TYPE "U" "DE-ION"* AIR CIRCUIT BREAKER

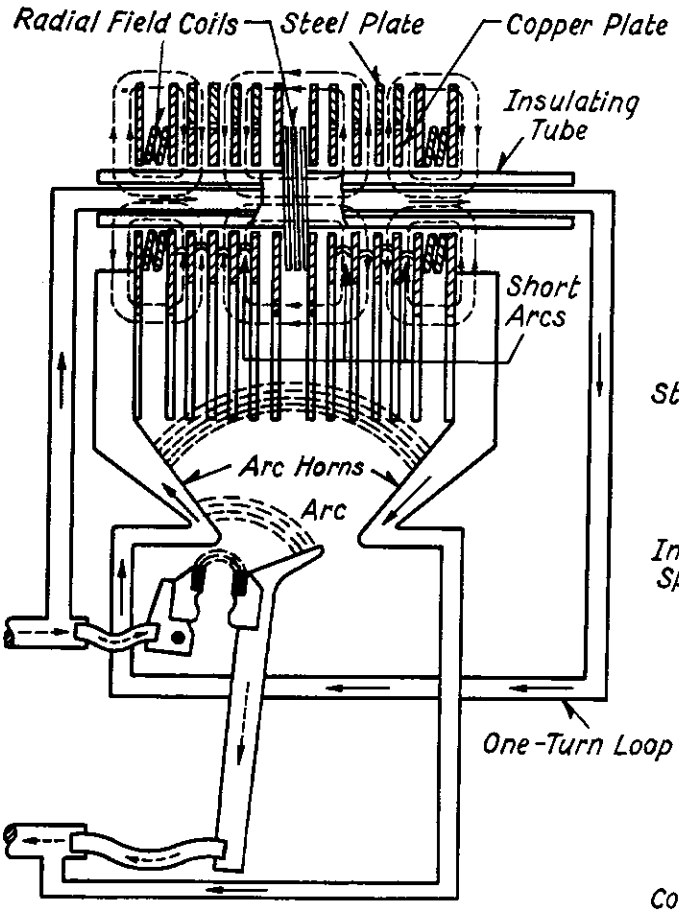

FIG. A

The Type "U" Breaker having voltage ratings of 7500 and 15,000 volts. 250,000 and 500,000 Kv-a.

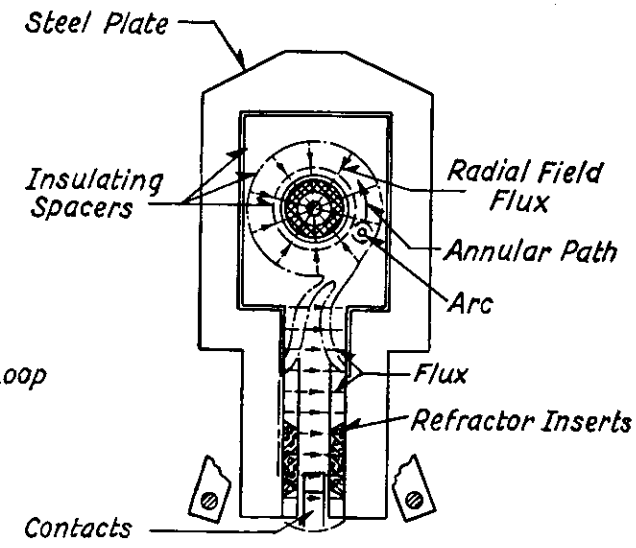

FIG. B

FIG. 1—TYPICAL ARRANGEMENT OF COMPONENT PARTS SHOWING METHOD OF DRAWING AND EXTINGUISHING THE ARC IN THE TYPE "U" "DE-ION" AIR CIRCUIT BREAKER

Theory of Operation

The de-ionizing chamber is built up of copper plates insulated from each other to form a series of gaps, as shown in Fig. A. Each copper plate is partially surrounded by a steel plate of the same thickness, Fig. B.

As the contacts separate, the arc is drawn as shown in Fig. A, and the circuit is completed as indicated by the broken arrows. It rises due to the magnetic field of the arc current, impinges on the arc horn immediately above, and current begins to flow through the one-turn loop. The individual steel plates act as a magnetic yoke which, when energized by the one-turn loop, supply additional magnetic field for moving the arc into the plate structure.

When the arc impinges on the copper plates, the radial field coils are introduced into the circuit. These coils supply the field for spinning the arc around the annular path, in the same manner that the armature conductor of a series motor is driven in a circular path by the field of the motor. The arc, as shown, is now broken up into a number of short arcs. The spinning action continues until a zero point occurs in the current. At that instant the circuit is interrupted.

Of course this action takes place much more quickly than it can be described. Complete interruption of the arc—drawing, moving it into the gaps, and spinning it—usually requires only one-half to one cycle on a 60 cycle wave. The arc may be spun at the rate of 20 revolutions per half cycle.

Details of the plates are shown in Fig. B. Refractory inserts insulate against the heat caused by the arc as the contacts open. The flux, indicated by dotted arrows, forces the arc into the annular path where it is spun around under the influence of the radial flux field. The bars, part of which are shown on each side at the bottom, are connected to the conductor in the center of the annular path and are shown more clearly in the picture of the entire circuit breaker.

* Trademark registered.
E4-3, C3-23

TYPE "U" "DE-ION" AIR CIRCUIT BREAKERS—Continued

General

De-ion air circuit breakers have been in successful operation since their inception in 1929. Over this period the breakers have been subjected to extensive interrupting tests both in the laboratory and on power systems. Through these years of use and development, there has been constructed a line of circuit breakers applicable to standard voltage ratings of 7500 and 15,000 volts.

Distinctive Features

Elimination of Oil.

No Oil Maintenance.

Excellent Performance at Repetitive Duty.

Fast Arc Extinction.

Universal Mounting Arrangements.

Mechanically and Electrically Trip-Free Solenoid Operating Mechanism.

Simplified Inspection and Maintenance with Attendant Reduction in Maintenance Costs.

Application

The Type "U" De-ion air breaker is a circuit breaker which operates entirely without oil or other liquid. It functions in a normal atmosphere and is not dependent upon the maintenance of any medium, such as air pressure or a vacuum. Due to the simplicity of the breaker its performance is dependable, clean cut, and free from uncertainty.

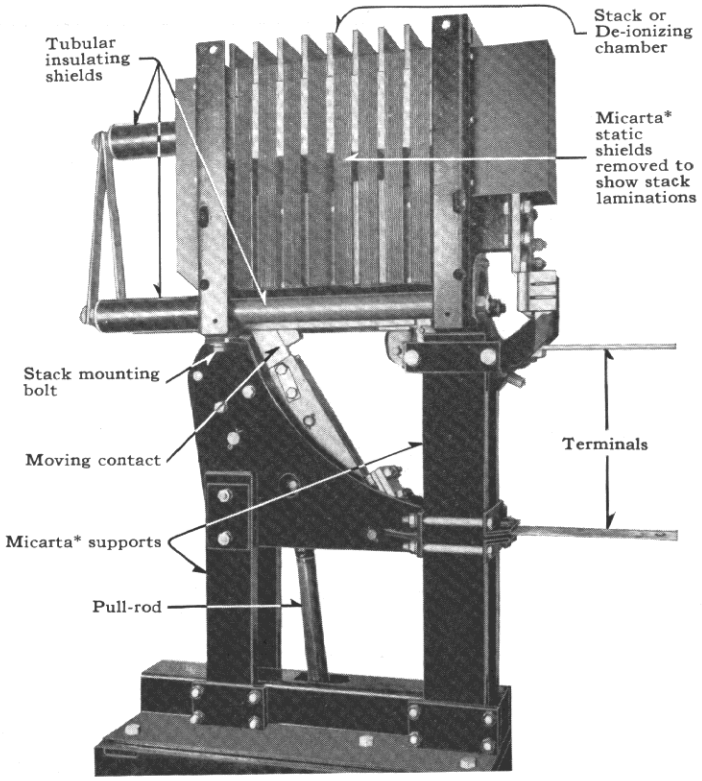

FIG. 2—SIDE VIEW OF SINGLE-POLE UNIT, TYPE 150-U-12 "DE-ION" AIR CIRCUIT BREAKER, STATIC SHIELD REMOVED

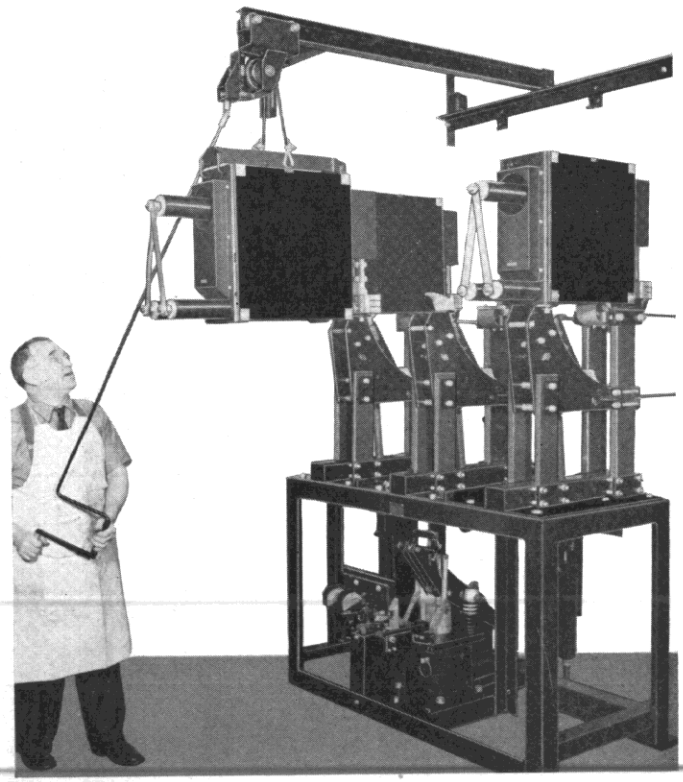

FIG. 3—USE OF STACK LIFTER WHEN INSTALLING OR REMOVING STACK OF TYPES 150-U-12 AND 150-U-22 "DE-ION" AIR CIRCUIT BREAKERS

The breakers have been designed for indoor service only, especially in generating and industrial plants where reliability under severe operating duty and minimum space required is of paramount importance. Breakers are of multiple single pole construction, single throw, and essentially of remote control form only. Breakers are available in one, two, three and four pole arrangements with mechanically and electrically trip free solenoid operating mechanism. In normal automatic short circuit protection the usual overload protective features, auxiliary switches, etc. can be added.

Due to the inherent characteristics of the breaker such as high speed arc control, arc resisting contacts, excellent mechanical construction, absence of oil, the reduction of maintenance has led to its use in highly repetitive services approaching contactor duty, such as reversing breakers for steel mill motors and primary breakers for arc furnaces on voltages of 6600 and 13,800 volts.

* Trademark registered.

TYPE "U" "DE-ION" AIR CIRCUIT BREAKERS—Continued

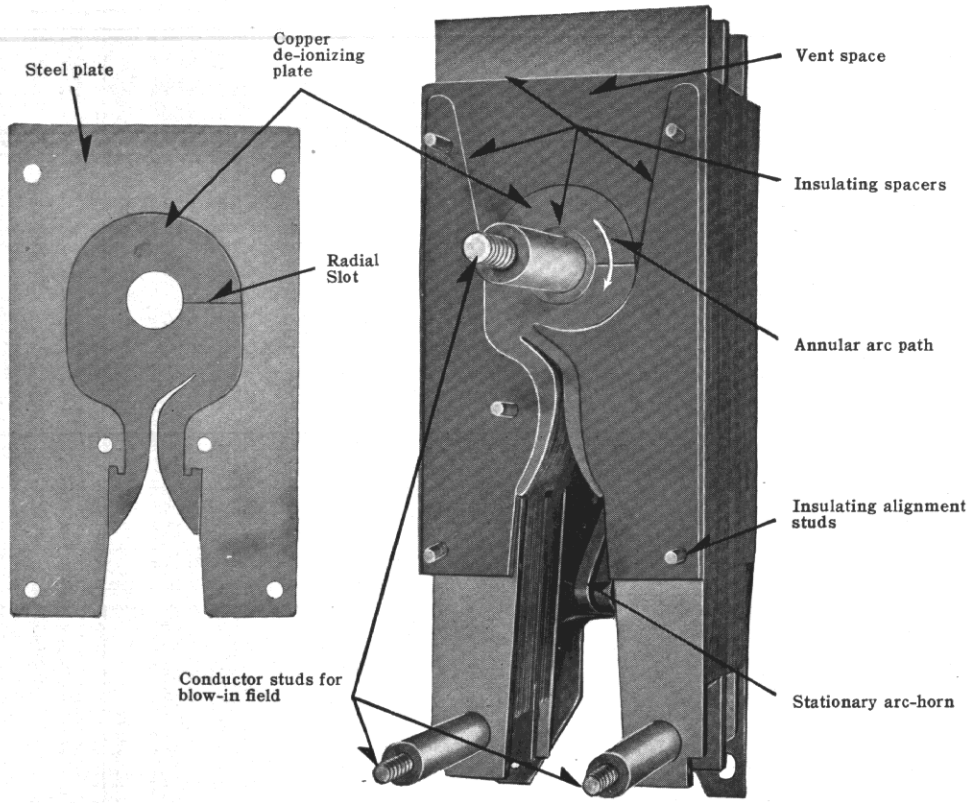

FIG. 4—PARTIALLY ASSEMBLED DE-IONIZING CHAMBER OF TYPE 25-U-25 "DE-ION" AIR CIRCUIT BREAKER

NOTE—The copper and steel plates are arranged in pairs in the same plane. These pairs of plates are spaced apart by the insulating spacers which are so shaped as to define the annular path in which the short arcs rotate and also to form individual vents for each short arc. The radial slots in the copper plates reduce eddy currents in these plates which in turn prevents weakening of the magnetic fields for rotating the short arcs in the annular paths.

Principle of Operation

The theory of operation of the De-ion air breaker is unlike that of any previous conventional breaker. Oil circuit breaker arc extinction is based upon the theory of the extinction of the long a-c. arc. The De-ion air circuit breaker theory concerns the short a-c. arc.

In this circuit breaker an arc is drawn in air and forced into a de-ionizing chamber where it is broken up into a multiplicity of short arcs which are moved over metal plates at a velocity sufficient to prevent burning. This movement of the arcs is maintained over an annular path until the current wave reaches zero, after which the arcs between the metal plates are de-ionized simultaneously, quickly changing from a good conductor to a good insulator. Thus, the arc is prevented from re-establishing and the circuit is thereby interrupted. See Fig. 1.

Investigation of the fundamental principles governing the conduction of electrical energy in a gas such as air, indicates that a thin layer of air immediately adjacent to the cathode (copper plate in de-ionizing chamber) regains its insulating qualities almost instantly, while the remainder of the arc path builds up at a much slower rate. As the current wave in an alternating-current arc approaches zero, and for a short time immediately following zero, the factors producing new ions in the arc path have practically ceased their activity. Initially the density of positive ions and electrons may be considered as substantially equal throughout, but the application of an electric field, due to the recovery voltage, disturbs this equality and the field becomes distorted. At the cathode, (copper plate in stack) electrons are repelled and positive ions are attracted. A positive space charge, therefore, develops in front of each copper plate which increases the dielectric strength there. Thus a thin layer of air immediately adjacent to each of the plates, the cathode layer, becomes de-ionized in an exceedingly short space of time.

Theory and experiment indicate that the first 250 volts, peak value, or about 175 volts R.M.S. value, are borne almost entirely by each cathode layer and that the ability to withstand this voltage is attained in a fraction of a microsecond. In order to provide a factor of safety in breaker design, sufficient gaps are used to give a working stress of about 110 volts per gap.

In the "De-ion" circuit breaker a single long arc drawn between the contacts is broken up into a large number of short arcs in series, each short arc no longer than the width of the thin air space between the plates. Since each short arc can withstand 110 volts almost instantaneously after zero current, 100 short arcs for instance, can withstand 110 x 100 or 11,000 volts and interrupt such a circuit. This is the principle upon which the "De-ion" circuit breaker operates.

Due to the fact that the metal plates of the de-ionizing chamber are insulated from each other, the restored voltage will not be distributed equally among the arc spaces and some would be overstressed in voltage and others would be understressed. For this reason, on the higher voltage breakers, static shields are applied to give a substantially uniform distribution of voltage over the spaces between the plates.

TYPE "U" "DE-ION" AIR CIRCUIT BREAKERS—Continued

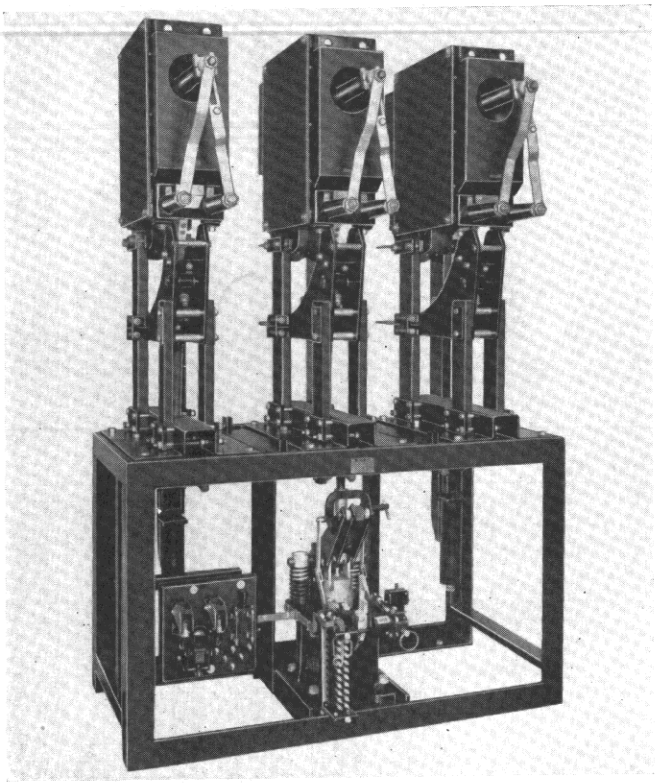

FIG. 5—TYPE 150-U-22 "DE-ION" AIR CIRCUIT BREAKER
Note clips between poles for interphase barriers.

From the time the arc leaves the arcing contacts, it must be handled as a cold cathode arc; in other words, it must be kept moving fast enough to prevent metal at the arc terminals from burning. Tests indicate the arcs travel over the de-ionizing plates at several times the velocity of sound. A specially designed blow-in magnet produces this rapid movement of the arc from the point at which it is drawn on the contacts to the transfer to the de-ionizing plates where it is cut into a series of short arcs. These arcs travel at a very high velocity and the action which is finally to dispose of them cannot take place until the current zero is reached. Radial coils, in series with the arc, arranged between the plates at intervals throughout the stack produce a circular motion of the arcs at high velocity during whatever period may remain of the particular half cycle in which they were transferred to the plates.

Although a description of this process of operation may seem lengthy, the time required for the De-ion air breaker to interrupt the circuit is very short. For currents above a few hundred amperes, the arc is drawn at the arc tips, moved into the stack of plates and interrupted within one cycle of arcing or less.

Construction

A **three-pole breaker** consists of three de-ionizing chambers or stacks and a solenoid operating mechanism.

The **de-ionizing chambers** are mounted at the extreme top of the structure and are so arranged that an arc drawn on the arcing contacts is driven directly into it by a magnetic blow-in field.

The de-ionizing chamber consists essentially of a stack of thin copper plates spaced a short distance apart by thin insulating spacers so that one surface of each plate forms the cathode of a short arc, the general arrangement being as shown in Fig. 5 which is a view of a 15 Kv. chamber partially dismantled. It is this part of the circuit breaker which actually interrupts the arc.

The arc is drawn at the two contacts shown below the arc horns which extend downward from the two ends of the plate stack. It is blown, by means of a powerful magnetic field, upward along the horns and against the plates. Each plate is similarly shaped with a tapered slot at the lower end. As the arc enters the tapered end slots, it diminishes in size which causes it to require a higer voltage and as a result, when the arc reaches the ends of the slots, it attaches itself quite readily to the plates, forming a short arc between each pair of plates. The arcs are then caused by magnetic fields to move very rapidly over the surface of the plates, around the circular pathway, until a zero point occurs in the current wave, at such a high velocity that no metal is burned.

With this annular path for the arc a very important advantage is obtained. The de-ionizing structure becomes an almost completely closed structure. The arc, when driven in, cannot get out again, and stays in until its extinction at the end of a half cycle.

The De-ionizing chamber may be raised for the purpose of inspecting the contacts and other parts which are inaccessible when the stack is in the normal operating position. A special lifting device may be furnished for the purpose of raising the stack and holding it up for inspection purposes.

Solenoid operating mechanism used is mechanically and electrically trip free in all positions of stroke and is the same mechanism used with corresponding indoor oil circuit breakers. The usual trip coils, auxiliary switches, operation counter and control relay panel are furnished as standard equipment.

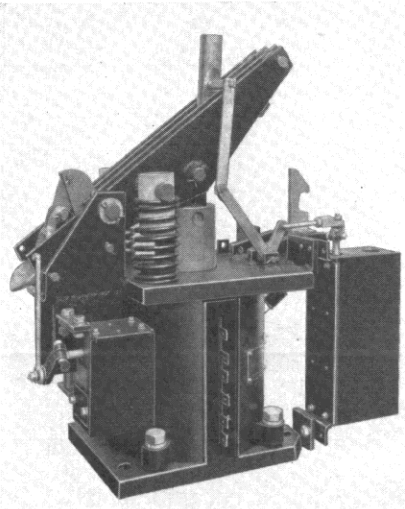

FIG. 6—TYPE SA-3 SOLENOID OPERATED MECHANISM IN OPEN POSITION

TYPE "U" "DE-ION" AIR CIRCUIT BREAKERS—Continued

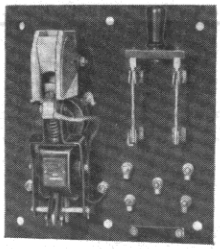

FIG. 7—CONTROL PANEL, COVER REMOVED

Trip-Free Control Panel

Standard equipment includes a trip-free control relay on a panel with a 2-pole, single-throw knife switch and five terminal studs. A cover encloses the panel completely. This trip-free feature prevents the burning out of the closing coil in case the control switch is held in the "close" position. If a short circuit exists at the time the breaker is closed, the breaker trips open and will not reclose even though the control switch is held in the "close" position. This feature prevents pumping.

Rectox* Rectifier

Where only a-c. is available for closing, an inexpensive full wave rectifier is recommended for use in conjunction with the solenoid mechanism. The complete rectifier for indoor service includes the Rectox element, also adjustable resistor, and fuses on the a-c. side, all mounted on a panel.

The adjustable resistor is supplied in order that the Rectox d-c. voltage and current may be adjusted to suit the breaker solenoid requirement, the lead resistance and the regulation of the a-c. supply. The fuses are supplied to protect the rectifier in case the load remains connected longer than the normal time. Fuses are rated at 30 to 50 per cent of the normal a-c. current drawn at full breaker closing current. A standard type "S" distribution transformer of suitable capacity is recommended for supplying 230 volts to the Rectox.

FIG. 8—TYPE "U" "DE-ION" AIR CIRCUIT BREAKER, 150-U-12, 600-AMPERE, 15,000 VOLTS, METAL-CLAD HORIZONTAL DRAWOUT ASSEMBLY

* Trademark registered.

TYPE "U" "DE-ION" AIR CIRCUIT BREAKERS—Continued

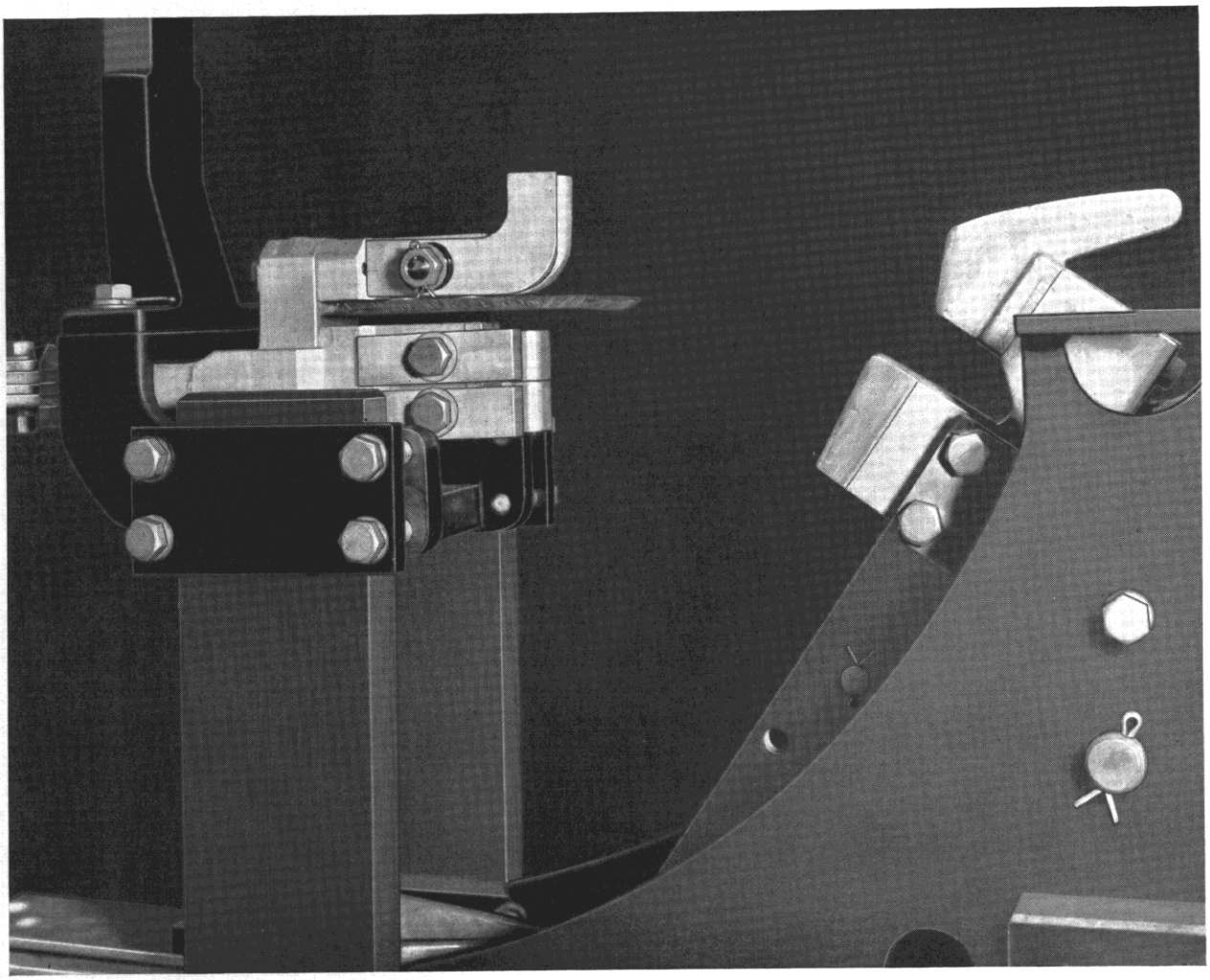

FIG. 9—1200-AMPERE CONTACTS, 150-U-12 OR 150-U-22 WITH ARC CHUTE REMOVED

TYPE "U" "DE-ION" AIR CIRCUIT BREAKERS—Continued

TABLE I

POWER AIR CIRCUIT BREAKER CHARACTERISTICS

Breaker Rated Voltage	Type of Breaker	Descriptive Data	Insulation Voltage Class	* Rated Amps. 60 Cycle	* Rated Amps. 25 Cycle	Interrupting Kv-a.	Short Time RMS Total Amps. Momentary Rating	Interrupting Capacity Current Limitation (Amps.)	Maximum Interrupting Capacity Rating in Amperes at Service Voltages — Volts 2300	2500	4150	5000	6600	7500	12000	15000	Breaker Time at 60 Cycle
2500	25-DH-100	33-670	7500	600	700	100000	40000	25000	25000	23000							8 Cy.
	25-DH-100	3-670	7500	1200	1400	100000	45000	25000	25000	23000							8 Cy.
	25-DH-100	33-670	7500	2000	2250	100000	50000	25000	25000	23000							8 Cy.
2500	25-DH-150	33-670	7500	1200	1400	150000	60000	37500	37500	35000							8 Cy.
	25-DH-150	33-670	7500	2000	2250	150000	60000	37500	37500	35000							8 Cy.
†5000	50-DH-50	.....	7500	600	700	50000	25000	12500	12500	11500	7000	6000					8 Cy.
†5000	50-DH-50	.....	7500	1200	1400	50000	25000	12500	12500	11500	7000	6000					8 Cy.
5000	50-DH-100	33-670	7500	600	700	100000	40000	25000	25000	23000	13800	11500					8 Cy.
	50-DH-100	33-670	7500	1200	1400	100000	45000	25000	25000	23000	13800	11500					8 Cy.
	50-DH-100	33-670	7500	2000	2250	100000	50000	25000	25000	23000	13800	11500					8 Cy.
5000	50-DH-150	33-670	7500	600	700	150000	40000	25000			21000	17500					8 Cy.
	50-DH-150	33-670	7500	1200	1400	150000	45000	25000			21000	17500					8 Cy.
	50-DH-150	33-670	7500	2000	2250	150000	50000	25000			21000	17500					8 Cy.
5000	50-DH-250	33-670	7500	1200	1400	250000	60000	36000			36000	30000					8 Cy.
	50-DH-250	33-670	7500	2000	2250	250000	70000	36000			36000	30000					8 Cy.
7500	75-U-22	33-675	15000	1200	1400	250000	40000	23000					23000	20000			8 Cy.
	75-U-22	33-675	15000	2000	2250	250000	50000	23000					23000	20000			8 Cy.
15000	150-U-12	33-675	15000	600	700	250000	30000	14000							12000	10000	8 Cy.
	150-U-12	33-675	15000	1200	1400	250000	30000	14000							12000	10000	8 Cy.
	150-U-12	33-675	15000	2000	2250	250000	30000	14000							12000	10000	8 Cy.
15000	150-U-22	33-675	23000	1200	1400	500000	80000	24000							24000	20000	8 Cy.
15000	150-CA-500	33-680	23000	1200	1400	500000	80000	45000					45000	40000	24000	20000	8 Cy.
15000	150-CA-1000	33-680	23000	1200	1400	1000000	90000	55000							48000	40000	8 Cy.
	150-CA-1000	33-680	23000	3000	4000	1000000	100000	60000							48000	40000	8 Cy.
15000	150-CA-1500	33-680	23000	2000	2250	1500000	130000	80000							72000	60000	8 Cy.
	150-CA-1500	33-680	23000	4000	5000	1500000	130000	80000							72000	60000	8 Cy.
15000	150-CA-2500	33-680	23000	4000	5000	2500000	180000	110000							110000	100000	8 Cy.
	150-CA-2500	33-680	23000	5000	6000	2500000	180000	110000							110000	100000	8 Cy.
									Maximum Interrupting Capacity Rating in Amperes at Service Voltages						22000 Volts	34500 Volts	
34500	345-CA-1000	33-680	34500	1200	1400	1000000	60000	30000							27000	17000	8 Cy.
34500	345-CA-1500	33-680	34500	1200	1400	1500000	70000	40000							40000	25000	8 Cy.

* The 25 cycle breaker may not have same dimensions as the 60 cycle breaker of same Kv-a. rating. Refer all 25 cycle applications to the nearest Westinghouse Sales Office.

† The 50-DH-50 breakers are available in Metal-Clad equipment only.

TABLE II

CLOSING AND TRIPPING CURRENTS, WEIGHTS—TYPE "U" BREAKERS

Type	Maximum 60 Cy. Current Capacity Amperes	Closing and Tripping Currents — Closing 125 V.	Closing 250 V.	Tripping 24 V.	Tripping 125 V.	Tripping 250 V.	Shipping Weight—Lb.
75-U-22	1200	88	54	20	6	3.0	2100
75-U-22	2000	88	54	20	6	3.0	2500
150-U-12	600	88	54	20	6	3.0	3000
150-U-12	1200	88	54	20	6	3.0	3100
150-U-12	2000	88	54	20	6	3.0	3500
150-U-22	1200	75	40	40	11	8.5	3500

TYPE "U" "DE-ION" AIR CIRCUIT BREAKERS—Continued

OUTLINE DIMENSIONS IN INCHES

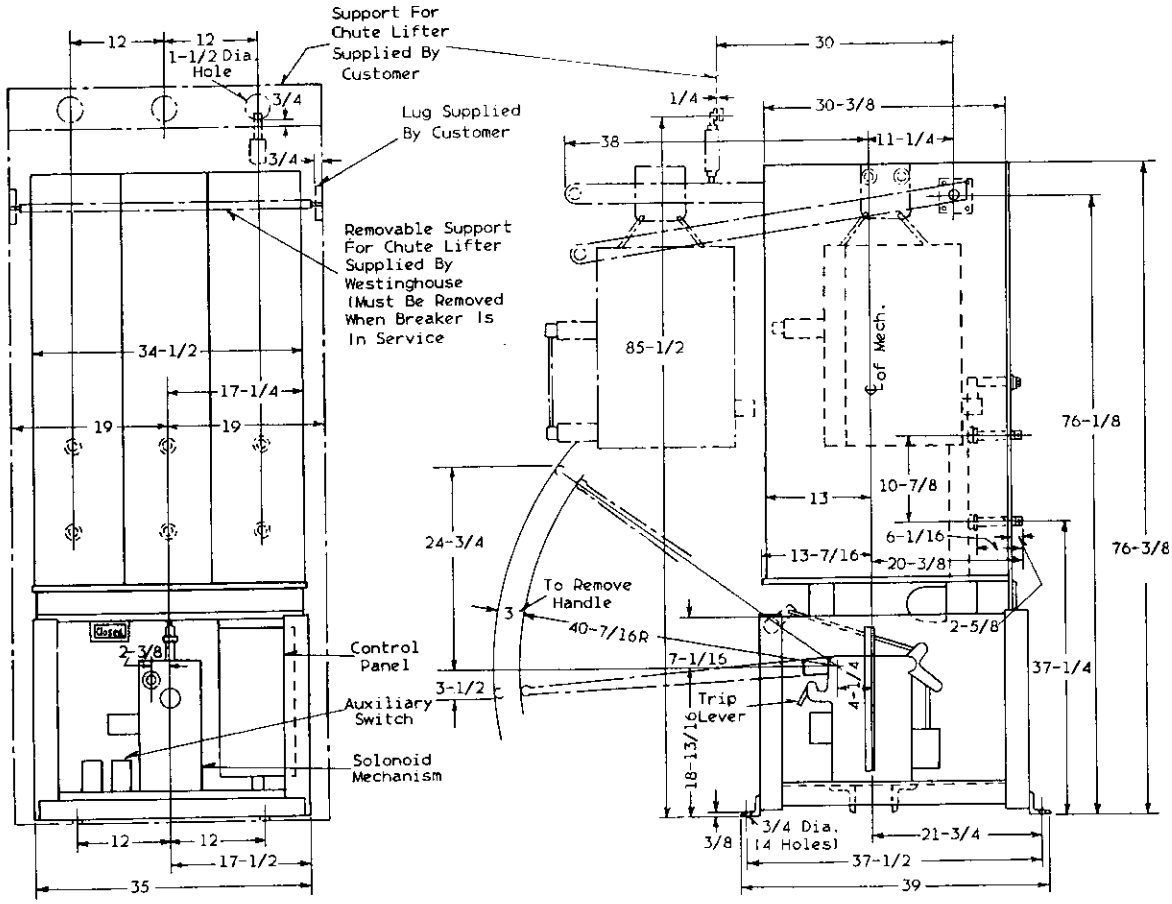

FIG. 10—OUTLINE DIMENSIONS OF TYPE 75-U-22, 1200- AND 2000-AMPERE, 3-POLE "DE-ION" AIR CIRCUIT BREAKER

Dimensions are for reference only. For official dimensions refer to the nearest Westinghouse Sales office.

TYPE "U" "DE-ION" AIR CIRCUIT BREAKERS—Continued

OUTLINE DIMENSIONS IN INCHES—Continued

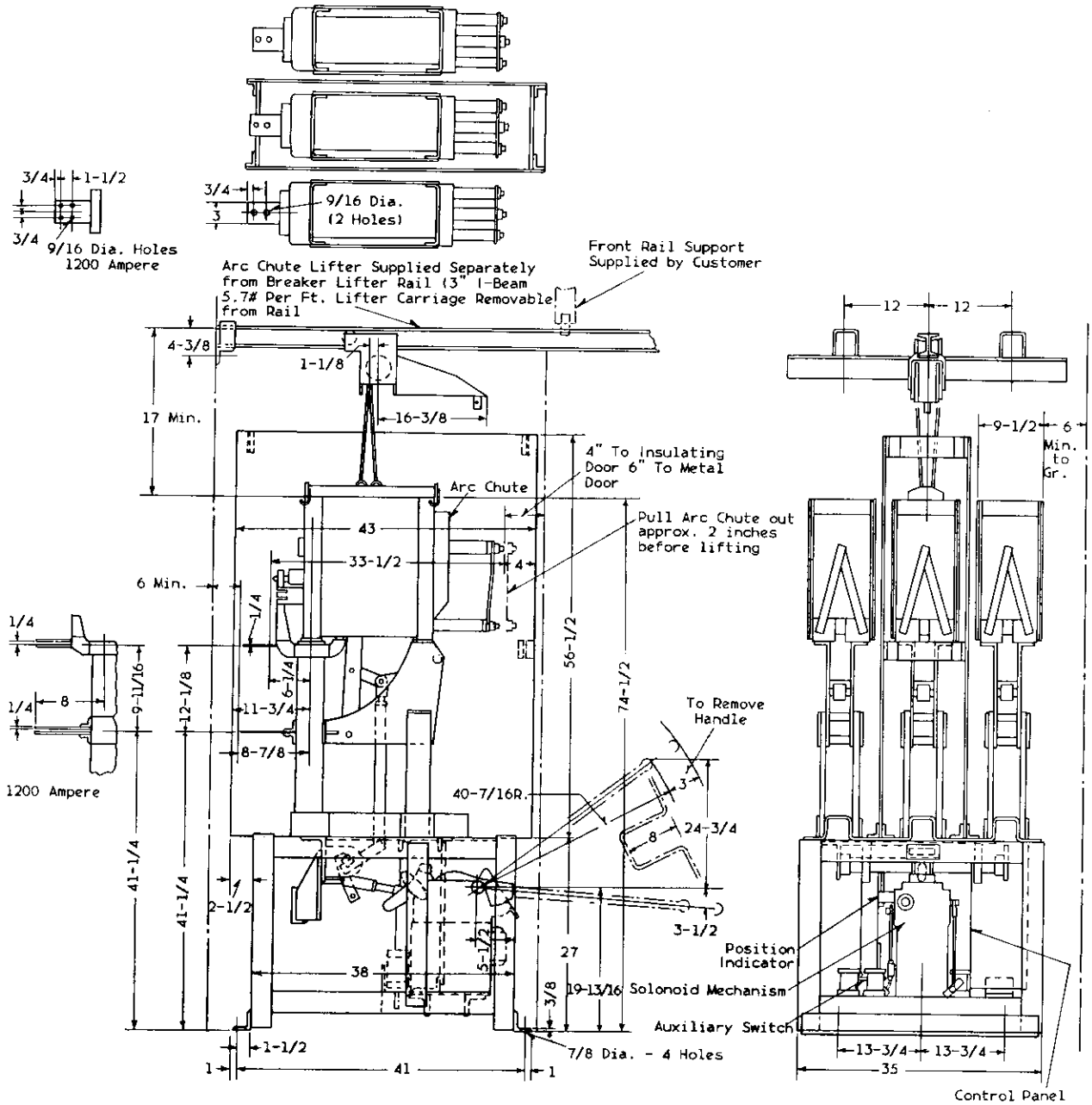

FIG. 11—OUTLINE DIMENSIONS OF TYPE 150-U-12, 3-POLE, "DE-ION" AIR CIRCUIT BREAKER

Dimensions are for reference only. For official dimensions refer to the nearest Westinghouse Sales office.

TYPE "U" "DE-ION" AIR CIRCUIT BREAKERS—Continued

OUTLINE DIMENSIONS IN INCHES—Continued

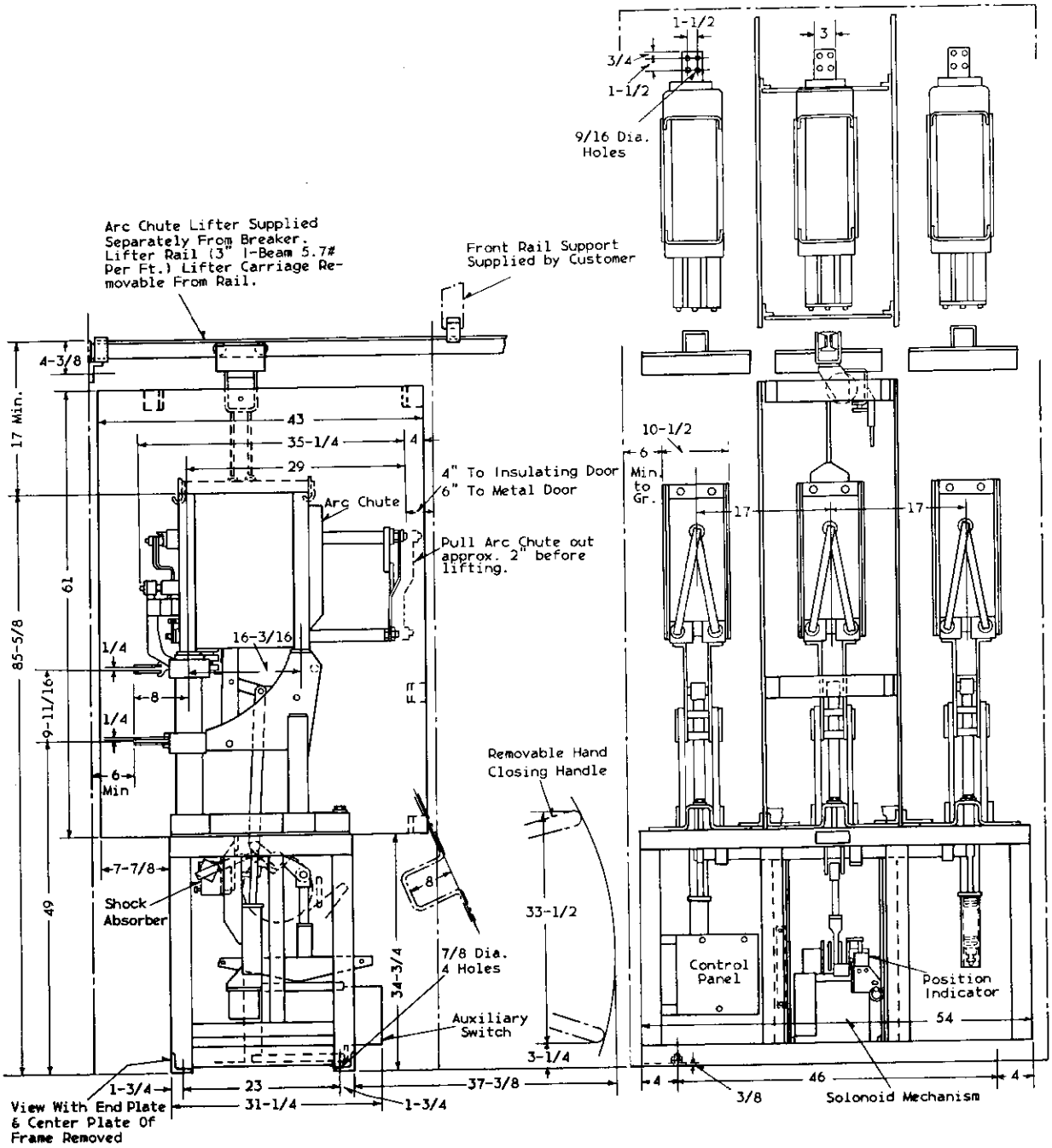

FIG. 12—OUTLINE DIMENSIONS OF TYPE 150-U-22, 3-POLE, "DE-ION" AIR CIRCUIT BREAKER

Dimensions are for reference only. For official dimensions refer to the nearest Westinghouse Sales Office.