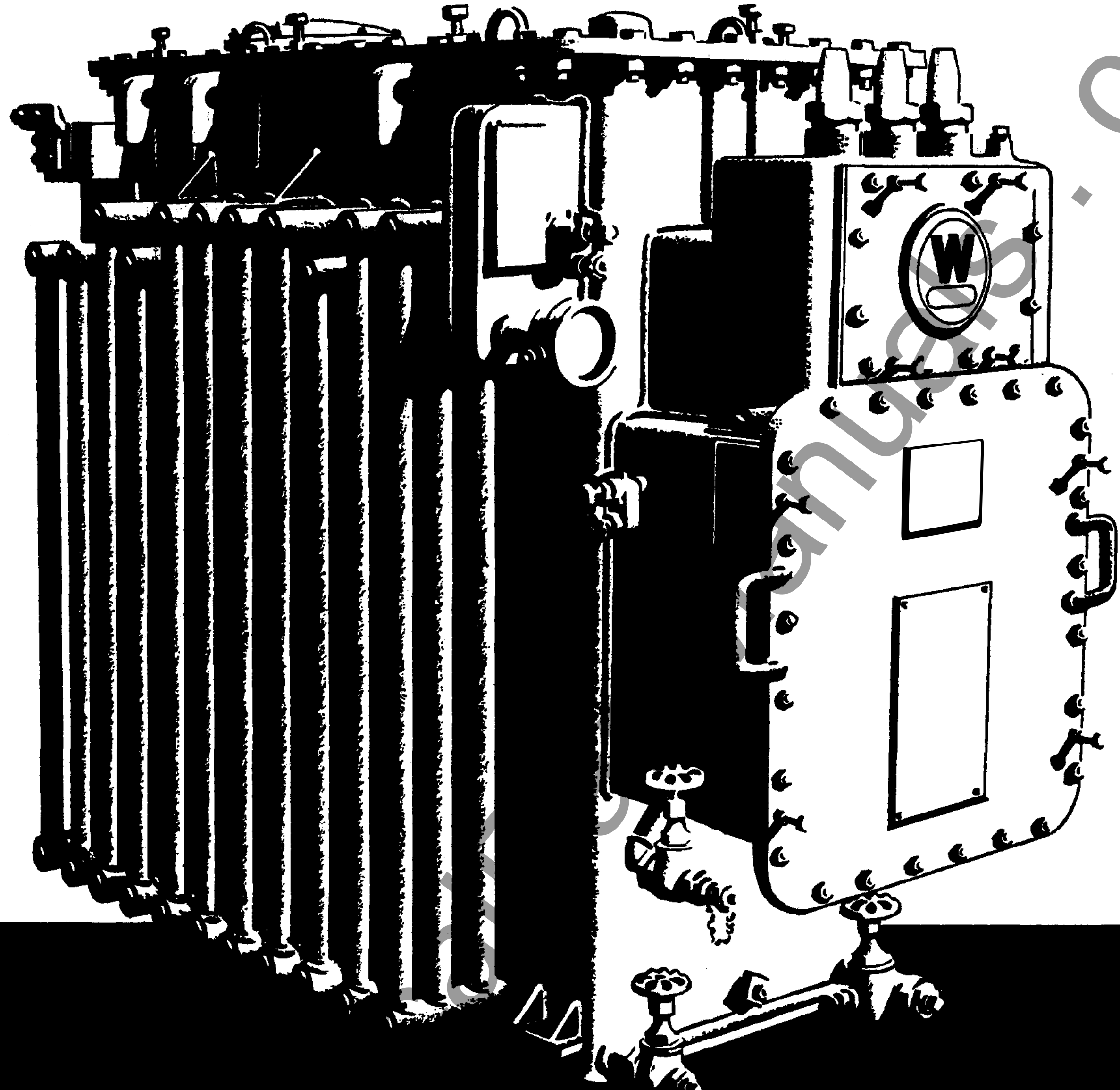
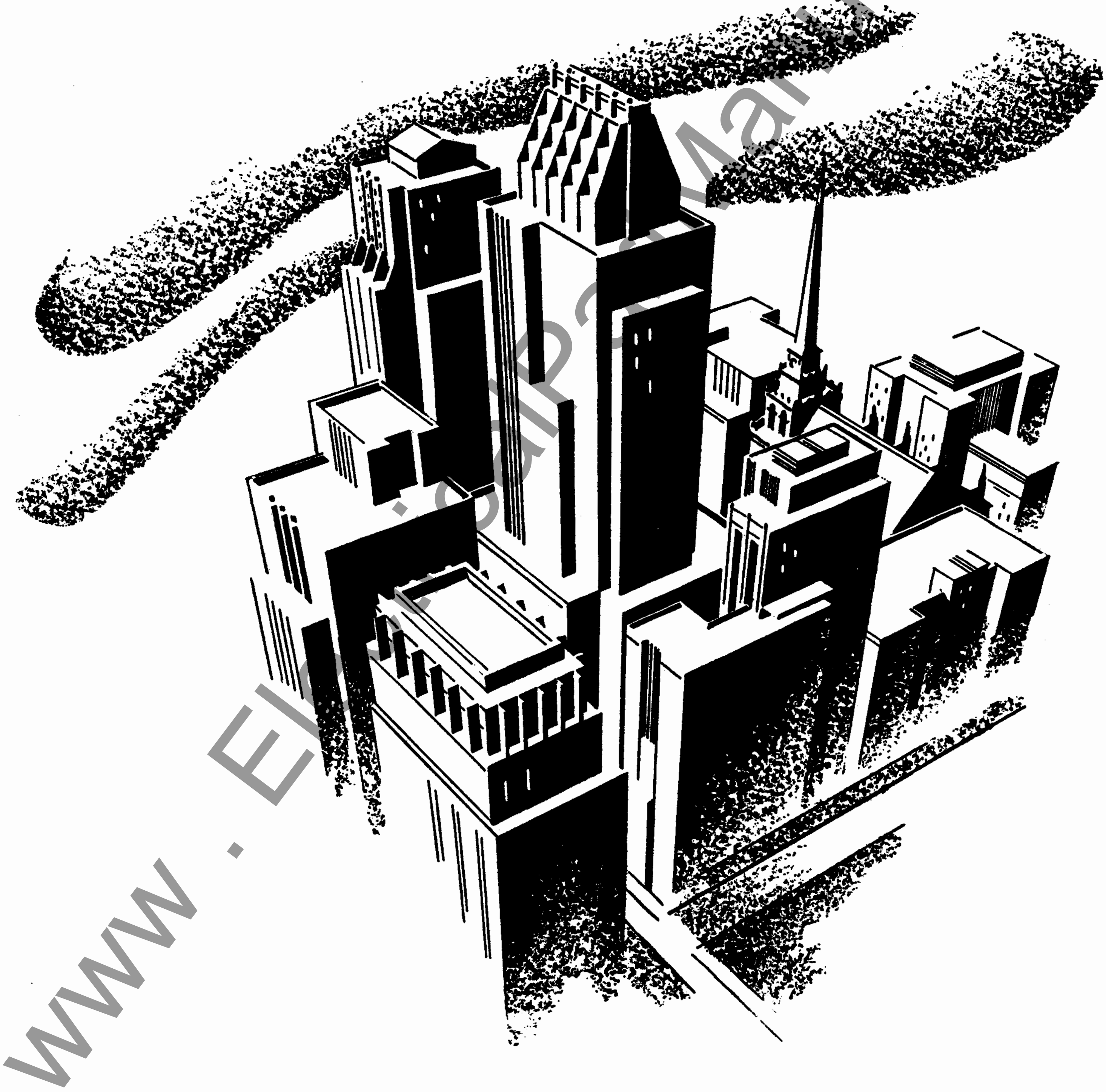
DATA 35-500



WESTINGHOUSE NETWORK TRANSFORMERS

WESTINGHOUSE

Westinghouse Network Transformers



— *Experience since the FIRST network . . .*

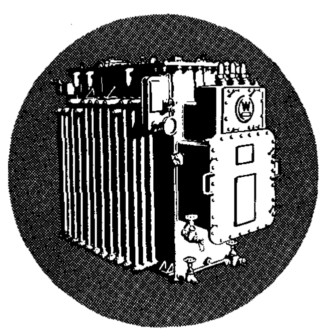
Advanced Design for the NEWEST!

Westinghouse experience with network transformers starts with the installation of the first secondary network distribution system nearly 20 years ago.

The possibilities of economy and service continuity which Westinghouse engineers recognized at that time have stimulated continuous research and development to extend those advantages more widely. They have been extended both through the increasing number of networks installed—and through the numerous improvements in equipment which Westinghouse has contributed.

The network equipment which Westinghouse provides today represents an accumulation of experience throughout the history of secondary network operation in the United States. During this time Westinghouse engineers have worked in close co-operation with power company engineers. The staff of the Consolidated Edison of New York, Inc., operators of the largest network system in the world, has aided in important developments. As a result Westinghouse Network Transformers and other network equipment combine the most complete field experience with research, engineering, and manufacturing facilities of recognized superiority throughout the world.

In this equipment, specifically designed to meet the special requirements of network operation, network operators find the best possible assurance of economy in installation, reliability in operation, and simplicity in maintenance.



Secondary Networks Improve

Vertical networks have solved special distribution problems in buildings of this type.

The Automatic Secondary Network System is the most reliable method yet developed to distribute power in concentrated load areas. Since the first automatic network system was installed in 1922, 164 cities have adopted the system. These cities range in population from 5,000 to 7,000,000, with over 40 per cent being under 100,000.

In many cities which have been partially served by networks, power companies now are extending the system to take advantage of additional savings and improved service. Other cities are finding that a complete change-over from radial to network systems is economical and a source of improved service.

A Type of Network for Every Requirement

Network systems properly applied will greatly reduce stand-by capacity needed in transformers for maximum reliability of service. A network system is simply a means for supplying power to a desired location *with two or more* paths *from the same* power source. Should one path fail, a second path will *instantly* and *automatically* take over. Applied to a city, a network usually extends its line up and down every street with solid connections at every intersection, forming a giant grid. A network system, for instance, can be designed to supply power from a transformer to an important piece of apparatus from two to four approaches—the equivalent of nearly that many stand-by distribution transformers with individual feeders.

Should trouble develop on any one of these approaches, there still would be lines capable of carrying the full load.

Networks Give These Advantages

1. The first cost of network systems is generally lower than that of any other distribution system.
2. The need for converter and transformer substations in high rent districts is eliminated. Substantial savings result in converting equipment, buildings, land or rent and annual charges.
3. Use of expensive heavy secondary mains is minimized. Transformers can be located close to the load. Same secondaries are used for both power and light without light "flicker" when motors start.
4. Larger—and more economical—sizes of transformers can be used, because the transformers feed into a common light and power secondary grid.
5. Transformer sizes can be standardized to a large extent—fewer sizes are required.
6. Current losses in secondary mains are minimized because secondary runs are comparatively short.
7. The network holds the load on the line in case of faults without resort to emergency tie switches or banked transformers.
8. Continuity of service can be maintained without use of storage batteries. Networks have proved their ability to maintain continuity of service equal to that of the source of supply.
9. Number and size of high-voltage feeders and the power losses of the feeders are greatly reduced because higher voltages can be employed. Subsurface congestion is relieved.
10. Maintenance is simplified—repairs and extensions can be made without service interruptions.

Service

over the complete range of Concentrated Load Requirements

Depending on location and type of service, network systems generally are classified as one or a combination of the following five classes:

Underground secondary networks—for metropolitan centers where equipment must be placed out of the way, where load concentrations are extremely high, and where continuous service is extremely important.

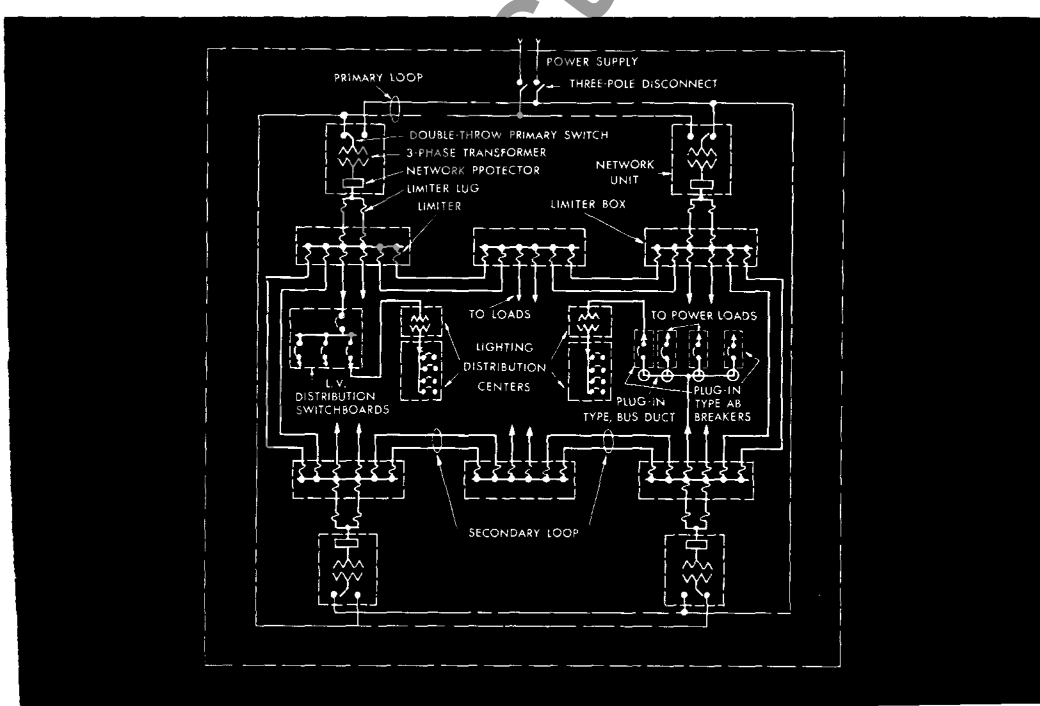
Overhead secondary networks—used in medium density residential or commercial areas where continuity of service is important but where congestion has not reached the point at which underground equipment is imperative.

Spot networks—installed for the service of individual customers with important loads requiring maximum reliability of service. Typical spot network applications include schools, hospitals, theatres, hotels, office buildings, powerhouses, and other similar loads.

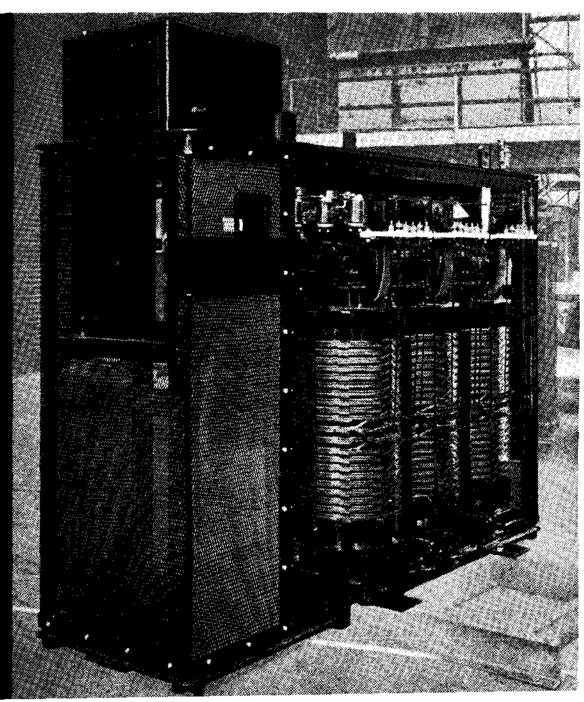
Industrial network systems—The network system in the industrial plant offers numerous advantages at a cost which compares favorably with that of the radial system: Service interruptions and delayed production due to cable faults are prevented; greater protection is afforded against sabotage of shop power lines; voltage regulation is practically uniform throughout the plant, often with savings in motor control equipment; loads can be rearranged or increased at a minimum cost.

The new ASL Air-cooled Transformers or the non-inflammable liquid-filled types, the new Westinghouse double-throw switch to reduce spare transformer capacity to a minimum, the new Westinghouse Limiters to keep secondary currents at safe values—all these contribute to making the Westinghouse Secondary Network System a method of power distribution which is safe, foolproof—and flexible enough to meet changing conditions and power emergencies better than any other system yet devised for industrial plants.

Vertical networks—a further development of the spot network to meet the special needs of tall buildings. Each may include a series of spot networks at various levels to provide maximum reliability of service at lowest possible cost.

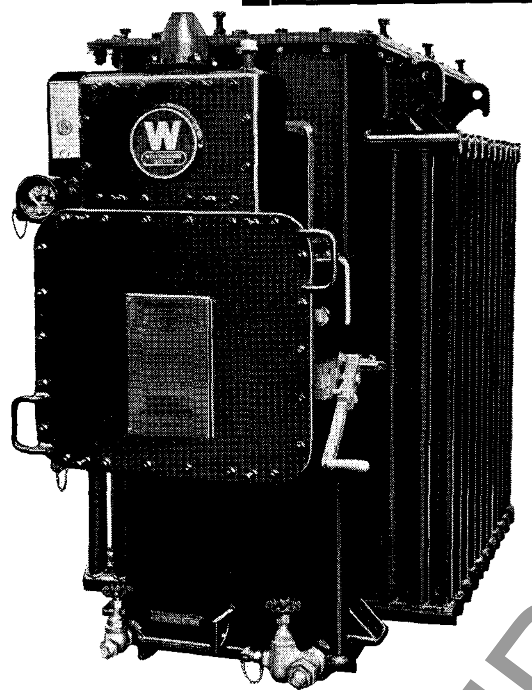


Many industrial plants today are adopting the network system for local distribution of power with maximum dependability. This diagram is illustrative of a typical plant network system.

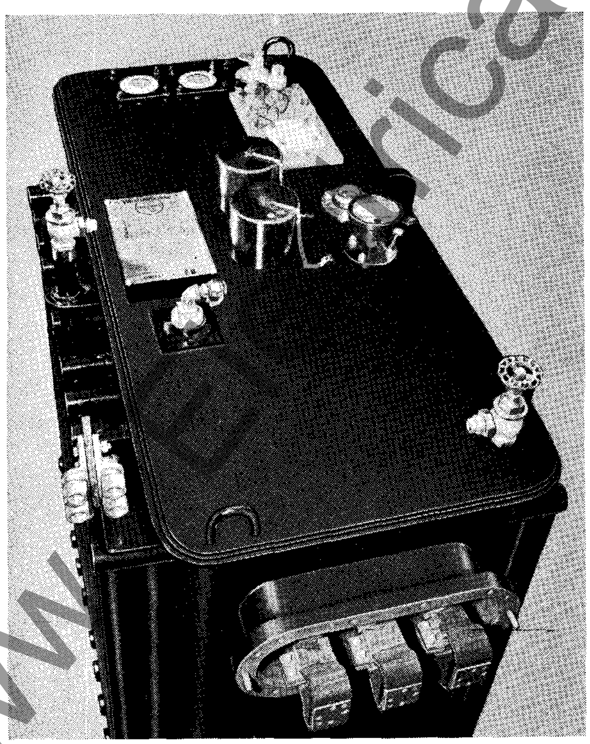


Partially completed air-cooled type ASL Network Transformer.

Westinghouse has Standard



The Westinghouse Standard Subway Network transformer meets all requirements of most underground network systems.



All controls are cover-mounted in this network transformer for congested areas.

It makes no difference what type of network you require or what your network problems are. Westinghouse has a transformer that will fit the requirements. Inside, outside, underground, or overhead, Westinghouse has the right transformer for that particular job.

A Compact, Efficient, Quiet Operating Transformer

From extensive experience with every variety of network problem, Westinghouse has developed a standard subway network transformer incorporating *all* the features necessary for safe dependable network operation.

This transformer is designed to fulfill all the requirements of most underground network systems. Extreme care is taken in every step of construction to assure maximum operating reliability. All necessary auxiliary devices such as liquid level gauges, valves, tap changers, switches, and protective interlocks assure proper operation and continuous service.

These transformers are available with either oil or Inerteen. Inerteen is a noninflammable cooling and insulating liquid.

For Maximum Accessibility in Vaults in Congested Areas— Accessories are Cover-mounted

Developed in close co-operation with operating engineers of the Consolidated Edison Company of New York, this network transformer is built specifically for applications where every cubic inch of installation space is at a premium. It is designed to provide maximum speed in adjustment or inspection with absolutely minimum maintenance cost.

All controls, including tap changer, grounding switch, filter and drain valves, thermometer, and liquid level gauges are mounted on the cover within easy reach when the vault grating is removed. This reduces considerably the area required by the vault.

Transformers

for any SPECIAL network application

In some cases the transformer can be placed in a vault up to 50 per cent smaller in cubic dimensions than that needed for other designs.

Submersible—If vault is flooded, the transformer will continue to operate in full safety. All covers are watertight—they are welded on the tank. All fittings below cover also are welded. Network protector has limiter type waterproof rubber-covered low-voltage bushings to permit watertight taping.

For Overhead Networks— the Triplex Transformer

The Triplex transformer combines continuous service with pleasing appearance on overhead networks in residential areas or suburban business districts.

Triplex transformers are made by placing three single-phase core and coil assemblies, one above the other, in a slender tank. The tank is no larger in diameter than that of a standard single-phase transformer. It can be mounted directly to the pole, its shape conforming to that of the pole and making a neat appearing installation.

Co-ordinated insulation is available for protection against lightning.

For Ultimate Safety of Network Operation— Air-cooled Transformers

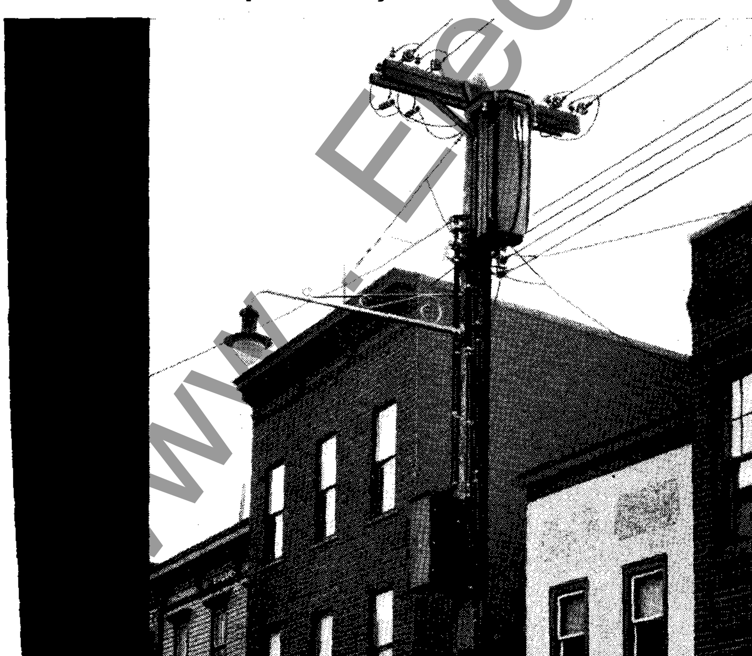
Air-cooled transformers are the latest development for complete transformer safety. This is the ideal transformer for indoor installation where large crowds of passers-by make the safety factor especially important. Because *not a drop of liquid* is required for cooling and insulating purposes, even the remotest hazard of explosion, fire, and toxic gases is eliminated.

Industrial spot networks benefit immensely with this transformer. It can be placed inside the plant near workmen and important operations with full safety. Placing it inside the plant near the load eliminates long secondary cable runs and reduces installation costs.

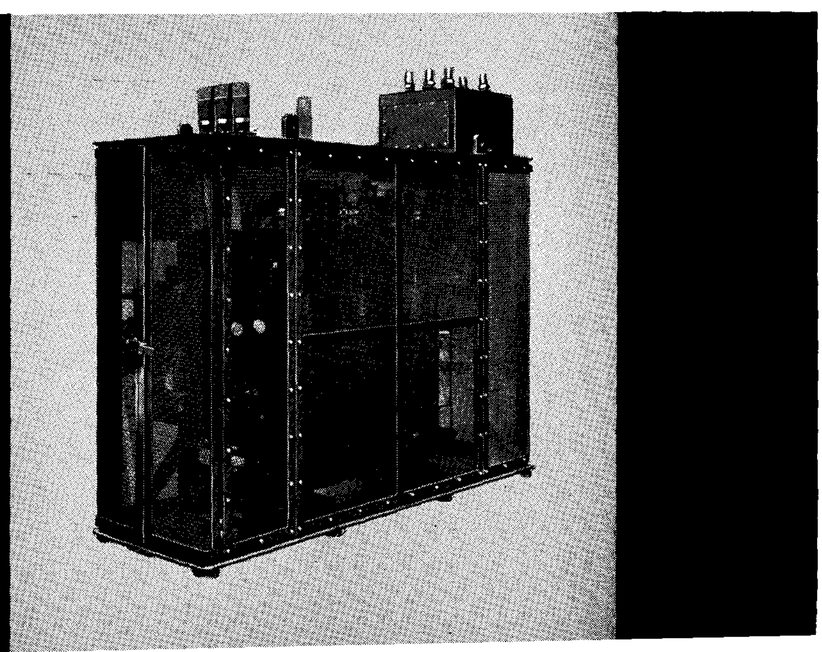
No vault is required to meet National Electric Code requirements. Dimensions and weights compare favorably with liquid-filled types. Greater economy in space requirements is possible because valves, cooling tubes, fluid level gauges, etc., have been completely eliminated.

Low maintenance—Only an occasional inspection is required. Apparatus incident to use of a liquid for cooling and insulating is eliminated entirely!

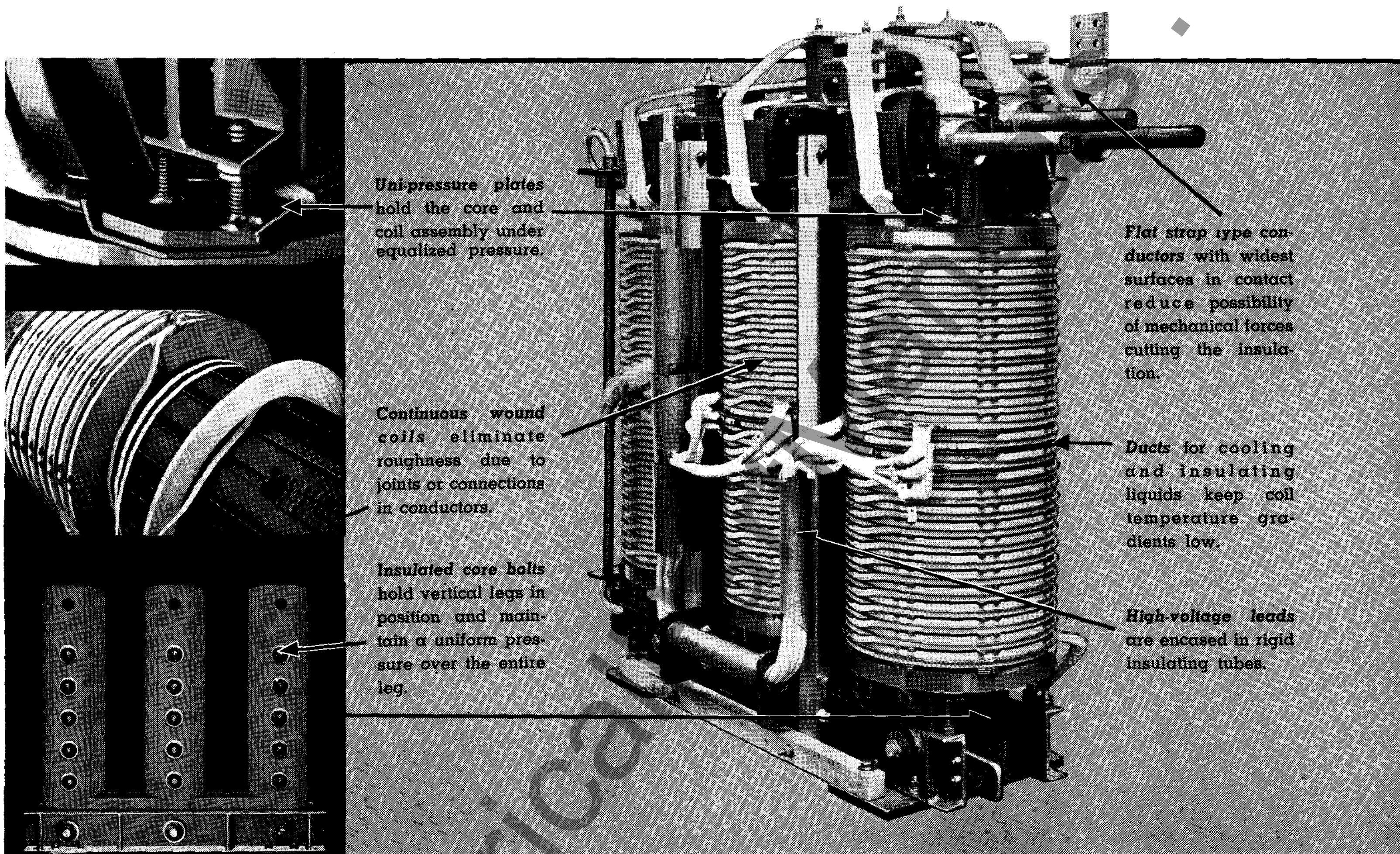
Triplex transformers are specially designed for pole mounting to serve overhead networks.



Air instead of liquid, for cooling and insulating, eliminates all explosion hazards in this air-cooled transformer.



Here's why Westinghouse Network Transformers



Selected Materials and Careful Processing Produce Efficient Magnetic Circuit

To back up the inherent reliability of the network system, it is imperative that the utmost reliability be built into network equipment. Only the best materials, combined with superior engineering and manufacturing ability and exhaustive testing, give Westinghouse Network Transformers unsurpassed reliability over a long life.

Insulation against eddy currents is provided by a thin film of insulation applied to each lamination. The insulation adheres to the metal under the most severe operating conditions. It effectively breaks up eddy current paths and minimizes losses.

Low sound level. Westinghouse engineers can calculate in advance the natural period of vibration of any core, and so can build cores that will not resonate with the magnetostriction vibrations of the core steel. This, plus the extremely low magnetostriction of the best silicon steel and the care taken to bolt the lamination tightly together, assures the lowest possible sound level.

give more dependable service, over a longer lifetime

Copper, Insulation, and Coil Structure Protect Against Troubles in Windings

Special electrolytic copper, of high ductility, removes a primary cause of insulation failures. It bends readily without developing slivers, burrs, or scales to pierce or abrade insulation, is the purest and has the highest conductivity of any copper produced.

Continuous wound coils of disc or "pancake" type construction eliminate the chance of a joint breaking from vibration or rough handling. There are no joints—coils are one continuous conductor from start to finish.

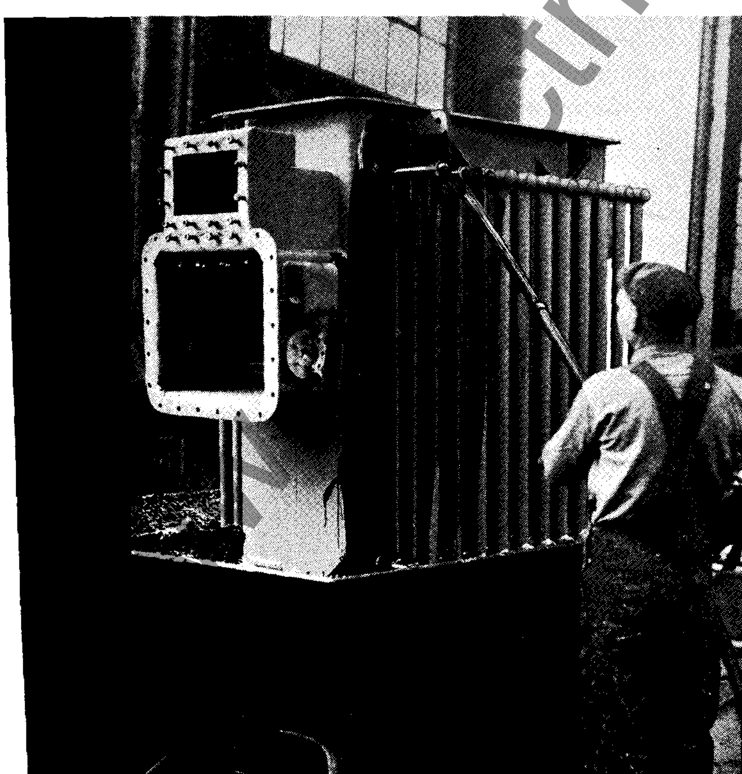
Tested insulation assures reliability. Layers of high grade insulating paper are machine wound around each conductor. The coil stack is thoroughly dried, pre-shrunk, and vacuum impregnated in its dielectric liquid assuring full insulation strength at the start. Every coil is given a high frequency turn-to-turn test to assure perfect insulation in the windings.

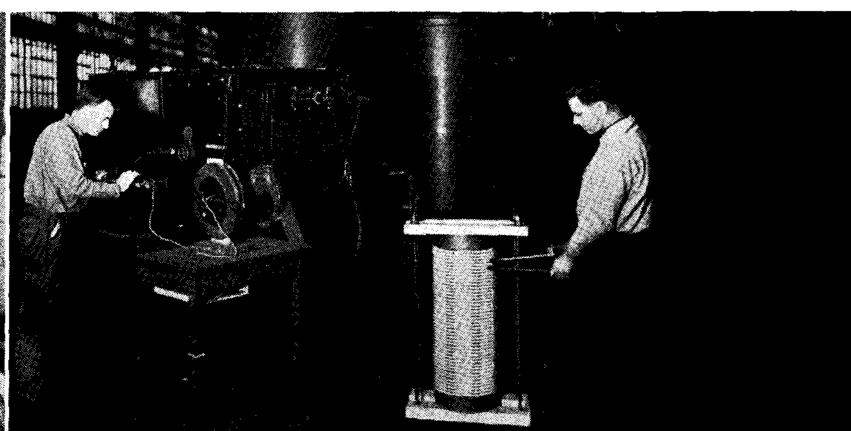
Uniform cooling of the coils is facilitated by the disc type construction. At least one side of every conductor is directly exposed to the cooling medium. Spacing of coil discs is ample to allow free circulation of cooling medium, minimizing hot spots.

Short-circuit stresses minimized by adjustable pressure plates which allow the high and low-voltage coils to be accurately centered. Centering the coils keeps short-circuit stresses in a horizontal plane and eliminates almost all tendency toward coil distortion—often the cause of insulation failures.

Low impedance—Westinghouse Network Transformers are designed to have a low impedance of from four to five per cent. This improves voltage regulation, adds greatly to the useful temporary overload range of the transformer, and practically eliminates light flicker.

Copper bearing steel tanks used on network transformers for underground service have high corrosion resistance. Coated electrode welding seals all seams against moisture. Tanks are thoroughly shot blasted to remove all grease, rust, and mill scale, then given three coats of paint by the flow process. Tanks are given a final test at 7½ pounds per square inch pressure for six hours to assure absolute fluid tightness.

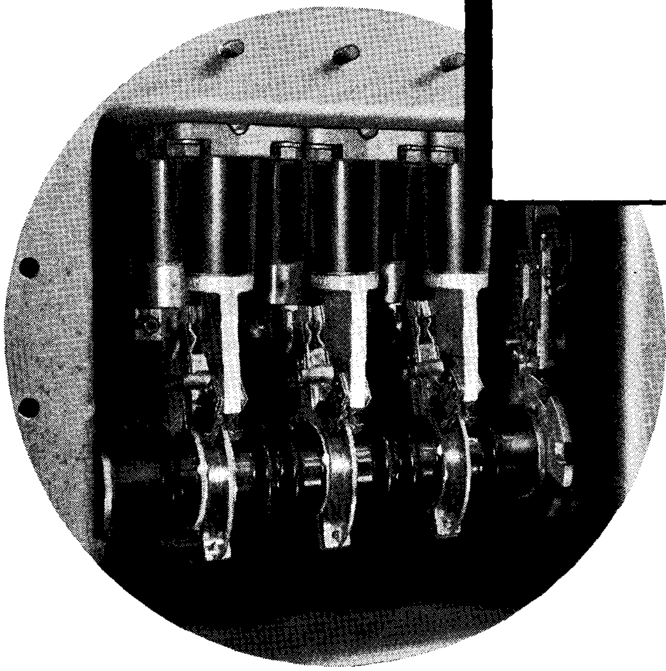




High frequency testing of transformer coils, above.

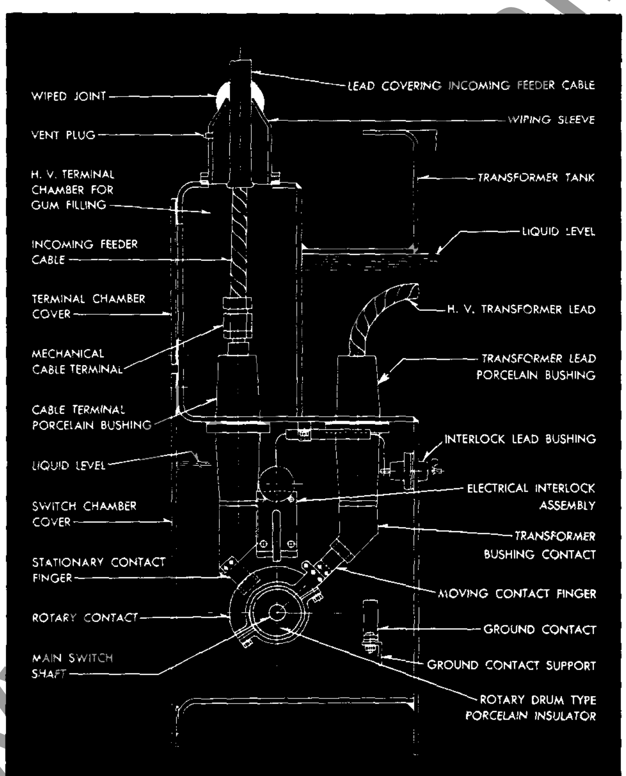
Painting Tanks—A finish which resists deterioration is put on every tank by the flow painting process. Three coats of paint, one primer and two finish coats, are applied. Each coat is baked on.

Complete accessories . . .



The rotary switch is foolproof in operation. It cannot ground a live feeder because of wrong operating sequence.

Sectional view of the rotary switch.



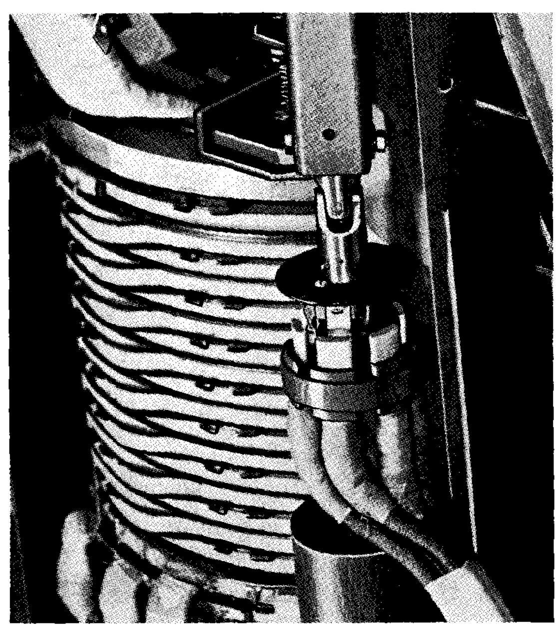
Rotary Switch Combines Simplicity — Safety

For disconnecting and grounding the transformer end of a network feeder for repairs—*to give absolute protection to workmen and equipment*—this rotary high-voltage switch is a foolproof device. No complicated device to force the proper sequence of operation is necessary. The sequence of "open" to "transformer" to "ground" is inherent. An operator cannot ground a live feeder.

Switch cannot move directly from "open" to "ground." From the "open" position the contacts swing around to "transformer" and from there to "ground." If the feeder is energized an electrical interlock operates and locks the switch in the "transformer" position so that it cannot be moved to the "ground" position until the feeder is de-energized. When the feeder is not energized the switch can be moved to "ground."

Strong construction of all parts provides complete reliability with ample support for every individual unit in the assembly. Wet-process porcelain insu-

Tap changer can be operated from outside the tank with minimum effort—nothing to stick or jam.



. *to meet any operating requirement with maximum reliability*

lators of heavy construction insulate all live parts from the tank. The switch case is welded to the tank.

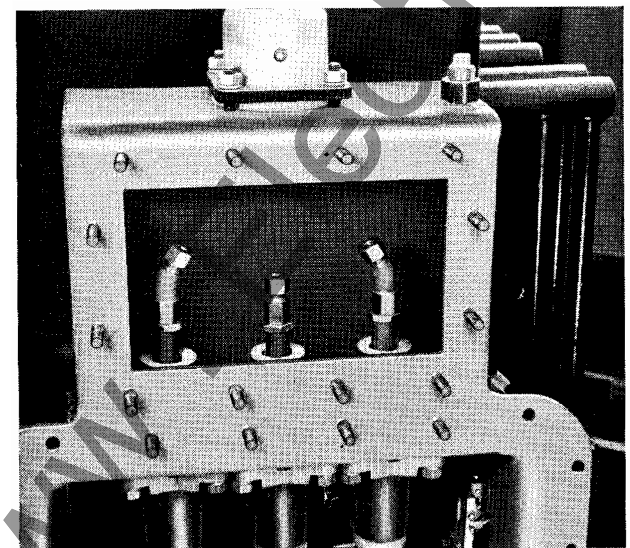
High conductivity copper in blades and contacts will carry 200 amperes continuously without exceeding a 55-degree centigrade temperature rise. In the ground position the switch will stand 15,000 amperes for two seconds without damage and without appreciable movement of the parts.

An ingenious, yet simple and reliable, quick-break mechanism is available where it is desired to have the switch break the transformer exciting current.

No-load Tap Changer

The no-load tap changing device is located inside the transformer tank and is hand-operated from the outside. It is self-aligning and cannot be locked in short-circuit or open-circuit position. Mechanical interlock may be supplied to prevent operation while transformer is energized. An indicator clearly shows tap connections.

Terminal chamber simplifies connections—allows connections to be made without draining the high-voltage switch chamber.



Network Protector Attached with Simplified Connections

Provision for mounting the network protector on the end of the transformer includes removable flexible connectors which fasten to the low-voltage studs. The porcelains are removable through the protector housing when the protector is rolled out. The low-voltage studs are keyed to the porcelains to prevent the inside end of the studs from turning when the studs are tightened.

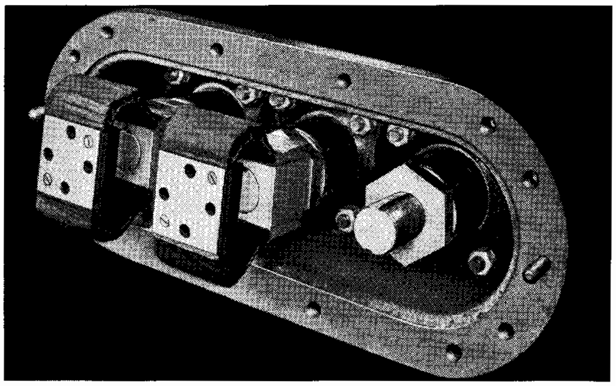
Flexibility in mounting connections not only permits easy installation despite mounting irregularities, by absorbing stresses, but often permits greater interchangeability of equipment.

Terminal Chamber Simplifies Connections—

Quicker, easier connection or disconnection of high voltage cables is provided in the newest type terminal chamber. Special two-way clamp-type terminals are easy to reach and make connection or disconnection possible in a fraction of the time required with former types.

A terminal chamber is available to accommodate a triple conductor or three single conductors. Connections can be made without draining the high-voltage switch chamber.

Flexibility of new network protector connections permits easy mounting, alleviates stress of any mounting surface irregularity and allows greater interchangeability of equipment.



Aids for Safety . . .

HCL Detector Protects Inerteen-filled Transformers

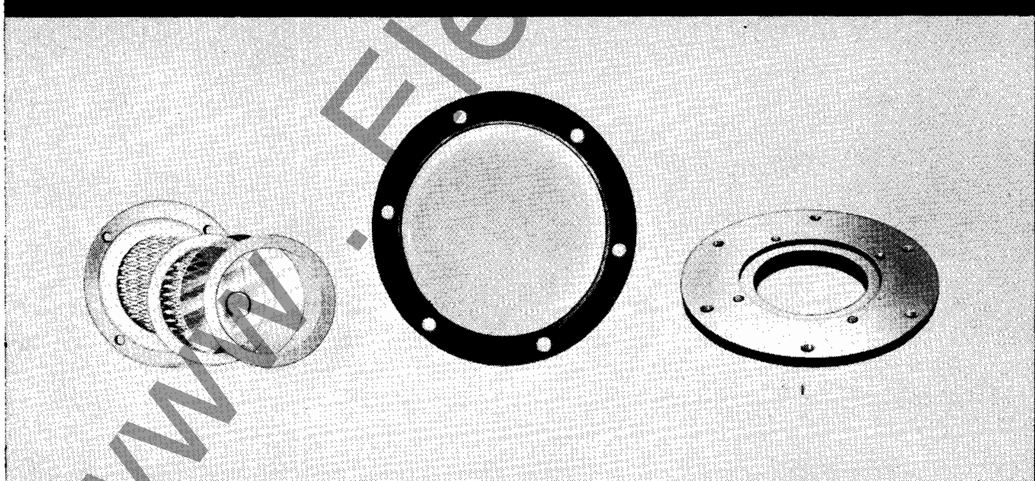
HCL Detector.

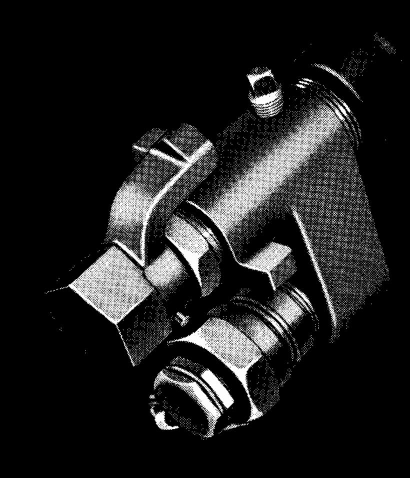
The HCL Detector developed by Westinghouse, increases the reliability of Inerteen-filled transformers.

When hydrogen chloride gas, which is formed when an arc decomposes Inerteen or similar liquids, is present in a transformer the Detector is caused to operate. By making suitable connections it can be used to operate an alarm or to remove the transformer from its feeder.

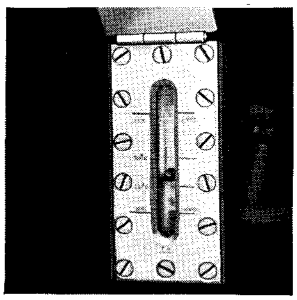
All Inerteen-filled network transformers are equipped with a glass diaphragm relief device designed to rupture at a pressure of about 15 pounds per square inch.

Sampling device makes it easy to extract Inerteen to test its condition. Close clearances and positive sealing make it leak-proof under all temperature conditions.

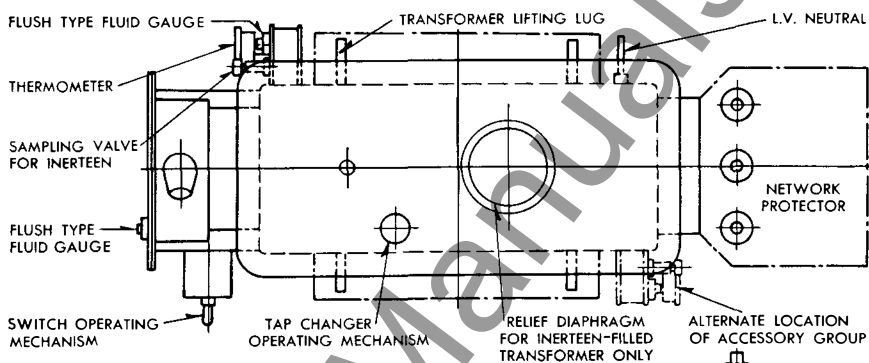


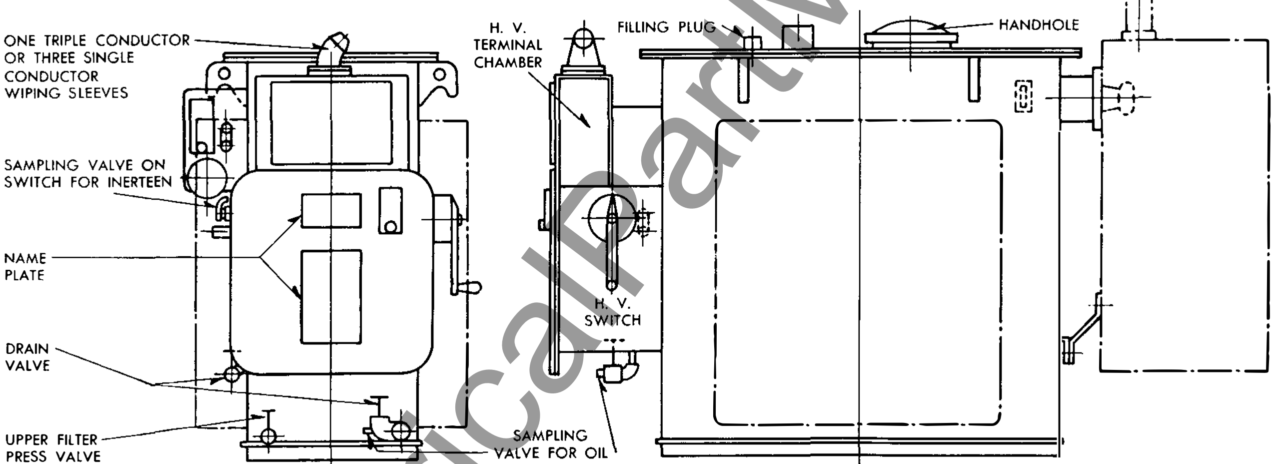


Simplicity . . . Low Maintenance



Flush type liquid level gauge is protected by cover.

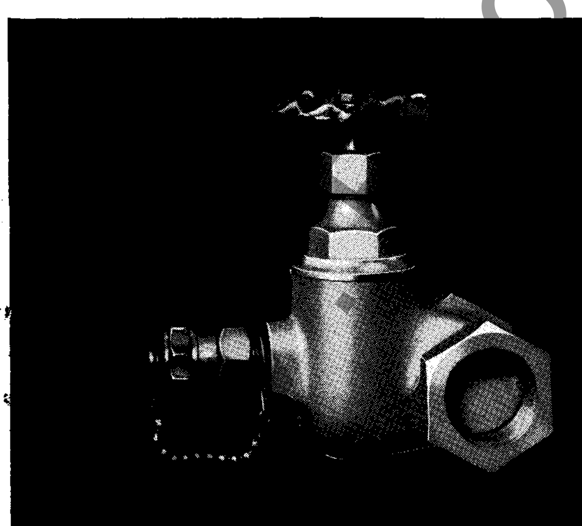


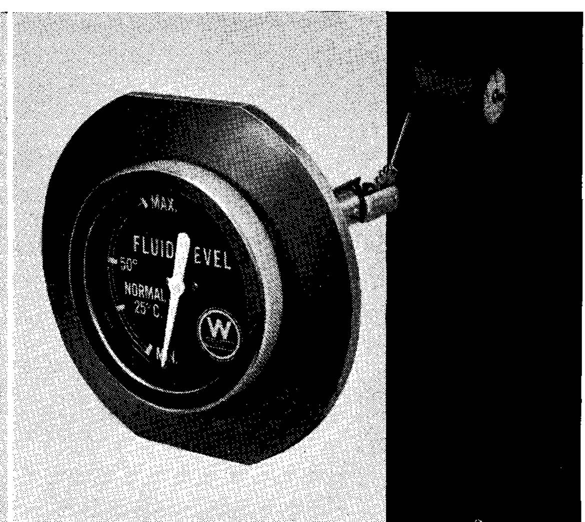


For convenience, a drain valve and sampling device are supplied.

Dial thermometer, with or without alarm contacts, is frequently supplied on network transformers.

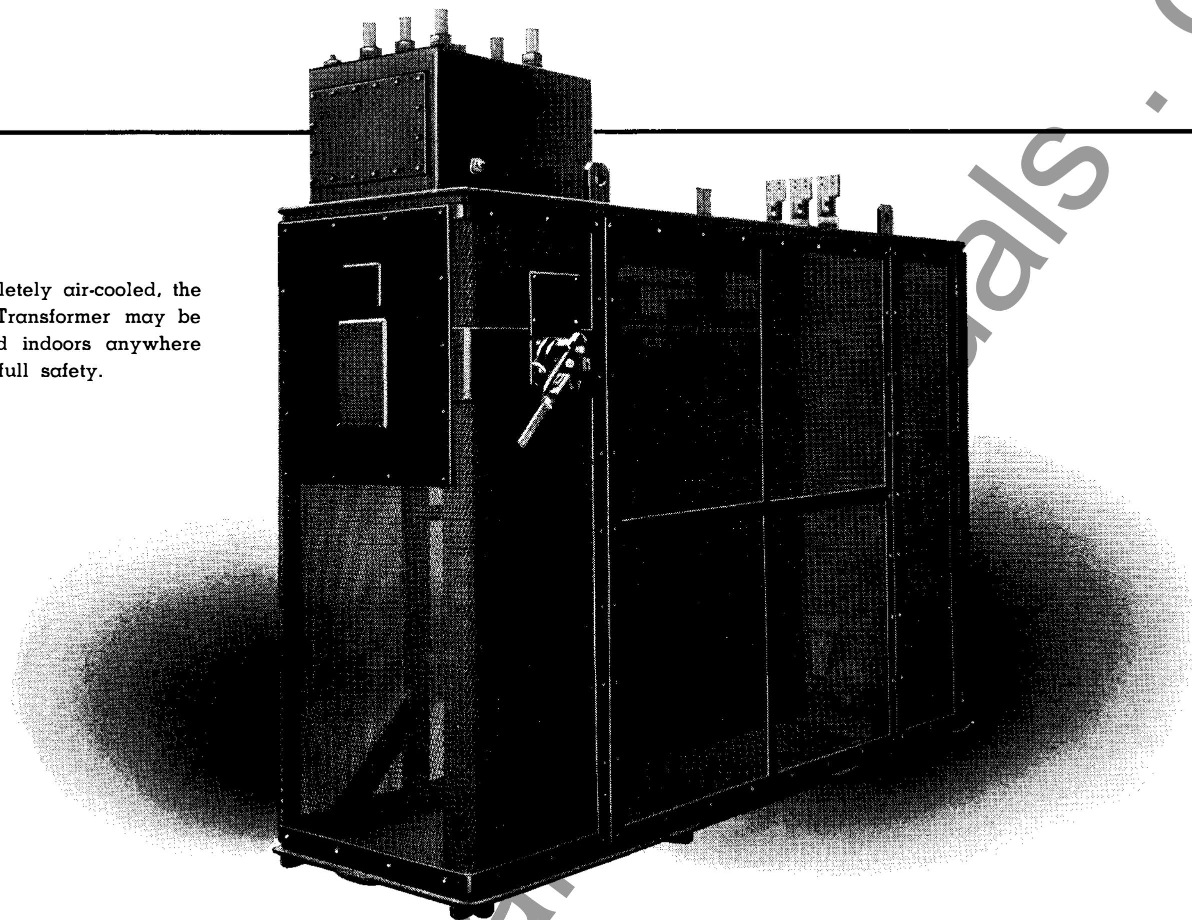
Magnetic liquid level gauge for welding to the transformer cover.





FITTINGS FOR EXTRA OPERATING CONVENIENCE

ASL Air-cooled Network Transformers



Completely air-cooled, the ASL Transformer may be placed indoors anywhere with full safety.

The latest Westinghouse Contribution to Network Systems!

With the development of the "spot" network system and its application in heavily loaded areas, such as in large buildings and in industrial plants, there also developed a need for a standard of transformer safety beyond anything previously available.

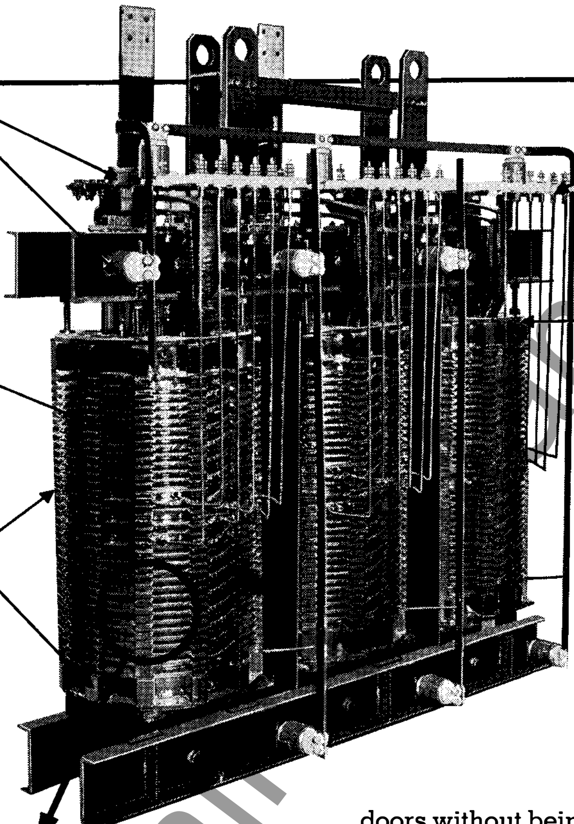
Westinghouse answered this problem by entirely *eliminating* the liquid in transformers. The ASL Air-cooled Transformer was developed and applied to various installations over a period of five years to prove its safety and dependability of operation. Only after such thorough field testing did Westinghouse recommend it for network applications requiring maximum safety.

Today the Westinghouse ASL Transformer is the *only* completely developed field-tested air-cooled transformer available in ratings large enough for network service.

No explosion hazard—nothing to burn—no toxic gases are generated at any time. It can be placed anywhere in vertical or spot networks with perfect safety to surroundings and people nearby. As evidence of its safety features the State of Pennsylvania has approved it for use in coal mines.

No vault is required—the ASL can be installed in-

provide maximum safety for indoor network systems



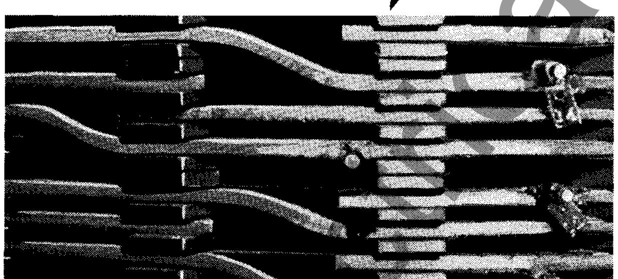
All leads supported by porcelain.

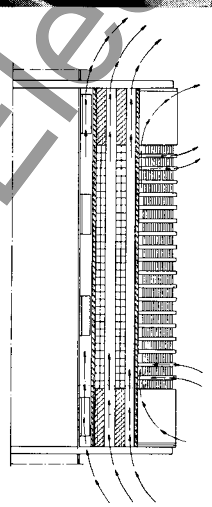
Porcelain terminal blocks rigidly support the tap leads.

Pancake coils give maximum surface exposed for cooling.

Pressure applied uniformly to high and low-voltage coils by pressure rings.

Coils spaced and supported by porcelain blocks.





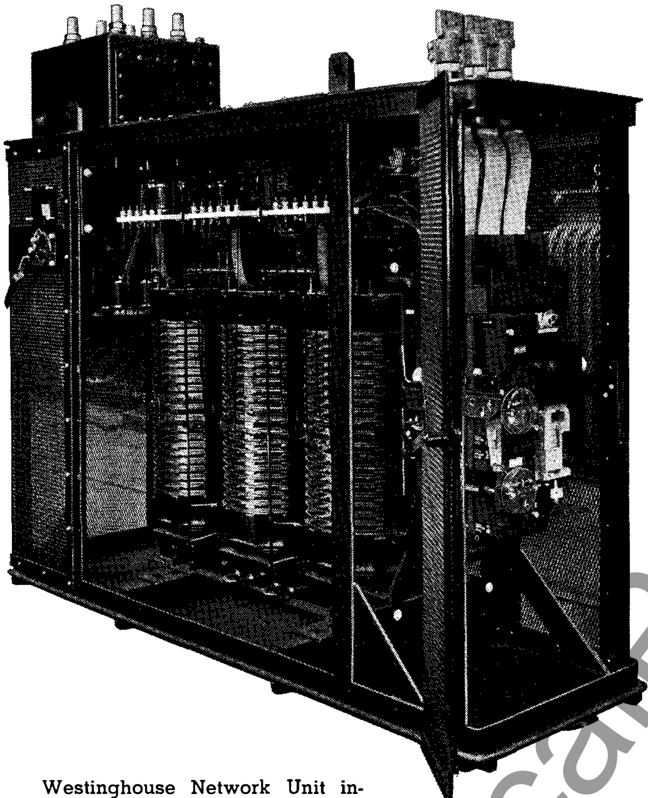
Windings are firmly block-spaced to permit full circulation of air.

doors without being placed in a protective vault and still meet all National Electric Code requirements. The type ASL saves floor space compared to liquid-filled types and weighs less in most ratings. It is easy to install.

Special insulation resists effects of heat. Porcelain, mica, asbestos and air permit operation at higher temperatures than is possible with liquid-filled types. Expanded metal housing permits free circulation of cooling air.

Natural draft ventilation—Large ducts allow air to circulate through the windings. Windings are block-spaced to admit maximum cooling air. Vertical ducts between high and low tension coils and core aid air circulation by providing an uninterrupted natural draft path.

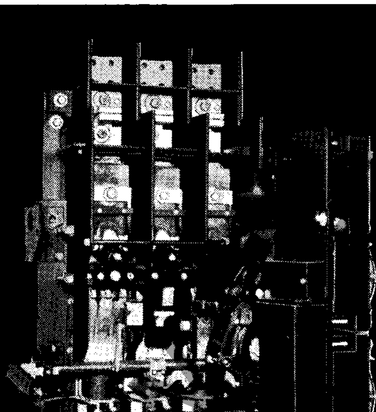
Network Reliability Assured



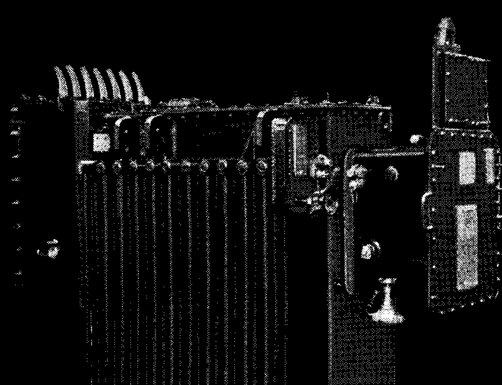
Westinghouse Network Unit including three-phase transformer, double-throw primary switch and secondary network protector.

Pioneers in the development of network equipment, Westinghouse engineers have worked closely with operating engineers from the beginning in the solution of network operating problems. The result of such co-operative development work is Westinghouse equipment for every network requirement, providing utmost dependability at reasonable first cost and lowest operating costs.

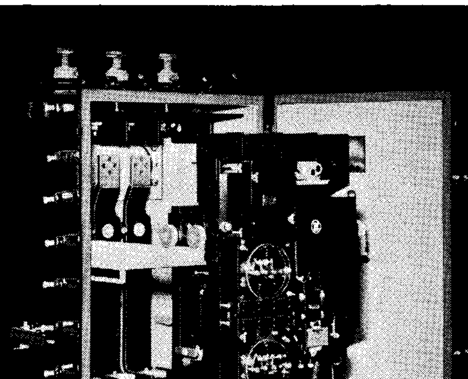
Protector and transformer combined. Aside from the primary or feeder cable system the secondary or network cable system and the network transformer, special equipment required for network operation includes the low-voltage network protector. In recent and generally approved practice, transformer and network protector are combined, the protector being mounted on the end of the transformer.



Open-type, separate mounted Type CM-22 Net-Work Protector with mechanism-relay frame swung aside.



Complete Network Unit, with transformer and network protector.



Subway transformer-mounted unit rolled out on the rails ready to be removed without disturbing any cable connection.

when you give Westinghouse

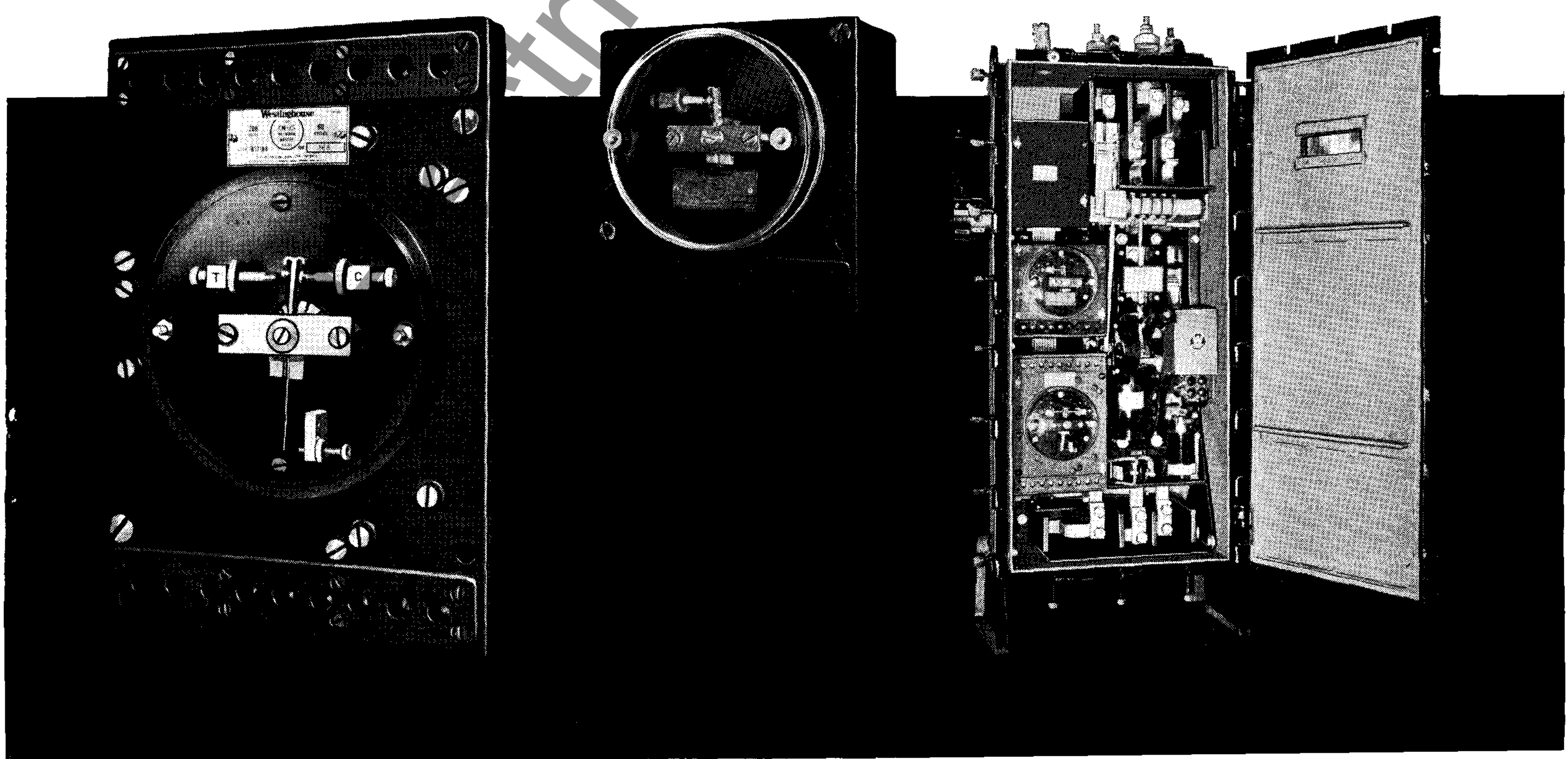
undivided responsibility

Sturdy connections. Secondary voltage leads are brought out through porcelain stud bushings enclosed by a steel throat with a drilled flange to which the protector is bolted. In the standard design, the low-voltage cables are connected to the network protector through stud-type porcelain bushings in the top of the housing. Other designs to fit specific operating conditions are available.

A high degree of accessibility and reliability mark Westinghouse network protectors. Certain parts for subway or open-type protectors are completely interchangeable, regardless of ampere capacity. "De-ion" interrupters on the main contacts result in low maintenance cost.

Fast-action relays are the heart of the network protector. Relays used in Westinghouse protectors are especially designed for the heavy-duty requirements of network operation. These relays are characterized by such advanced design features as extremely fast operation; light, sturdy, moving elements that reduce bearing pressures; compactness; and accessibility that permits individual circuits to be tested without removing the relay.

Continuity and economy of electrical service which earn maximum revenue and good will for the operating company are assured by Westinghouse complete network equipment, designed as a unit and installed as a unit.

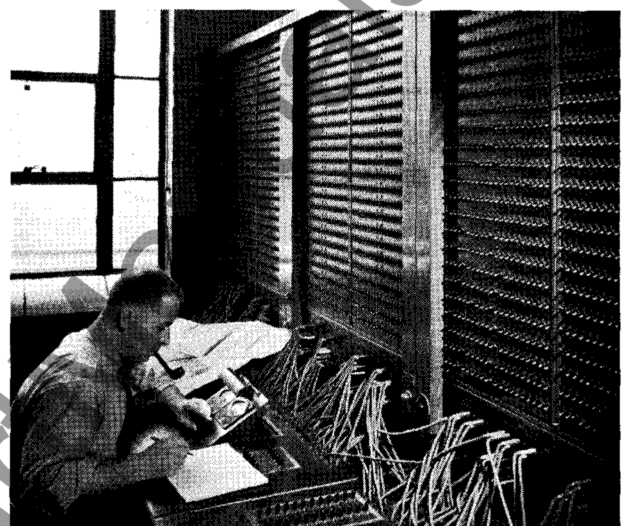


Westinghouse Plans—
Builds Networks from A to Z

Throughout its 56 years of transformer design and manufacturing experience Westinghouse has been engaged aggressively in searching for new ideas and carrying them through to their practical applications. Our policy has been to get at the root of every new problem, and then build the apparatus to answer that problem. Our efforts have made us more than just fabricators of apparatus.

The direct current calculating board is an example of the engineering service available to Westinghouse customers. Planning of alternating-current secondary network systems is greatly simplified by this direct-current calculating board. Network systems are set up in miniature on this board and subjected to conditions simulating those on the actual line. Results are noted and measurements are made directly to eliminate long intricate calculations.

This board has saved hundreds of dollars for Westinghouse customers. They have been able to do in days, the calculations that usually take weeks, and there is no question as to accuracy. The board gets the answer. It has been checked many times by tests on networks in operation.



This Direct Current Calculating Board saves weeks of hard work in planning a-c secondary networks. It tells engineers how a network will react under all conditions before a single wire is installed.

When you consider a secondary network, call in Westinghouse as your partner. You'll get the benefit of more years of experience, more engineering, manufacturing, and testing facilities, and the aid of the Company that *gets results for you* beyond just building your apparatus.

WESTINGHOUSE CONTRIBUTIONS TO THE SECONDARY NETWORK SYSTEM

1923—Built the first three-phase automatic reclosing network protector.

1924—Built the first subway type automatic reclosing network protector.

1925—Built the first network protector with pump-proof features.

1927—Built the first three-phase network master relay.

1928—Applied the first porcelain-insulated three-position switch to a network transformer.
—Introduced solder-sealed stud-type bushings and Cork-Vellumoid gaskets.

1929—Developed the first nonsensitive reverse current trip scheme for network protectors.

1930—Built first network balancers to prevent circulating currents between transformer banks.
—Furnished transformers for the first vertical network system in a large office building.

1932—Built the first three-position switch to break transformer exciting current.
—Built the first low-loss, oil insulated, single-phase network transformers.
—Introduced the first light-duty network protector for overhead secondary network systems.

1933—Introduced "De-ion" arc chambers on network protectors to reduce size and maintenance.

1934—Built the first three-phase, low-loss oil-insulated network transformer.
—Introduced high-frequency testing of high-voltage windings in transformers.
—Built the first foolproof, single-button interlocked three-position switch operating mechanism.

1936—Built the first noninflammable, nonexplosive, network transformer—an air-cooled three-phase unit.
—Introduced sliverless copper in windings.
—Built the first network relay without gearing, eliminating chief source of friction.

1937—Furnished all protectors for first network system installed in a powerhouse.

1938—Developed the HCL detector for protection of noninflammable liquid-filled transformers.

1939—Introduced simple geared-motor closing mechanism for heavy-duty network protectors.

1940—Heavy-duty protector interrupting ratings increased as much as 100 per cent.

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