fuse tube. Other manufacturers place the fuse element in a tube filled with powdered or granular materials and depend upon this material to absorb the vaporized fuse metal, and to extinguish the arc. In the case of an oil circuit breaker or an S & C Fuse, the gap is formed in the circuit by mechanical means which are entirely independent of vapor pressure, and the arc is quenched by drawing it through a dielectric liquid.

Why Some Kinds of Fuses Fail

Experience with the various methods of circuit interruption has shown that the expulsion type of fuse fails when the current is raised to a value which is only sufficient to melt the reduced section of the element, because the melting of this reduced section does not establish a sufficient gap to prevent the re-establishment of the circuit. Both the expulsion and powder-filled fuses fail during heavy short-circuits because of enormous pressures causing destruction of the fuse tube, or because of the ionization of a sufficient quantity of fuse element vapor through which the arc is re-established and maintained.

The S&C Fuse

And the Fundamentals of High Voltage Fuse Design

Requirements for a Successful Fuse

During failure of equipment, the current may vary between the limits of an overload and a short-circuit of considerable magnitude. Also the phase relationship between the current and voltage during equipment failure, and the point on the voltage wave at which the short circuit occurs, will be subject to wide variations. When these self-evident facts are considered together with the conditions outlined in foregoing paragraphs, it will be apparent that the fundamental requirements of a high voltage fuse are:

(1) The fuse element should be of minimum section and length so as to reduce the quantity of ionized vapor to a minimum.

(2) The fuse element vapor must be vented to prevent destruction of the fuse tube.

(3) The arc must be drawn out and quenched, setting up a gap having a flash-over voltage greater than the maximum normal or transient value of the line voltage.

Principles of the S & C Fuse

An examination of the illustration on the opposite page will show that the following features which are so necessary for the interruption of high voltage circuits, have been incorporated in the design of the S & C Fuse.

(1) The fuse element is of minimum section and length, resulting in uniform time-current characteristics and in a minimum of ionized vapor when the fuse is blown.

(2) The fuse element is shielded by the brass ferrule, completely protecting it from corona, which makes possible the manufacture of successful fuses for 2.2 Kv. to 132 Kv. having an ampere rating as low as one-half ampere.

(3) A vent cap is provided for releasing the pressure when the fuse is blown under short-circuit conditions. The entire assembly is enclosed in a glass tube which will withstand a hydraulic test pressure of 1000 lbs. per square inch.

(4) A positive gap is introduced into the circuit by the rapid retraction of the moving arcing terminal through a high dielectric liquid, this gap being formed regardless of whether the fuse element is blown during either overload or short-circuit conditions.

(5) The arc is drawn down through and quenched by a high dielectric arc-extinguishing liquid.

Compared With an Oil Circuit Breaker

In fact, the operation of an S & C Fuse immediately following the melting of the fuse element is similar to the operation of the most expensive oil circuit breakers, but in addition has the following advantages:

(1) The arc is quenched in a liquid which, not only is non-inflammable, but also, is one of the most effective fire extinguishers. The vapors of this liquid will not support combustion nor endanger adjacent equipment.

(2) The moving arcing terminal of an S & C Fuse possesses practically no inertia and under short-circuit conditions clears the circuit in ½ to 1½ cycles, whereas, an oil circuit breaker will require from 6 to 60 cycles to clear the circuit after the trip coil has been energized.

(3) When an S & C Fuse is blown under short-circuit, the replacing of the fuse completes the necessary maintenance, whereas, under similar conditions an oil circuit breaker would require dismantling, inspection of contacts, and probable replacement of oil, resulting in a maintenance expense many times greater than the refill cost of a set of S & C Fuses.

How the S&C Fuse Operates

The Arc Is Quenched

In the interrupting of a circuit, the action of the S & C Fuse is directed at the extinction of the arc before it has had time to gain in volume and therefore become troublesome.

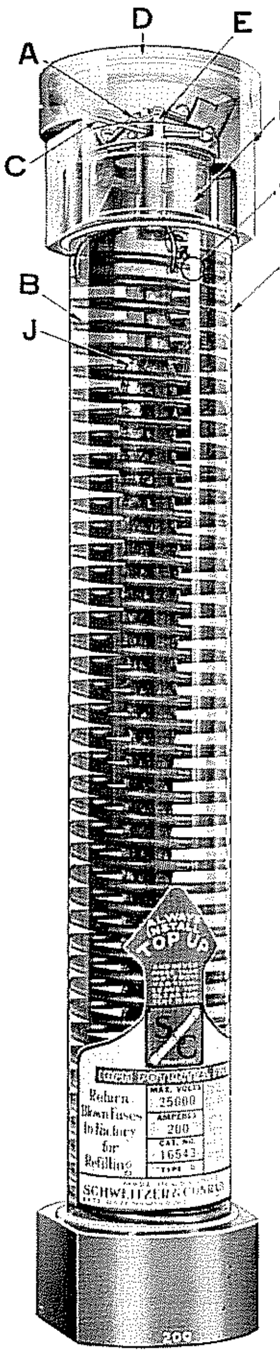


Fig. 3

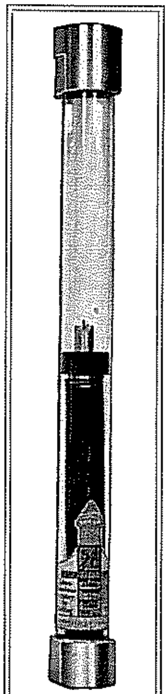


Fig. 4 (After Blowing)

The Principal Parts

A typical S & C Fuse as shown in the phantom, or "X-Ray" illustration, Fig. 3, consists essentially of:

A—Fuse Element—designed to melt at definite current values.
B—Coil Spring—normally extended.
C—Strain Wire of small size and high tensile strength—holding the coil spring extended.
D—Vent Cap—for relieving excess pressure.
E—Moving Terminal—acts as arcing terminal when the fuse blows.
F—Heavy Glass Tube—sealed into brass ferrules.
G—Arc-extinguishing Liquid—filling glass tube.
H—Funnel-shaped Liquid Director or Nozzle—attached to arcing terminal.
J—Flexible Copper Cable—for carrying the current and thus preventing heating of the spring.

Fuse Operation

In a circuit protected by the S & C Fuse, when the current reaches a certain predetermined value, the fuse element (A) melts, shunting the load current to the strain wire (C) and this wire, being of small current carrying capacity, instantly melts and allows the coil spring (B) to contract.

The contracting of the spring accomplishes two very important things. A stream of arc-extinguishing liquid is forced through the liquid director (H) into and around the arc, effectively quenching it. At the same time the circuit is opened wide, setting up a gap, over which the arc will not re-establish.

The entire operation of the S & C Fuse is usually completed in ½ to 1½ cycles.

In most cases, the fuse simply functions in the manner described above. In cases of severe operation, such as a short-circuit on a system of large capacity, the pressure in the fuse tube is released through the safety vent cap (D) provided for that purpose.

Two Types of Construction of the S&C Fuse

Two types of fuse construction, designated as "B" and "D" are manufactured to cover the range of 2,200 to 132,000 volts and ½ to 400 amperes, as listed on pages 14 and 15.

Fuses of type B construction are supplied in the lower current ratings and up to 73,000 volts. Fuses of the type D construction have extra high interrupting capacity and are always supplied in the higher current ratings up to 73,000 volts and all current ratings at higher voltages. Type D Fuses are available also for lower current ratings at the lower voltages in order to provide the extra high interrupting capacity sometimes desirable for those ratings. (See page 11.)

Type B Fuse Construction

The drawing at the right shows the Type B construction of the S&C Fuse. In this type, the fuse element is enclosed in an arc barrier of insulating material.

Type B Fuse Clips

In the Type B construction the ferrules of the fuse are cylindrical and the Type B Clips have a corresponding circular form where they grip the ferrules. A Type B Clip is illustrated below. It is to be noted that the fuse is held under spring pressure from the clip, and this is augmented by pressure from the retaining bale which exerts a squeezing effect upon the clip as the bale is swung into place over, and locked by, a projecting boss.

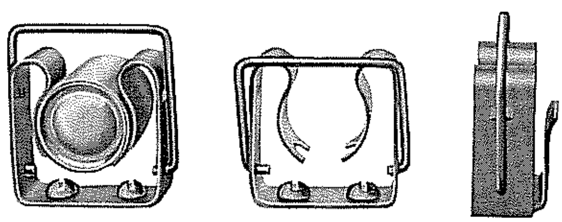


Fig. 5—Type B Fuse Clips

Not only do the S&C Fuse Clips provide ample contact, but in addition they hold the fuse with more than usual firmness. As a result, the contact surfaces are not easily corroded and the fuse will not be thrown out of the clips when it is subjected to the powerful magnetic forces resulting from a short-circuit.

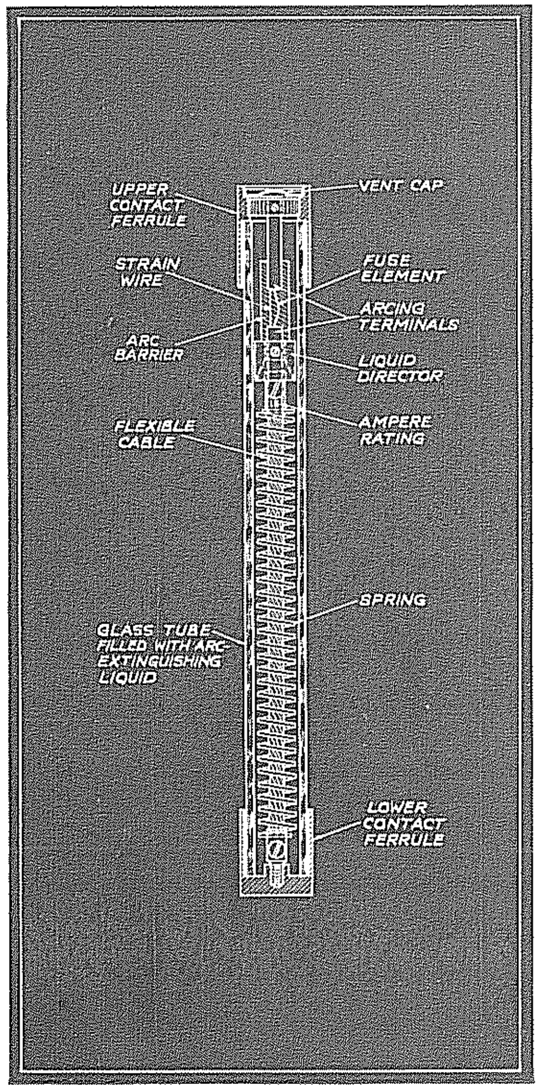


Fig. 6—Type B, S & C Fuse Construction

The S&C Fuse Clips just described are always included on fuse mountings regularly supplied by Schweitzer & Conrad, Inc. When fuse mountings are purchased elsewhere, the genuine S&C Fuse Clips should be specified for use with S&C Fuses.

Two Types of Construction of the S&C Fuse—Cont'd.

Type D Construction

In the Type D Construction, the fuse element is placed in a separate "explosion chamber" at the upper end of the fuse and above the level of the liquid.

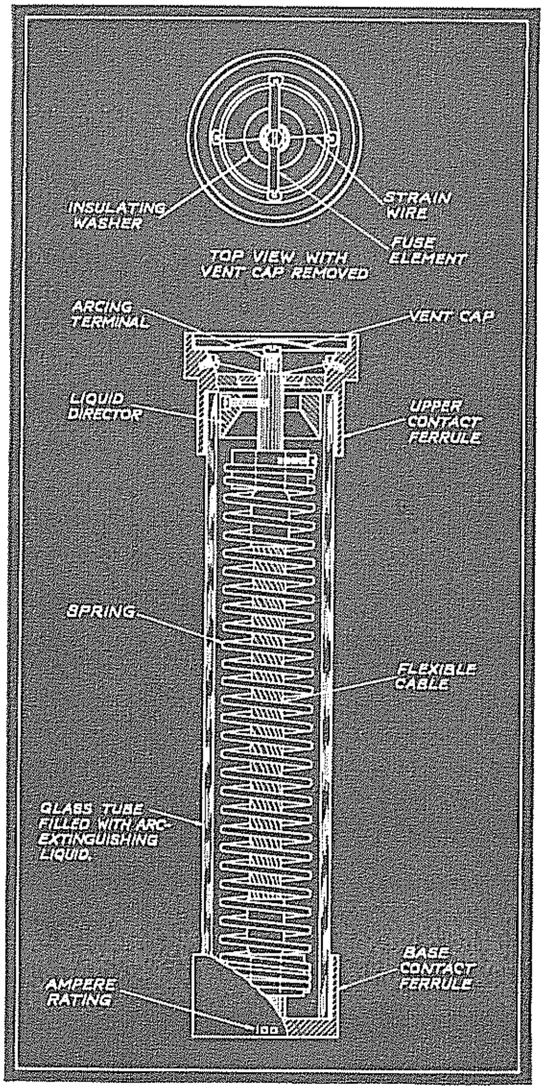


Fig. 7—Type D, S & C Fuse Construction

When a Type D Fuse is blown during overload or short-circuit, the pressure resulting from vaporization of the Fuse Element is confined to the chamber above the Insulating Washer and below the Vent Cap. The result is that during short-circuit the vent cap blows off before excessive pressures develop in the glass tube.

Type D Fuse Clips

In the Type D Fuse Construction the ferrules have flat contact surfaces. The ferrules of the Type D Fuse are larger than the Type B and the flat contact surfaces allow easy insertion and removal of the fuse regardless of the heavy pressure from the double spring action of the clips.

Like the Type B Clips described on the opposite page, the Type D Clips hold the fuse firmly under all conditions by means of the retaining bales and provide contact which is not likely to be impaired by corrosion. For that reason users of the S & C Fuse should specify the genuine S & C Fuse Clips if mountings are ordered from other manufacturers.

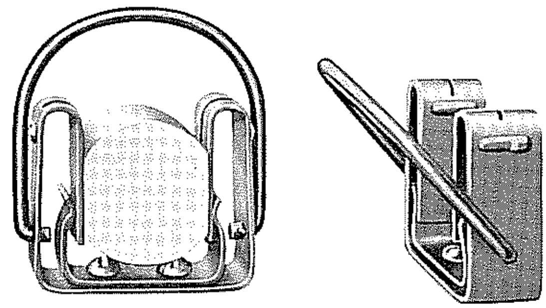


Fig. 8—Type D Fuse Clips

Type DLC (Low Current) Fuse

The Type DLC is a variation of the Type D Construction in which a very low current rating is combined with high interrupting capacity. This assembly consists of an ingenious combination of levers and fuse element arranged so that less than 1/100 of the tension of the heavy spring is transmitted to the small fuse element.

The application of this assembly makes possible a current rating as low as ½ ampere, with an over-all mechanical strength equal to that of S & C large ampere capacity fuses. The ½ ampere Type DLC Fuse blows at 8/10 ampere in approximately 10 seconds. This fuse, therefore, will be blown by the current which flows through the primary winding of a standard potential transformer during a short circuit at or near the secondary terminals.

The S&C Fuse

Has Numerous Advantageous Features

Rapid Operation

The time required by an S & C Fuse to clear a short-circuit on a 60-cycle system is from ½ to 1½ cycles, or from 1/120 to 1/40 second.

During overloads, the time required to melt the fuse element will depend upon the current volume but when the fuse element is melted, the clearing of the circuit is just as rapid as on short-circuits. In other words, *the speed with which the circuit is actually interrupted after the fuse element is melted is not dependent upon the value of the current at the instant the fuse is blown.*

This speed of the S & C Fuse is of decided advantage under two of the most common conditions. In the case of a short-circuit, the S & C Fuse will clear so rapidly that the disturbance is localized. In case of insulation failure, the S & C Fuse often clears the circuit before a complete breakdown of the insulation occurs. The damaged equipment is, therefore, disconnected before either the equipment or the system is subjected to the effects of a short-circuit.

S & C Fuses Do Not Endanger Nearby Apparatus

Ordinary fuses frequently communicate an arc to adjacent equipment and busses because they expel conducting vapor. That an S & C Fuse does not expel conducting vapor, has been conclusively proven in nineteen tests during which a piece of dry cotton was suspended six inches directly above each fuse. The fuses were blown during short-circuit and in only one case the cotton was ignited by the action of the fuse. However, the flame was so rapidly extinguished by the fuse liquid vapor that the burning of the cotton could barely be detected.

S & C Fuse Liquid Will Not Burn or Freeze

The liquid used in the S & C Fuse is non-inflammable; in fact, it is the best electric fire extinguisher obtainable. Also, this liquid will not freeze in any climate in which it might be used, the freezing point being 65° below zero F.

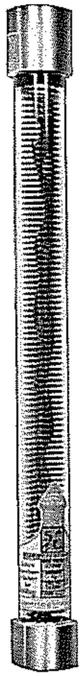


Fig. 9

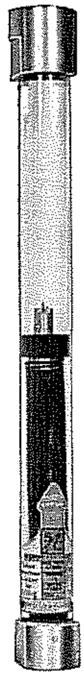


Fig. 10

Blown Fuse Distinguishable at a Distance

The S & C Fuse when blown is distinguishable at a distance (see Fig. 10). This not only saves time and expense, but eliminates the danger attending the removal and testing of fuses to determine whether they are blown.

Return Blown Fuses to the Factory for Refilling

Blown fuses returned to the factory for refilling are first disassembled; all obsolete or damaged parts are discarded and the remaining parts which meet the mechanical and electrical requirements are thoroughly cleaned. The fuses are then assembled, just as new fuses are assembled, and the latest improvements are always incorporated when S & C Fuses are thus reconstructed.

This refilling, which is actually reconstructing, therefore, wipes out all depreciation or obsolescence which might be charged against fuses regardless of when they were originally purchased.

Although extreme care and special processes requiring special equipment are necessary to do the work properly, the cost of refilling is not high. When it is understood that the refill charge covers complete rejuvenation of the fuses, and therefore disposes of depreciation and obsolescence, the charge is found to be remarkably low.

The S&C Fuse

Special Field Tests Have Shown Definitely Satisfactory Results

For a number of years S & C Fuses have been applied by electric service companies in installations connected to their distribution and transmission systems where it is possible to obtain enormous short-circuit currents. This extended service experience has developed a well earned reputation for the S & C Fuse, as being capable and dependable under severe operating conditions.

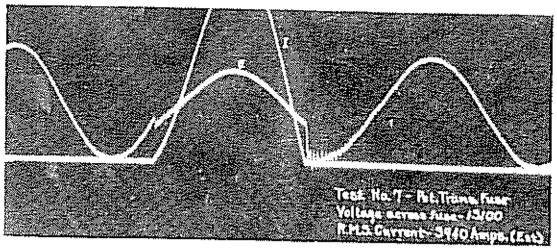


Fig. 11—Oscillogram Record of Test of S & C, Type B, Potential Transformer Fuse Interrupting 3940 Amperes

Numerous tests were made to determine the performance of these fuses before placing them on the market. Also many tests have been made by power companies to verify the interrupting capacity. Such tests have been made under a variety of conditions. All tests have shown the ability of this fuse to interrupt currents, from the smallest amount necessary to melt the fuse element, to enormous short-circuits, with a certainty and rapidity not ordinarily attributed to this class of equipment.

The oscillograph records reproduced here as Figures 11, 12, 13 and 14 are typical of the

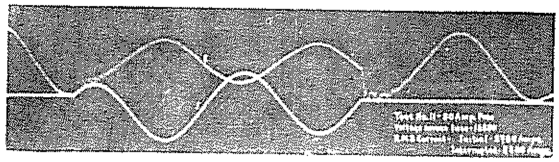


Fig. 12—Oscillogram Record of Test of S & C 50-Ampere Fuse Interrupting 5380 Amperes

results of tests conducted on super-power systems. The results, Figures 11, 12 and 13, were obtained by connecting S & C Fuses, of the ampere ratings mentioned, between the phase wire and ground of a 22,000 volt metropolitan system.

The results shown in Figure 14 were obtained in a 3 phase test with a 150 ampere S & C Fuse connected between each phase wire and ground of a 60,000 volt system. The time required for an S & C Fuse to blow and clear the circuit is dependent upon the ratio between the short-circuit current and the current rating of the fuse, and this accounts for the longer interval appearing in Figure 14.

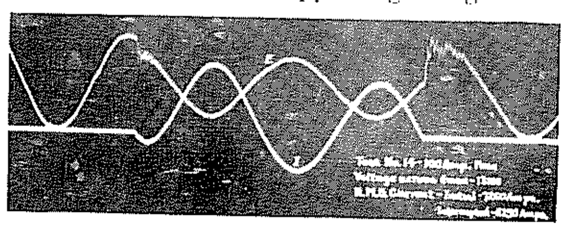


Fig. 13—Oscillogram Record of Test of S & C 100-Ampere Fuse Interrupting 6150 Amperes

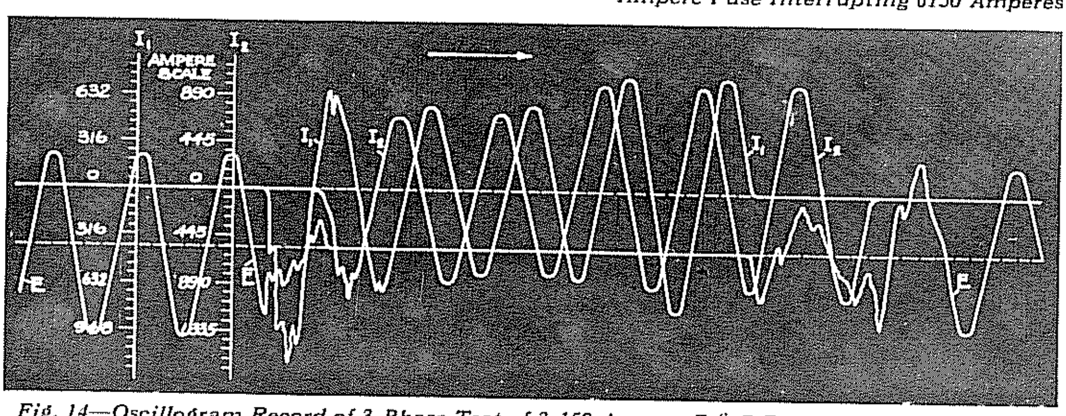


Fig. 14—Oscillogram Record of 3-Phase Test of 3-150 Ampere S & C Fuses Connected Between Phase Wire and Ground of a 60,000-Volt System

S&C Fuse Application Recommendations

For Power and Distribution Application

The proper application of high voltage fuses in power and distribution transformer installations requires that consideration be given to both the transient and normal load conditions which may occur during operation. Detailed investigation of transient conditions shows that:

(1) The energizing of an unloaded transformer is often accompanied by an initial rush of current comparable to the full load current rating of the transformer, whereas the exciting current, a few cycles after energizing the transformer, is only from 3 to 5% of the full load current rating.

(2) The energizing of an incandescent lamp load is accompanied by a rush of current approximately five times the Kw. rating of the load because of the high positive temperature coefficient of the tungsten filament. This rush of current decreases rapidly due to the increase in the lamp filament resistance with increasing temperature, and becomes normal in a few cycles.

(3) The starting current drawn by squirrel cage motors amounts to from 250 to 400% of the full load current rating of the motors.

No damage results from such momentary over-currents, providing that they do not persist until destructive temperatures have developed in the transformer windings.

In the case of large transformers, the momentary over-capacity demands will generally be a smaller percentage of the transformer rating than in the case of small transformers, because large transformers supply a number of different loads, the transient current demands of which do not occur at the same instant.

After taking these facts into consideration it will be apparent that to prevent unnecessary interruptions to service, due to transient conditions, the ampere rating of a high voltage fuse must be several times the full load current rating of the transformer.

An attempt should not be made to apply high voltage fuses to protect a transformer during overloads of 150 to 200 per cent of the transformer full load current rating, because unnecessary fuse operation will result during transient conditions which do not last a sufficient length of time to develop destructive temperatures in the transformer windings. Where overload protection is considered necessary, it should be obtained by the installation of fuses or circuit breakers in the secondary circuit.

The most satisfactory results will be obtained when S & C Fuses are applied for isolating the transformers, and for protecting the system during extreme overload or short-circuits resulting from grounds or breakdown of equipment.

Experience has shown that for small transformers, the ampere rating of the primary voltage fuses should be from 4 to 8 times the full load current rating of the transformer, while for large transformers the ampere rating of the primary voltage fuses should be from 2 to 4 times the full load current rating of the transformer.

S & C Fuse Application Recommendations—Cont'd

Table of Recommendations

The table, page 12, gives recommendations for the application of S & C Fuses in distribution and power transformer installations for the purpose of isolating the transformer from the system during short circuits or insulation failures. When fuses of the largest ampere ratings are required for installation at remote locations, a check should be made of the system reactance to be sure that the available short-circuit current will blow the fuse.

Type of S & C Fuse to Use

When the maximum three-phase short-circuit Kv-a. is less than 75,000, Type B fuses will give the necessary protection.

When the maximum three-phase short-circuit Kv-a. is greater than 75,000 or less than 175,000 Kv-a., Type D fuses should be applied.

When the maximum three-phase short-circuit Kv-a. is greater than 175,000 Kv-a., Type D, Size 5 fuses should be applied.

Full information on the types and sizes of S & C Fuses may be found by referring to pages 6, 7 and 16 for description, and to pages 14 and 15 for listing.

Number of Fuses to Use

The voltage rating of the fuse should always be at least equal to the system voltage. Two fuses should always be installed in a single-phase installation and three fuses should always be installed in a three-phase installation.

For Potential Transformer Application

Either the Type B—"PT," or the Type DLC ½ ampere, S & C Fuse should be applied in potential transformer installations.

The Type B—"PT" is suitable for disconnecting the transformer in case of transformer failure. The Type DLC ½ ampere fuse will disconnect a potential transformer during a short circuit at the secondary terminals, as well as during a transformer failure.

When it is desirable to limit the amount of current which will flow during a potential transformer failure, the S & C Wire Wound Resistor should be applied in connection with the Type DLC ½ ampere S & C Fuse.

A bulletin describing S & C Current-Limiting Resistors and their application is available and will be furnished upon request.

Other Applications

The numerous applications of S & C Fuses not coming under the foregoing classes are best treated by individual recommendations. Among such applications are the following:

1. To disconnect carrier current coupling condensers in case of condenser failure.

2. To disconnect telephone equipment when telephone lines come in contact with power lines.

3. For the purpose of shunting distribution feeder reactors during normal operation so as to improve the circuit voltage regulation and reduce the loss. During a short-circuit the fuse blows, cutting the reactors into service before the oil circuit breakers have time to open.

4. To prevent line interruptions due to suspension insulator flash-overs during lightning disturbances.

5. To prevent service interruptions due to lightning arrester failure.

6. On High Voltage DC Electric Railway circuits.

7. In radio broadcasting for interrupting the high voltage, highly inductive plate circuit during tube failure.

Table of Recommendations for Application of the S & C Fuse

Single Phase Recommendations

1-Ph. K V A	2,300 Volts		4,000 Volts		6,600 Volts		11,000 Volts		13,200 Volts		22,000 Volts		33,000 Volts		1-Ph. K V A
	Full Load Amp.	Rating of Fuse Amp.	Full Load Amp.	Rating of Fuse Amp.	Full Load Amp.	Rating of Fuse Amp.	Full Load Amp.	Rating of Fuse Amp.	Full Load Amp.	Rating of Fuse Amp.	Full Load Amp.	Rating of Fuse Amp.	Full Load Amp.	Rating of Fuse Amp.	
1.5	0.65	5	0.38	3	0.23	2									1.5
2.5	1.09	8	0.63	5	0.38	3	0.23	2	0.19	2					2.5
3	1.30	8	0.75	5	0.46	3	0.27	2	0.23	2					3
5	2.18	12	1.25	8	0.76	5	0.46	3	0.38	3	0.23	2			5
7.5	3.26	20	1.87	10	1.14	8	0.68	5	0.57	5	0.34	3			7.5
10	4.35	20	2.50	15	1.52	10	0.91	5	0.76	5	0.46	3	0.30	3	10
15	6.53	30	3.75	20	2.27	12	1.37	8	1.14	8	0.68	5	0.46	3	15
25	10.9	40	6.25	30	3.79	20	2.27	12	1.89	10	1.14	8	0.76	5	25
37.5	16.3	60	9.37	40	5.68	30	3.41	20	2.84	15	1.70	10	1.14	8	37.5
50	21.8	75	12.5	50	7.58	30	4.55	25	3.79	20	2.27	12	1.52	10	50
75	32.6	100	18.7	75	11.4	50	6.82	30	5.68	25	3.41	20	2.27	12	75
100	43.5	150	25.0	100	15.2	60	9.10	40	7.58	30	4.55	25	3.03	15	100
150	65.3	200	37.5	150	22.7	75	13.7	60	11.4	50	6.82	30	4.55	25	150
200	87.0	250	50.0	150	30.3	100	18.2	75	15.2	60	9.10	40	6.06	30	200
250	109	300	62.5	200	37.9	150	22.7	75	18.9	75	11.4	50	7.58	30	250
333	145	400	83.1	250	50.5	150	30.3	100	25.2	100	15.2	60	10.1	50	333
400	174	400	100	300	60.6	200	36.4	100	30.3	100	18.2	75	12.1	50	400

3-Phase Recommendations

3-Ph. K V A	2,300 Volts		4,000 Volts		6,600 Volts		11,000 Volts		13,200 Volts		22,000 Volts		33,000 Volts		44,000 Volts		66,000 Volts		3-Ph. K V A
	Full Load Amp.	Rating of Fuse Amp.	Full Load Amp.	Rating of Fuse Amp.	Full Load Amp.	Rating of Fuse Amp.	Full Load Amp.	Rating of Fuse Amp.	Full Load Amp.	Rating of Fuse Amp.	Full Load Amp.	Rating of Fuse Amp.	Full Load Amp.	Rating of Fuse Amp.	Full Load Amp.	Rating of Fuse Amp.	Full Load Amp.	Rating of Fuse Amp.	
4.5	1.13	8	0.65	5	0.39	3													4.5
5	1.25	8	0.72	5	0.44	3													5
7.5	1.88	10	1.09	8	0.66	5	0.39	3	0.33	3									7.5
9	2.26	12	1.30	8	0.79	5	0.47	3	0.39	3									9
10	2.50	15	1.45	10	0.88	5	0.53	5	0.44	3									10
15	3.77	20	2.18	12	1.31	8	0.79	5	0.66	5	0.39	3							15
22.5	5.65	25	3.27	20	1.97	12	1.18	8	0.99	8	0.59	5							22.5
25	6.30	30	3.64	20	2.19	12	1.31	8	1.09	8	0.66	5							25
30	7.54	30	4.33	20	2.63	15	1.58	10	1.31	8	0.79	5	0.53	5					30
37.5	9.43	40	5.42	25	3.28	20	1.97	12	1.64	10	0.99	8	0.66	5					37.5
45	11.3	50	6.50	30	3.94	20	2.36	12	1.97	12	1.18	8	0.79	5	0.59	5			45
50	12.6	50	7.24	30	4.38	20	2.63	15	2.19	12	1.31	8	0.88	5	0.66	5			50
75	18.8	75	10.9	40	6.58	30	3.94	20	3.28	20	1.97	12	1.31	8	0.99	8			75
100	25.1	100	14.5	60	8.76	40	5.27	25	4.38	20	2.63	15	1.75	10	1.31	8			100
112.5	28.3	100	16.3	60	9.85	40	5.92	30	4.93	25	2.96	15	1.97	12	1.48	10			112.5
150	37.7	150	21.8	75	13.1	50	7.90	40	6.58	30	3.94	20	2.63	15	1.97	12	1.31	8	150
200	50.3	150	28.9	100	17.5	75	10.5	40	8.76	40	5.27	25	3.50	20	2.63	15	1.75	10	200
225	56.5	200	32.7	100	19.7	75	11.8	50	9.85	40	5.92	30	3.94	20	2.96	15	1.97	15	225
300	75.4	250	43.3	150	26.3	100	15.8	60	13.1	50	7.90	40	5.27	25	3.94	20	2.63	15	300
450	113	300	65.0	200	39.4	150	23.6	75	19.7	75	11.8	50	7.90	40	5.92	30	3.94	20	450
600	151	400	86.7	250	52.7	150	31.6	100	26.3	100	15.8	60	10.5	40	7.90	40	5.27	25	600
750	188	400	109	300	65.8	200	39.4	150	32.8	100	19.7	75	13.1	50	9.85	40	6.58	30	750
1,000			145	400	87.6	250	52.7	150	43.8	150	26.3	100	17.5	75	13.1	50	8.76	40	1,000
1,200			173	400	105	300	63.2	200	52.7	150	31.6	100	21.2	75	15.8	60	10.5	40	1,200
1,500					131	400	79.0	250	65.8	200	39.4	150	26.3	100	19.7	75	13.1	50	1,500
2,000					175	400	105	300	87.6	250	52.7	150	35.0	100	26.3	100	17.5	75	2,000
2,500							131	400	109	300	65.8	200	43.8	150	32.8	100	21.9	75	2,500
3,000							158	400	131	400	79.0	250	52.7	150	39.4	150	26.3	100	3,000
3,750									164	400	98.5	300	65.8	200	49.3	150	32.8	100	3,750
5,000											131	400	87.6	250	65.8	200	43.8	150	5,000
6,000											158	400	105	300	79.0	250	52.7	150	6,000
7,500													131	400	98.5	300	65.8	200	7,500
10,000													175	400	131	400	87.6	250	10,000

Higher Voltage Recommendations will be given on application.
Time-Current Curves and Data applicable to S & C Fuses will be furnished on request.

The S&C Fuse

Should Be Installed with Top Up and Not More than 45° from the Vertical

The S & C Fuse is designed for installation in a vertical position with the vent cap up (See Fig. 3, page 5), in which position the blowing of the fuse element is followed by the quickest release from excessive pressure, the maximum speed of the arcing terminal, and the maximum benefit is derived from the arc-extinguishing liquid. When it is necessary to install the S & C Fuse at an angle, the angle should never be greater than 45° from the vertical, and the pressure vent should always be up.

A few typical S & C Mountings shown here, illustrate correct methods of fuse installation. Bulletin 202 on outdoor, and Bulletin 222 on indoor fuse mountings and combinations, describe and illustrate these lines more completely.

S & C Mountings are designed with a complete knowledge of fuse engineering. They are, therefore, electrically and mechanically correct and it is important that they should always be specified for use with the S & C Fuse. In that way this reliable fuse will be unhampered by deficiencies in the equipment on which it is used and, therefore, more reasonably, may be expected to perform as intended.

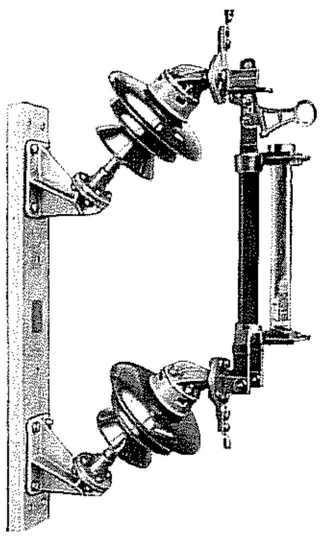


Fig. 15—37,000-Volt Type GK-SM Outdoor Fused Disconnect

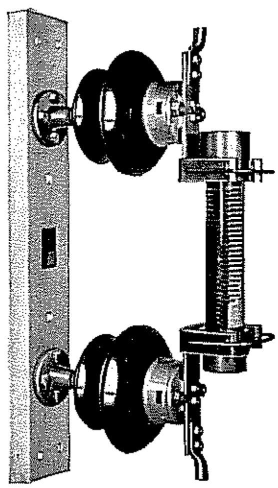


Fig. 16—25,000-Volt Type B-M Outdoor Fuse Mounting

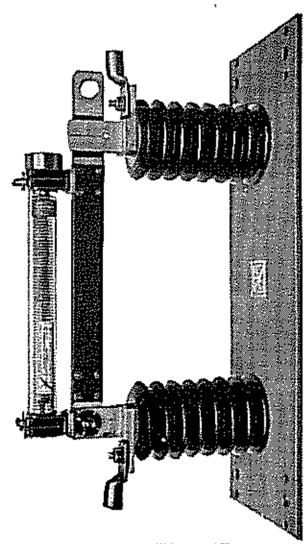


Fig. 17—25,000-Volt Type KC-SM Indoor Fused Disconnect

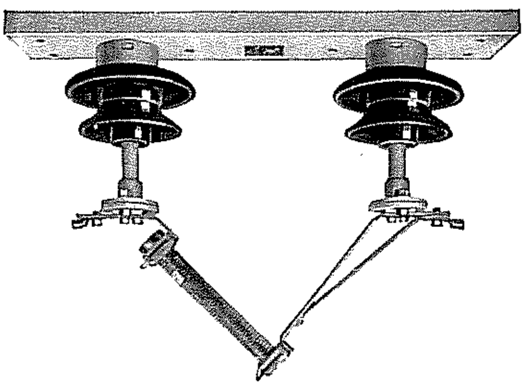


Fig. 18—25,000-Volt Type F-M Fuse Mounting

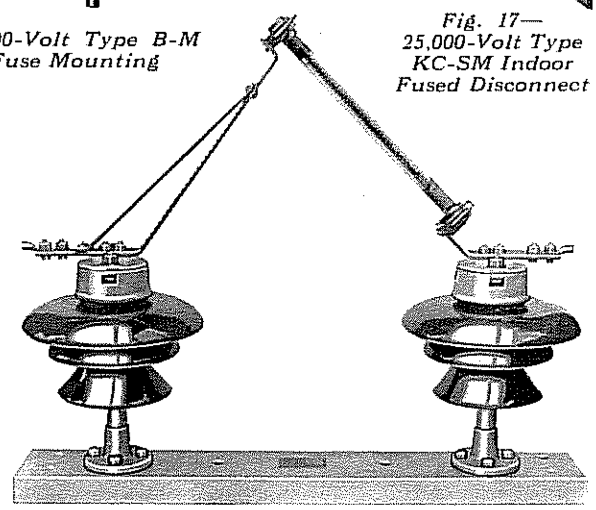


Fig. 19—37,000-Volt Type E-M Outdoor Fuse Mtg.

The S&C Fuse

Ordering Information—7,500 to 50,000 Volts

‡Type	Rating Amperes	7,500 Volts Clip Centers 8" Catalog Number	7,500 Volts List Price	7,500 Volts Clip Cat. No.	15,000 & 25,000 Volts* Clip Centers 11½" Catalog Number	15,000 & 25,000 Volts* List Price	15,000 & 25,000 Volts* Clip Cat. No.	37,000 Volts Clip Centers 15" Catalog Number	37,000 Volts List Price	37,000 Volts Clip Cat. No.	50,000 Volts Clip Centers 18" Catalog Number	50,000 Volts List Price	50,000 Volts Clip Cat. No.	Rating Amperes	‡Type
Type B	P. T. †	16001	$ 3.50	2110	16003	$ 4.50	2110	16004	$ 7.50	2110	16005	$12.00	2110	P. T. †	Type B
	1	16101	3.50	2110	16103	4.50	2110	16104	7.50	2110	16105	12.00	2110	1	
	2	16111	3.50	2110	16113	4.50	2110	16114	7.50	2110	16115	12.00	2110	2	
	3	16121	3.50	2110	16123	4.50	2110	16124	7.50	2110	16125	12.00	2110	3	
	5	16131	3.50	2110	16133	4.50	2110	16134	7.50	2110	16135	12.00	2110	5	
	8	16141	4.00	2110	16143	5.50	2110	16144	9.50	2110	16145	15.00	2110	8	
	10	16151	4.00	2110	16153	5.50	2110	16154	9.50	2110	16155	15.00	2110	10	
	12	16201	5.00	2120	16203	8.00	2120	16204	18.00	2120	16205	28.00	2120	12	
	15	16211	5.00	2120	16213	8.00	2120	16214	18.00	2120	16215	28.00	2120	15	
	20	16221	5.00	2120	16223	8.00	2120	16224	18.00	2120	16225	28.00	2120	20	
	25	16231	5.00	2120	16233	8.00	2120	16234	18.00	2120	16235	28.00	2120	25	
Type DLC	½	16901	8.20	2130	16903	12.30	2130	16904	22.00	2130	16905	33.00	2130	½	Type DLC
	1	16911	8.20	2130	16913	12.30	2130	16914	22.00	2130	16915	33.00	2130	1	
	2	16921	8.20	2130	16923	12.30	2130	16924	22.00	2130	16925	33.00	2130	2	
Type D	5	16331	8.20	2130	16333	12.30	2130	16334	22.00	2130	16335	33.00	2130	5	Type D
	10	16351	8.20	2130	16353	12.30	2130	16354	22.00	2130	16355	33.00	2130	10	
	15	16371	8.20	2130	16373	12.30	2130	16374	22.00	2130	16375	33.00	2130	15	
	20	16381	8.20	2130	16383	12.30	2130	16384	22.00	2130	16385	33.00	2130	20	
	25	16391	8.20	2130	16393	12.30	2130	16394	22.00	2130	16395	33.00	2130	25	
	30	16401	8.20	2130	16403	12.30	2130	16404	26.00	2130	16405	38.00	2130	30	
	40	16411	8.20	2130	16413	12.30	2130	16414	26.00	2130	16415	38.00	2130	40	
	50	16421	8.20	2130	16423	12.30	2130	16424	26.00	2130	16425	38.00	2130	50	
	60	16501	12.90	2140	16503	17.60	2140	16504	40.00	2140	16505	50.00	2140	60	
	75	16511	12.90	2140	16513	17.60	2140	16514	40.00	2140	16515	50.00	2140	75	
	100	16521	12.90	2140	16523	17.60	2140	16524	40.00	2140	16525	50.00	2140	100	
	150	16531	16.40	2140	16533	22.30	2140	16534	54.00	2140	16535	68.00	2140	150	
	200	16541	16.40	2140	16543	22.30	2140	16544	54.00	2140	16545	68.00	2140	200	
	250	16601	48.20	2150	16603	62.30	2150	16604	95.00	2150	16605	120.00	2150	250	
	300	16611	48.20	2150	16613	62.30	2150	16614	95.00	2150	16615	120.00	2150	300	
	400	16621	48.20	2150	16623	62.30	2150	16624	95.00	2150	16625	120.00	2150	400	

†P. T. is an abbreviation for Potential Transformer Fuse of approximately 1 ampere.

‡See Page 6 for explanation of Type Letters.

*Fuses listed under this heading are labeled 25,000 volts and this rating is furnished for service on all voltages above 7,500 and up to and including 25,000 volts.

Notice of List Price Change

With this issue the list prices of some sizes of S & C Fuses have been changed in order that a uniform discount could be made to apply on all sizes. *Therefore, with this price list use only discount sheets specifically applying to this bulletin.*

The S&C Fuse

Ordering Information—73,000 to 132,000 Volts

‡Type	Rating Amperes	73,000 Volts Clip Centers 24"			88,000 Volts Clip Centers 30"			110,000 Volts Clip Centers 36"			132,000 Volts Clip Centers 42"			Rating Amperes	‡Type
		Catalog Number	List Price	Clip Cat. No.	Catalog Number	List Price	Clip Cat. No.	Catalog Number	List Price	Clip Cat. No.	Catalog Number	List Price	Clip Cat. No.		
Type B	**P. T.** †	16006	$18.00	2120	......	$.....	......	......	$.....	......	......	$.....	......	**P. T.** †	Type B
	1	16206	18.00	2120	......	......	......	......	......	......	......	......	......	**1**	
	2	16216	18.00	2120	......	......	......	......	......	......	......	......	......	**2**	
	3	16226	18.00	2120	......	......	......	......	......	......	......	......	......	**3**	
	5	16236	18.00	2120	......	......	......	......	......	......	......	......	......	**5**	
	8	16246	22.00	2120										**8**	
	10	16256	22.00	2120	......	......	......	......	......	......	......	......	......	**10**	
		......	......	......	......	......	......	......	......	......	......	......	......		
		......	......	......	......	......	......	......	......	......	......	......	......		
		......	......	......	......	......	......	......	......	......	......	......	......		
Type DLC	**½**	16906	40.00	2130	16907	45.00	2130	16908	50.00	2140	16909	150.00	2150	**½**	Type DLC
	1	16916	40.00	2130	16917	45.00	2130	16918	50.00	2140	16919	150.00	2150	**1**	
	2	16926	40.00	2130	16927	45.00	2130	16928	50.00	2140	16929	150.00	2150	**2**	
Type D	**5**	16336	40.00	2130	16437	45.00	2130	16538	50.00	2140	16639	150.00	2150	**5**	Type D
	10	16356	40.00	2130	16457	45.00	2130	16558	50.00	2140	16659	160.00	2150	**10**	
	15	16416	40.00	2130	16477	50.00	2130	16578	70.00	2140	16679	170.00	2150	**15**	
	20	16426	40.00	2130	16487	50.00	2130	16588	70.00	2140	16689	170.00	2150	**20**	
	25	16436	40.00	2130	16497	50.00	2130	16598	70.00	2140	16699	170.00	2150	**25**	
	30	16446	50.00	2130	16507	70.00	2140	16608	130.00	2150	16709	180.00	2150	**30**	
	40	16456	50.00	2130	16517	70.00	2140	16618	130.00	2150	16719	180.00	2150	**40**	
	50	16466	50.00	2130	16527	70.00	2140	16628	130.00	2150	16729	180.00	2150	**50**	
	60	16506	60.00	2140	16607	140.00	2150	16638	160.00	2150	16739	190.00	2150	**60**	
	75	16516	60.00	2140	16617	140.00	2150	16648	160.00	2150	16749	190.00	2150	**75**	
	100	16526	60.00	2140	16627	140.00	2150	16658	160.00	2150	16759	190.00	2150	**100**	
	150	16536	130.00	2150	16637	150.00	2150	16668	170.00	2150	16769	200.00	2150	**150**	
	200	16546	130.00	2150	16647	150.00	2150	16678	170.00	2150	16779	200.00	2150	**200**	
	250	16606	150.00	2150	16657	170.00	2150	......	......	......	......	......	......	**250**	
	300	16616	150.00	2150	16667	170.00	2150	......	......	......	......	......	......	**300**	
	400	16626	150.00	2150	16677	170.00	2150	......	......	......	......	......	......	**400**	

†P. T. is the abbreviation for Potential Transformer Fuse of approximately 1 ampere.

‡See Page 6 for explanation of Type Letters.

S&C Fuse Clips

Catalog Number	Type of Fuse	Size of Fuse (See page 16)	List Price Per Pair
2110	B	No. 1	$1.00
2120	B	No. 2	1.00
2130	D or DLC	No. 3	2.00
2140	D or DLC	No. 4	2.50
2150	D or DLC	No. 5	6.00

Dimensions and Shipping Weights

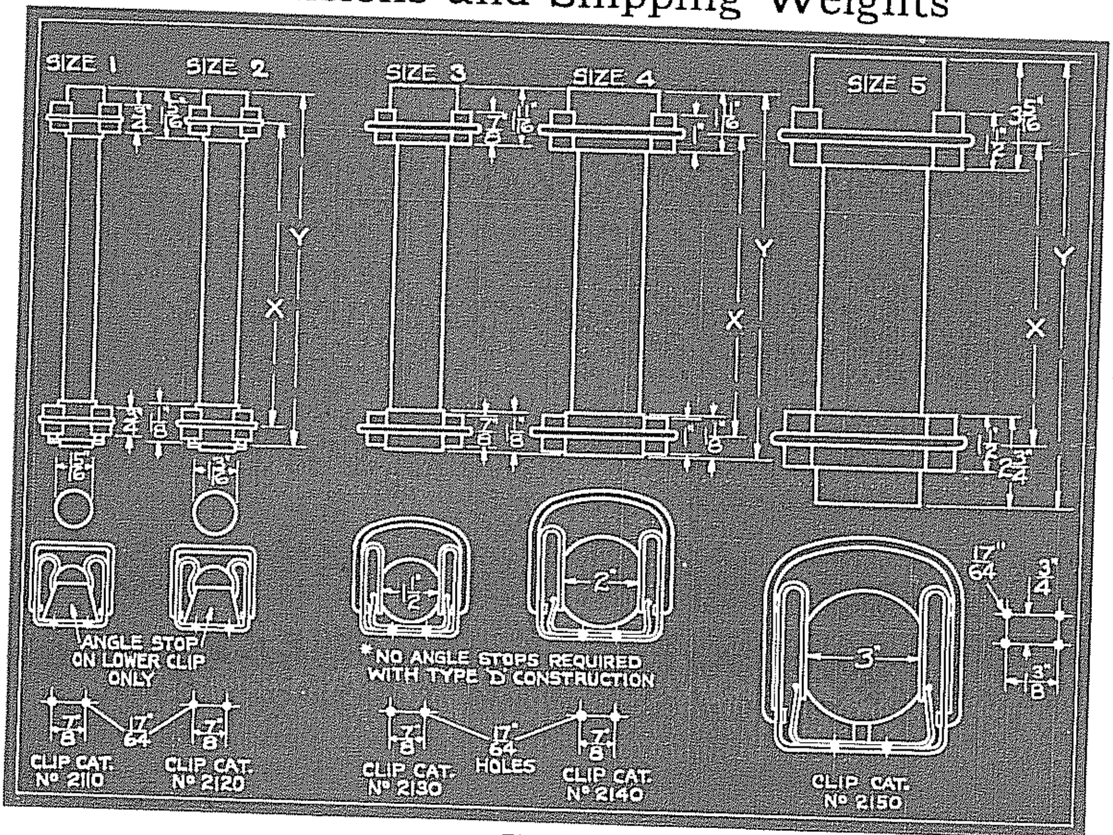


Fig. 20

Max. Volts	TYPE B CONSTRUCTION: Size 1 Rating Amperes	"Y" Inches	Wt. Lbs. Pkd.	Size 2 Rating Amperes	"Y" Inches	Wt. Lbs. Pkd.	TYPE D (Including Type DLC) CONSTRUCTION: Size 3 Rating Amperes	"Y" Inches	Wt. Lbs. Pkd.	Size 4 Rating Amperes	"Y" Inches	Wt. Lbs. Pkd.	Size 5 Rating Amperes	"Y" Inches	Wt. Lbs. Pkd.	Clip Centers All Sizes "X"
7,500	P.T.-1-2-3 5-8-10	9 5/16	1½	12-15-20-25	9 5/16	2	½-1-2-5-10 15-20-25 30-40-50	9 11/16	3½	60-75-100 150-200	9 11/16	6	250-300-400	12½	18	8″
15,000 and 25,000	P.T.-1-2-3 5-8-10	12 13/16	1¾	12-15-20-25	12 13/16	2⅛	½-1-2-5-10 15-20-25 30-40-50	13 3/16	4	60-75-100 150-200	13 3/16	7	250-300-400	16	24	11½″
37,000	P.T.-1-2-3 5-8-10	16 5/16	2	12-15-20-25	16 5/16	2¼	½-1-2-5-10 15-20-25 30-40-50	16 11/16	4½	60-75-100 150-200	16 11/16	8	250-300-400	19½	30	15″
50,000	P.T.-1-2-3 5 8-10	19 5/16	2¼	12-15-20-25	19 5/16	2⅝	½-1-2-5-10 15-20-25 30-40-50	19 11/16	5	60-75-100 150 200	19 11/16	9	250-300-400	22½	36	18″
73,000	....	....	....	P.T.-1-2-3 5-8-10	25 5/16	3¼	½-1-2-5-10 15-20-25 30-40-50	25 11/16	5½	60-75-100	25 11/16	12	150-200-250 300-400	28½	50	24″
88,000	....	....	....	....	....	....	½-1-2-5-10 15-20-25	31 11/16	12	30-40-50	31 11/16	21	60-75-100 150-200 250-300-400	34½	70	30″
110,000	....	....	....	....	....	....	....	....	....	½-1-2-5 10-15-20-25	37 11/16	30	30-40-50 60-75-100 150-200	40½	85	36″
132,000	....	....	....	....	....	....	....	....	....	....	....	....	½-1-2-5-10 15-20-25-30 40-50-60-75 100-150-200	46½	100	42″

S&C Fuse Tongs

For the placing and removal of fuses, two types of Fuse Tongs, shown below, are offered. These tongs are made of seasoned hard wood, kiln dried, and given special treatment and finish to prevent moisture absorption.

The Type H is for use where the operator is at the approximate height of the fuse and can handle it with tongs which hold the fuse at a 90° angle with the handles. Quite often, however, the fuse is mounted at considerable height above the operator, in which case the Type HA Tongs are better used. These are in every way similar to the Type H, except that they hold the fuse at a 45° angle with the handles, and, therefore, make the handling of fuses at difficult angles quite easy.

Take 4 Sizes of Fuses

The size limit of fuses which it is possible to handle with these tongs will depend somewhat on the ability of the operator and the location of the fuse. However, the tongs will tightly grip S & C Fuses of the Nos. 1, 2, 3 and 4 sizes, dimensions of which are given on page 16. Size 5 fuses cannot be handled with tongs.

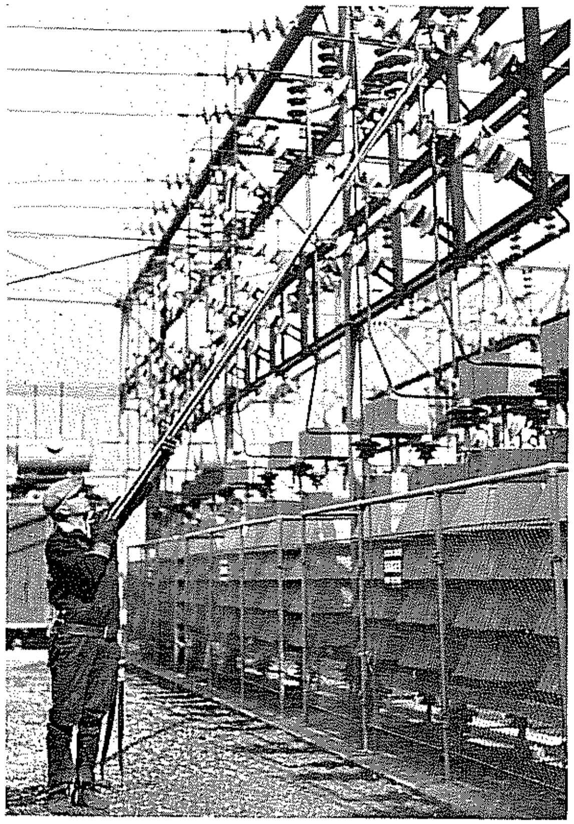


Fig. 21

Type H Fuse Tongs (90°)

Fig. 22

Max. Volts	Cat. No.	Length	List Price	Wt. Pkd., Lbs.
25000	1013	4 ft.	$15.00	15
73000	1016	7 ft.	18.00	25
88000	1017	12 ft.	25.00	45
88000	1018	16 ft.	27.00	75

Type HA Fuse Tongs (45°)

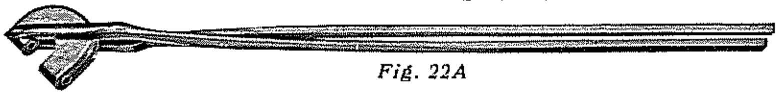


Fig. 22A

Max. Volts	Cat. No.	Length	List Price	Wt. Pkd., Lbs.
25000	1023	4 ft.	$16.00	15
73000	1026	7 ft.	19.00	25
88000	1027	12 ft.	26.00	45
88000	1028	16 ft.	28.00	75

The S&C Fuse

Also Made in the Form of a Primary Cutout

For Distribution Circuits

For application on distribution circuits, the S & C Fuse is also supplied with a weatherproof, insulating housing, and this arrangement is called the Type DP Cutout. It is principally applied on 2200 to 6600 volt systems for primary protection on distribution transformers of 50 to 300 KVA capacity.

Fig. 23—Type DP Cutout containing the S & C Fuse

Type DP Cutout

This cutout consists of a special form of the S & C Fuse, designed for attachment to an insulated handle and for inserting in a weather proof, insulating housing. This housing contains adequate self-aligning contact clips to which are connected the flexible leads appearing in the illustration.

The complete cutout occupies a space of only 5″x5″x21″ and makes possible an unusually neat appearing installation.

Fuses for the Type DP Cutout are rated at 10, 20, 30, 40, 50, 60, 75, 100, 150 and 200 amperes.

High Interrupting Capacity

Numerous tests and wide use under service conditions have shown the interrupting capacity of the Type DP Cutout to be approximately 10,000 amperes at 4000 volts.

Bulletin 201 gives complete information, and will be gladly supplied on request.

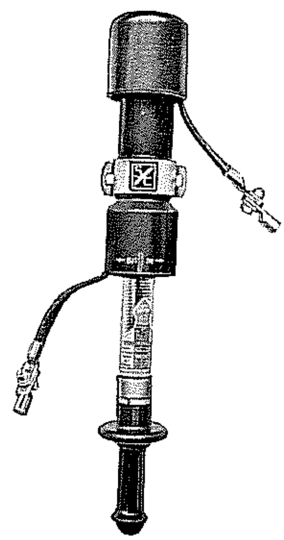


Fig. 24—Showing how the Fuse is removed from the Cutout by means of the Insulated Handle to which the Fuse is attached

The S&C Fuse for Load Breaking

How to Interrupt Load Currents in Switch Operation, with the S & C Fuse, and Save the Cost of an Oil Circuit-Breaker

A Money Saving Arrangement

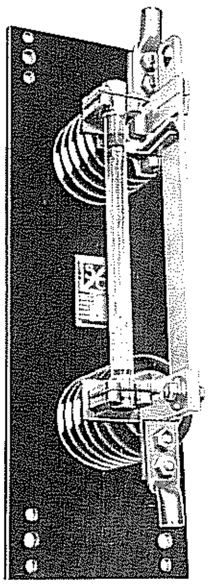


Fig. 25—Type YB Fuse-Break, Load-Interrupting Switch for Indoor Service. Patented

There are numerous places in every large generating or distributing system where it is desirable to have a simple means of interrupting load currents, at moderate and high voltage, without the use of an expensive oil circuit-breaker. Where opening of the circuit is infrequent, this is conveniently accomplished at a great saving over the cost of an oil circuit breaker, by using the *S & C, Type YB, Fuse-Break, Load-Interrupting Switch.*

One form of this switch is shown in Fig. 25. It consists of a disconnecting switch arranged so that the blade is shunted by an S & C Fuse of low ampere rating. When the fuse is out of the clips the switch blade is locked in the closed position, but the inserting of the fuse releases the lock for the opening of the blade. The close up view of the top section of the switch, Fig. 26, shows the blade locked when the fuse is removed.

How It Operates

To interrupt a load the S & C Fuse is first inserted in the clips and then the disconnecting switch blade is opened rapidly. An arc is thereby drawn between the blade and the contact clip at the instant the blade leaves the clip.

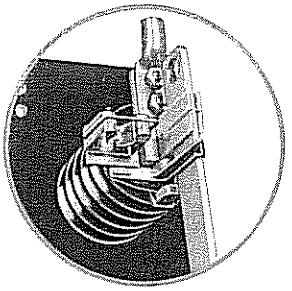


Fig. 26—Showing how the Switch Blade is locked until a Fuse is placed in the Fuse Clips

The voltage across the arc is equal to the product of the current in the circuit and the resistance of the fuse. This voltage is very small, being in the order of approximately 100 volts when interrupting a 200 ampere load. The arc quickly becomes unstable and is extinguished as it is lengthened by the movement of the switch blade away from the clip. The extinction of the arc is followed by the blowing of the fuse which opens the circuit.

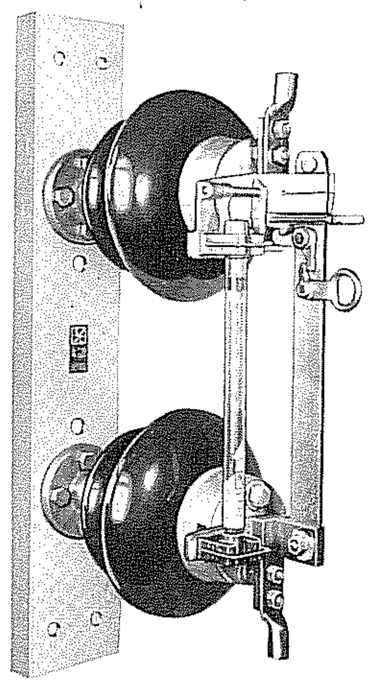


Fig. 27—Type YB Fuse-Break, Load-Interrupting Switch for Outdoor Service. Patented

Many Possible Applications

Another form of the YB Fuse-Break Load-Interrupting Switch is shown in Fig. 27. This form has an extra lock on the switch blade, which locks the switch blade in the closed position until released by a downward pull with a switch stick.

The possible applications of the YB Fuse-Break Load-Interrupting Switch are many and varied. Correspondence on this subject is invited, and recommendations and quotations will be made on request.

Many in Use

The YB Fuse-Break Load-Interrupting Switch has been time-tried-and-tested and is giving satisfactory service. More than three hundred are in use on one system.

The S&C Fuse

Name, Label and Package

Trade Name and Patents

Although it is occasionally referred to and described in the trade as "Carbon Tetrachloride," "Tetrachloride," "Pyrene," "Liquid," and "Chemical" Fuse, *the correct trade name is "S & C Fuse."*

The manufacture, sale and use are controlled by United States and Foreign Patents, granted and pending. The S & C Fuse is manufactured in the United States only by Schweitzer & Conrad, Inc., Chicago.

A Mark of Reliability

This is the label affixed to the S & C Fuse. Its primary purpose is to carry details of description pertaining to the individual fuse, and to caution the user to install the fuse

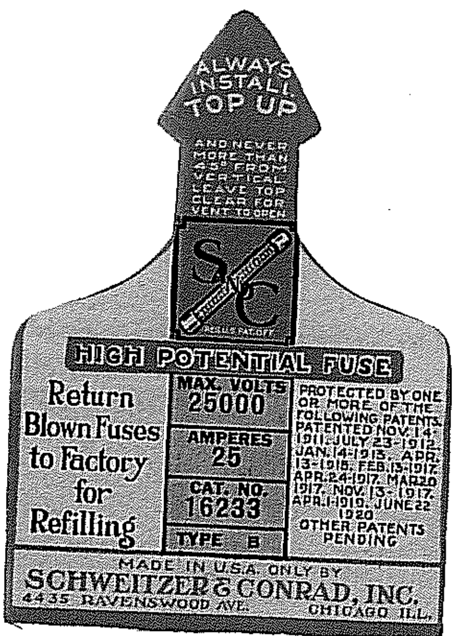


Fig. 28—S & C Fuse Label

with the top up. In addition, it is the feeling of the S & C organization that this label is the mark which shows the pride of the makers in the perfection of the product; that it gives assurance to the purchaser that the fuse has been built, or refilled, as the case may be, to the high standards for which the S & C factory has become known throughout the industry, and that the fuse can be relied upon to perform its function thoroughly and effectively.

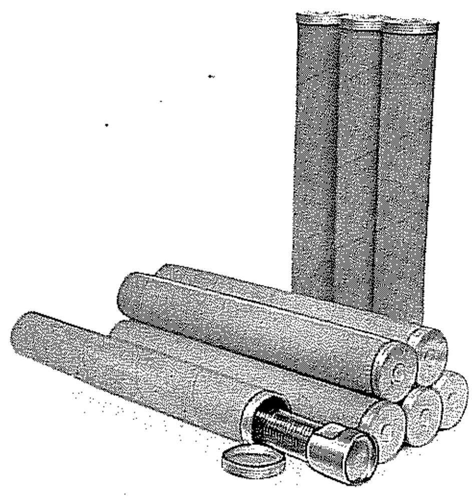


Fig. 29—Cartons in which S & C Fuses are packed

A Sturdy Convenient Carton

S & C Fuses of the smaller and medium sizes are packed for stocking in a strong cylindrical carton and labeled on the outside with the ampere and voltage ratings for quick identification.

Keep the Container

Users are urged to preserve these containers in their fuse stockroom or other convenient location where they will be easily available for repacking S & C Fuses when returning them to the factory for refilling. Thus returns of blown fuses will be made with facility and at the lowest packing cost.

S AND C