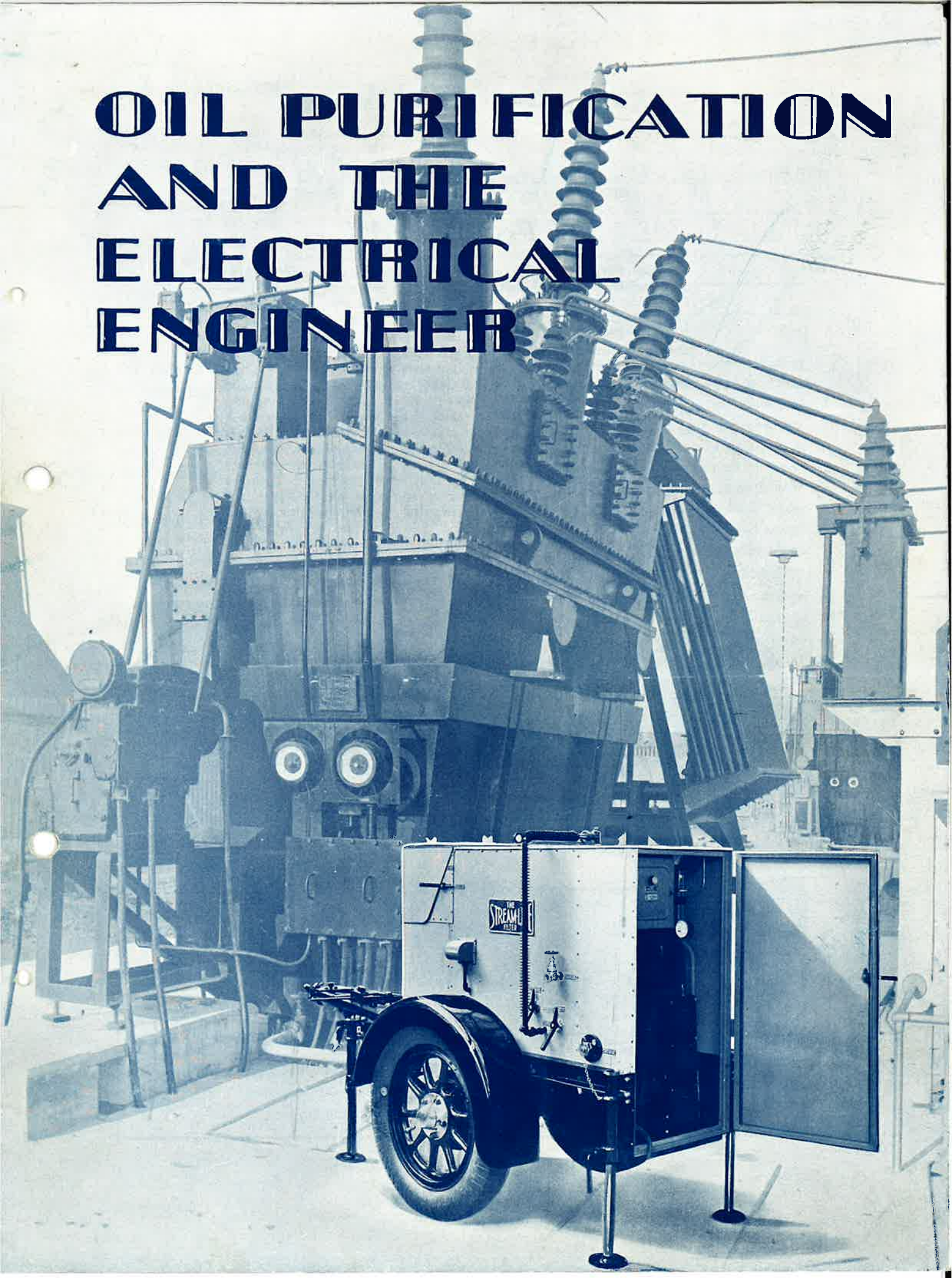
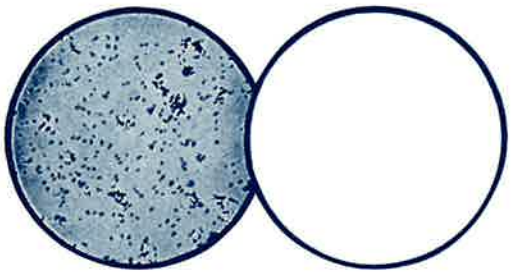
OIL PURIFICATION AND THE ELECTRICAL ENGINEER



Foreword

The Oil Purification plants described in this brochure all include a Stream-Line Filter. This filter, invented by Dr. H. S. Hele-Shaw, F.R.S., is now generally recognised as being the most perfect practical method of removing all traces of solid matter from liquids. For insulating oils where removal of moisture is also of the utmost importance the filter has another advantage in that the passages through it are so fine that the application of moderate heat and vacuum causes even the finest particles of moisture to be evaporated. The filter, in conjunction with the special vacuum receivers and pumps described, effects the removal of every trace of solid matter and moisture from the oil (even moisture which is usually considered to be in solution). The complete elimination of these impurities enables the oil to **maintain** the highest possible dielectric strength. The illustration on the left shows how perfect is the filtration process and that on the right is a reproduction of the certificate awarded to the inventor by the Franklin Institute of America. The usefulness and novelty of the invention have been widely recognised and patents have been granted to the inventor in all the principal countries of the world.



Microphotographs of films of oil before and after filtration. Magnification 500 times full size.


THE FRANKLIN INSTITUTE

A CERTIFICATE OF MERIT

TO

Henry Selby Hele-Shaw

For his Development of a Superior Filtering Device Involving Stream-line Principles

TABLE OF CONTENTS

Oil Purification

and the

Electrical Engineer

with special reference to

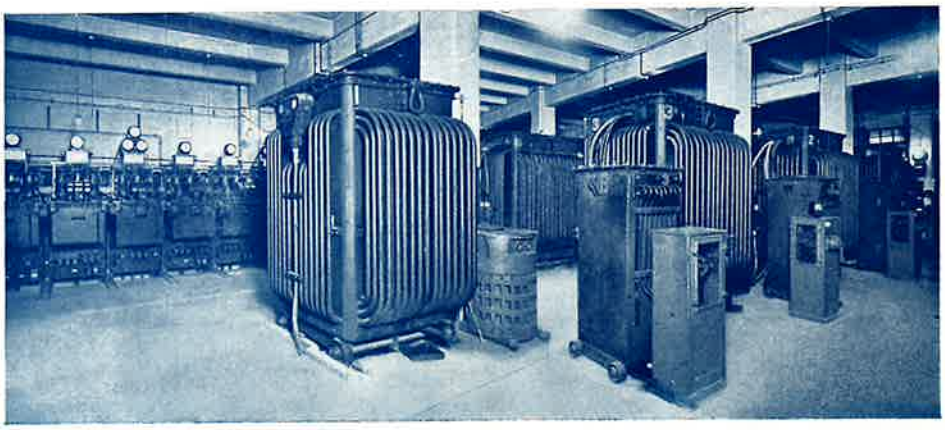
SECURITY IN THE OPERATION OF CIRCUIT BREAKERS AND TRANSFORMERS.

The security of oil immersed circuit-breakers or transformers, depending as it does on the condition of the oil used for insulating and cooling purposes, is subject to serious diminution by the incidence of moisture, sludge, and other solid impurities.

Consequently after starting well by providing a clean, dry oil of low sludging tendency, the engineer must also provide means for removing any contamination which may arise. In a transformer protected by a calcium-chloride or silica-gel breather the oil is contaminated chiefly by fibrous matter and moisture from the insulating material and by the semi-solid sludge which forms in time even in the best oils. In the presence of a bare trace of moisture such impurities provide a conductive path through the oil, and the insulating protection is correspondingly reduced. Circuit-breakers have a further source of contamination in the products formed by arcing when a circuit is broken. Exceedingly fine semi-colloidal carbon is then produced.

Moisture and solid impurities present together have a much more damaging effect than either alone. Even partial purification therefore produces a substantial immediate improvement in the di-electric strength of the oil ; but in order to ensure a prolonged period of useful service from the oil it is essential to remove all of the impurities. The dissolved water must be removed as well as the free water and the finest solid particles must be eliminated no less certainly than the coarser impurities.

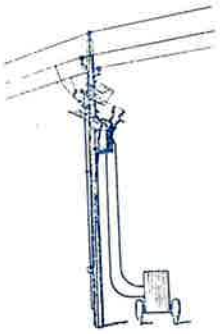
During the past thirty years Stream-Line Filters, Ltd. have been supplying a special form of filter equipment specifically designed for this purpose and which fully meets the most stringent requirements of the electrical engineer. Stream-Line Filters Ltd. offer in this brochure particulars of the models which have been developed as the result of experience in the service not only of electrical supply undertakings of all sizes in many parts of the world, but also of manufacturers of transformers, circuit-breakers, cables, condensers and other electrical plant.

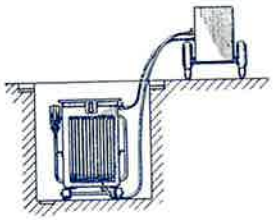


Circuit Breakers and Transformers in the Sub-Station of a London power company.

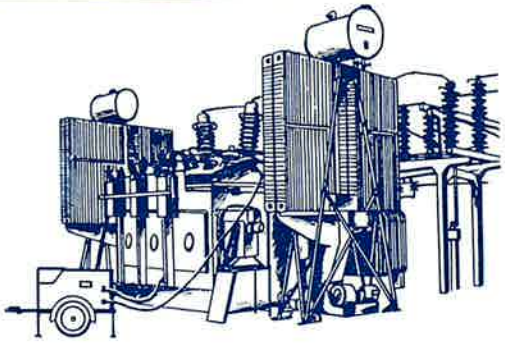
The oil in this apparatus is kept in good condition by the use of a portable Stream-Line Filter Plant.

PORTABLE STREAM-LINE FILTER PLANTS FOR INSULATING OIL.



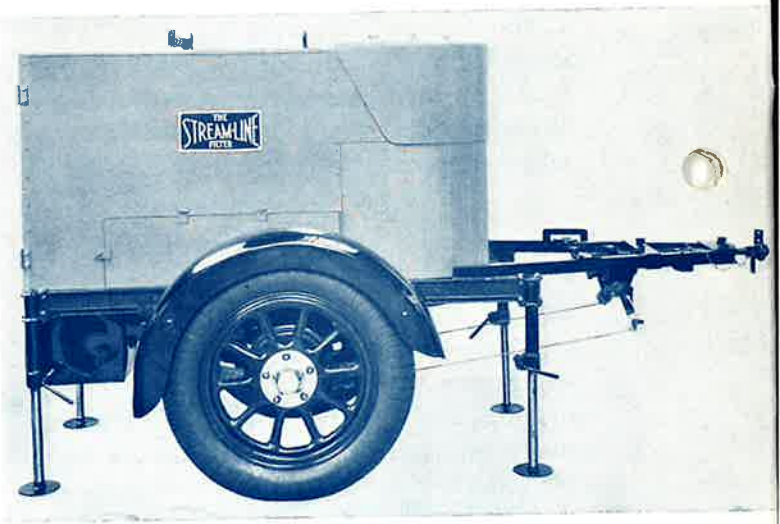


Illustrations shewing how portable Stream-Line plants are adapted to purify by circulation the oil in transformers, whether the latter be above or below ground level.



For all but the very largest transforming stations the usual requirements in connection with oil purification are best met by means of a portable filter which can be taken round from one transformer or breaker to another. The standard N-type Stream-Line filter plants are entirely self-contained weatherproof units, and they are made up either mounted on castors for wheeling about on the level floor of a power house, or mounted on pneumatic tyred trailers for towing at speed over the roads from one sub-station to another. The principles of operation are explained on pages 10 and 11 and the leading characteristics of the standard models are given on pages 12 and 13.

It is a very decided advantage of the plant that without any supplementary arrangements for pumping it will deal by circulation with the oil from a pole-mounted transformer or one sunk in a pit equally as well as from apparatus on ground level. The filter plant draws the oil from the transformer and pumps it back



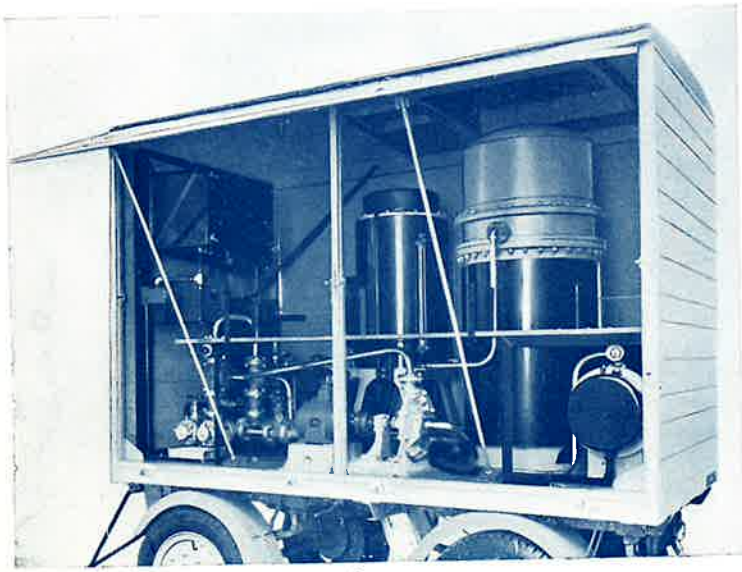
N37x Type Portable Stream-Line Filter Plant (as supplied to numerous electricity suppliers). Capacity 120 galls. per hour.

again in absolutely perfect condition—completely cleaned and totally dehydrated.

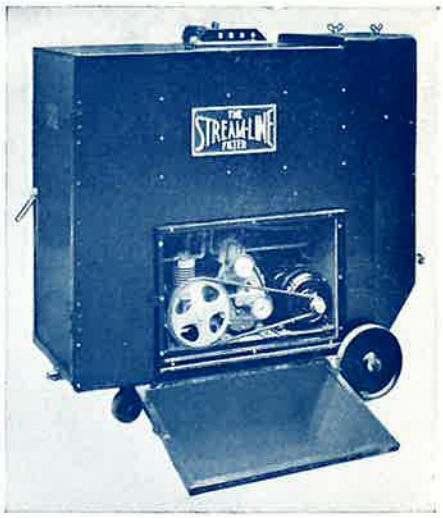
The filter system itself is coupled up to the transformer to form an entirely closed circuit, so that the benefit of perfect dehydration is not lost by subsequent contamination from the atmosphere. Moreover the whole equipment is enclosed in a weatherproof enamelled steel casing, so that it may be operated out of doors in all weathers.

The Stream-Line filter does not have to be opened up for cleaning, it does not have to be provided with fresh filter packs or filter aids, and it is free from the complications associated with the use of high speed mechanisms. It can be brought into service immediately the hoses and electrical cable have been connected up, and left unattended for long periods.

BELOW—An earlier type of portable plant constructed for special service in India. Capacity 300 gallons per hour.



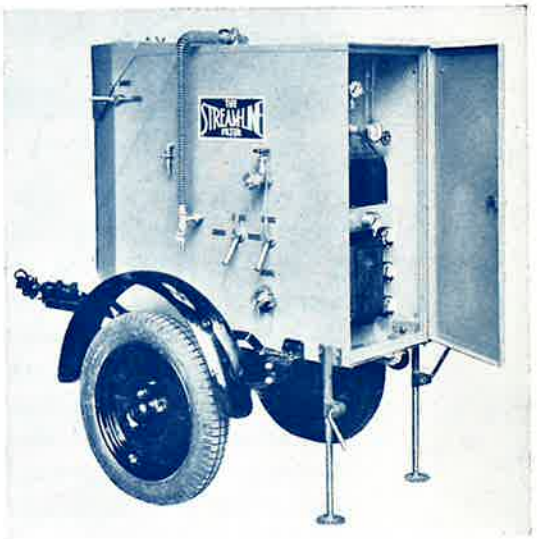
The photographs on this page show clearly the nature of the portable Stream-Line filters now available, by reference to one particular size – Model N19, with an output of 50 gallons per hour. The top pair of pictures show the standard N19 model, mounted on castors, with a shackle for lifting on to a lorry for transport. The control door, shown open on the left to reveal the electrical control gear, is only opened in practice once or twice during a day's operation; whilst the panel giving access to the pumping set (lifted off for the purposes of the right hand photograph) is only removed when the pumping plant requires lubrication.



The lower photograph illustrates the standard N19X model, which is identical with the N19 except that it is mounted on a pneumatic-tyred trailer suitable for towing over the roads. This view reveals the connections for flexible hoses and the three control handles by the movement of which the simple cleaning operation is carried out.

These plants and the N37 and N37X types illustrated on pages 4 and 10 are the sizes most commonly adopted for power station work and small distributing networks.

The bottom photograph is of interest as it shows an earlier model employing the same filter unit as the N19, in which the individual components can be seen and recognised. The present models incorporate essentially the same equipment, but more compactly arranged and protected by a weatherproof casing. The improvements have been effected without loss of accessibility to those working parts requiring occasional inspection, and a metering pump has been added to give increased output and easier control.



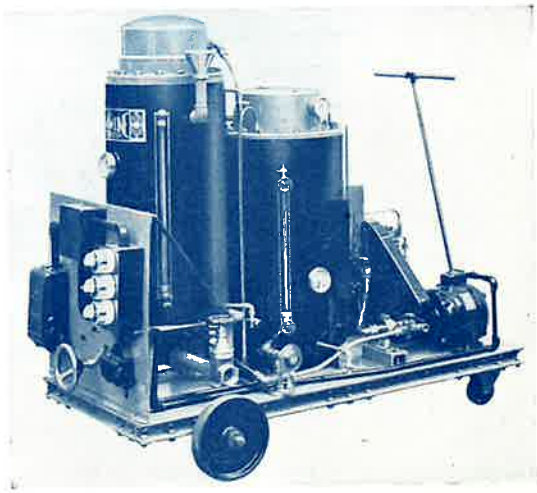
ABOVE.—Illustration of the N19X type of plant (on pneumatic tyred wheels) and two views of the N19 type (on castors). Capacity of both types 50 gallons per hour.

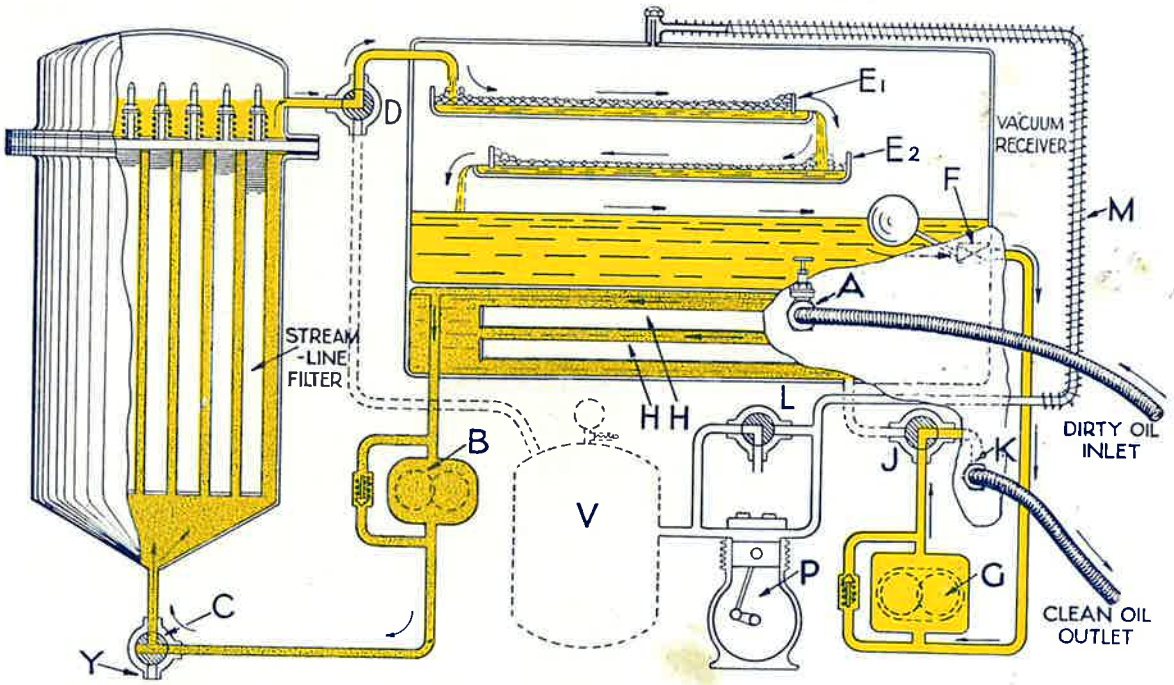
DRYING OUT NEW TRANSFORMERS, ETC.

In the makers' works and subsequently when installed on site new transformers and breakers need careful cleaning and drying by oil circulation. For this purpose the Stream-Line filter is ideal. It gives positive and perfect purification and dehydration of every particle of oil passed through it.

It should perhaps be emphasised that the vacuum dehydrating principle is in a class by itself for dehydrating by circulation. Moisture is positively and immediately ejected from the system, and as circulation continues the bulk oil in the transformer, which is becoming continually drier by mixing with the perfectly dry oil delivered by the filter. does not suffer any risk of contamination by exposure to the moisture already eliminated. This is at variance with the case of blotter presses and equipments relying upon absorption by filter aids, since in these the accumulated moisture already removed from the oil is held in the filter bed through which the oil is continually circulating. Obviously with such an arrangement a stage is reached at which the tendency will be for the nearly dry oil to absorb moisture from the filter bed rather than the reverse.

BELOW.—A view of the T19, an early type of plant with similar components differently arranged.





of moisture to take up the latent heat necessary to convert it into steam as it passes through the pack and the pressure falls to the vacuum maintained inside the packs.

DEHYDRATION.

The oil passes on from the filter into a vacuum receiver, and being in fact under vacuum from the time of passing the paper edges it is subjected to an intensive drying and de-ærating action. At the degree of vacuum prevailing the water is completely evaporated, and in the vacuum receiver the water vapour, air and other gases are mechanically separated from the oil in passing over a series of shallow trays marked E1, E2.

Two pumps are coupled up to the vacuum receiver. A dry vacuum pump P withdraws the water vapour and gases from the top of the receiver and maintains a vacuum of the order of 29″ of mercury. A special form of rotary pump G extracts the clean dry oil from the bottom of the receiver and delivers it to the clean oil tank, or back into the transformer when circulating. A float-controlled valve mechanism F maintains the oil level in the vacuum receiver so as to provide a liquid seal to prevent water vapour and gases from passing out with the oil. The same float mechanism also breaks the vacuum should for any reason the liquid level rise in the vacuum receiver beyond a certain point. This is to prevent damage to the dry vacuum pump. The filter can be used for continuous dehydration without any necessity for stoppages or renewals.

CLEANING.

Where there is any appreciable amount of solids to be removed, the resulting deposit can be cleaned off the filter packs, as shown opposite, by the simple process of reverse flow with compressed air. There is no need to open up the filter; the filter body is first drained by means of the valve C, the cock L is then turned through a quarter of a revolution which causes the dry vacuum pump P to compress air in the container V. The cleaning operation is effected by turning the cock D which causes the compressed air to discharge through the packs. The accumulation of solids is thereby dislodged from the packs and discharged at the point Y. The whole cleaning process is carried out in a few minutes, merely by the movement of the control levers on the exterior of the apparatus which actuate the valves as described.

The valve J is for the purpose of circulating the oil when the plant is started up. The oil is circulated until the correct temperature conditions are obtained, after which by moving the valves to the running position the discharge of clean oil commences.

The left hand illustration at the top of page 10 shews the normal arrangement of control switches, etc., for an N37 plant arranged for 3 phase AC supply. The three lower switches (seen on the right of the distribution box) control the heaters and the upper switch (seen on the left) the electric motor. A three pin socket for the attachment of the flexible cable can be seen immediately above and to the left of the heater switches. The thermometer, vacuum gauge and oil level gauge are also visible.

RESULTS.

The Stream-line Filter Plant described gives

(1) entire elimination of solid impurities, even the finest colloidal carbon.

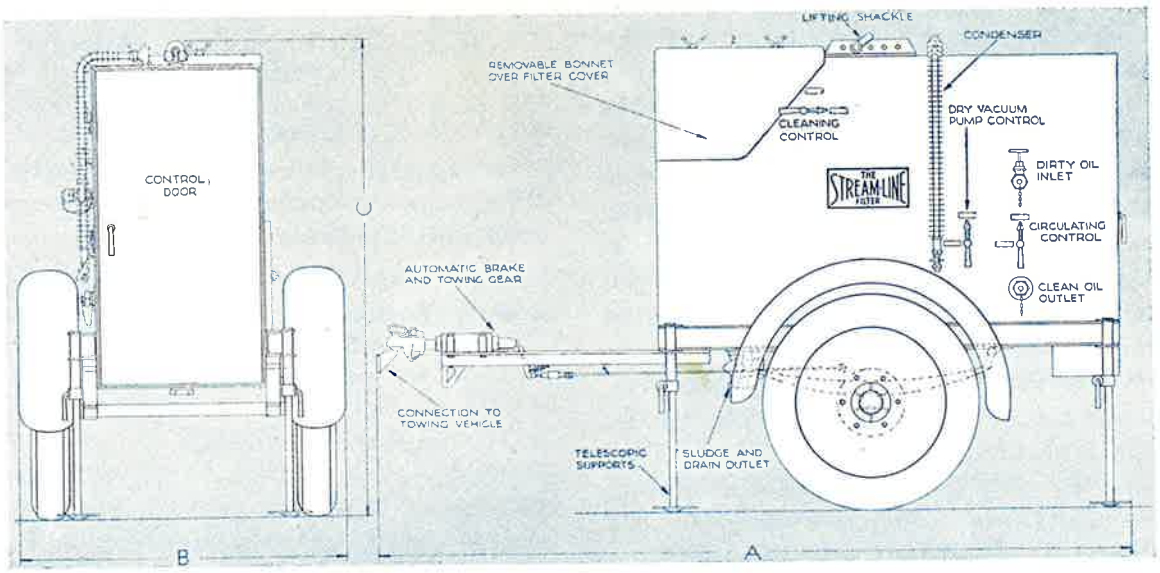
(2) complete dehydration including the removal of dissolved water.

(3) absolute de-æration including the removal of dissolved gases.

These results are obtained by a single passage through the filter plant, and are necessary to maintain the optimum insulating value of the oil. They cannot be completely achieved by means of blotter presses, centrifuges or devices depending on the use of filter aids. The use of a Stream-Line filter combined with a vacuum dehydrator is essential to obtain the maximum possible purity of insulating oil.

TYPE NX FILTER PLANT. (Prices, Dimensions and Weights).

All NX models are fitted with large diameter wheels having pneumatic tyres of ample size permitting easy manœuvring over uneven surfaces. N7X and larger sizes are mounted on robust springs and are fitted with automatically operated internally expanding brakes and towing gear so that they may be towed by motor vehicles at high speeds.



TYPE	Output* Gallons per hour	Overall Dimensions A	B	C	Shipping Weights and Measurements. Nett lbs.	Gross lbs.	Length	Breadth	Height	PRICE	Packing
N3 X	5	4′ 3″	2′ 0″	3′ 8″	482	664	3′ 7″	2′ 8″	4′ 1″		
N7 X	15	6′ 5″	3′ 9″	4′ 6″	1008	1416	4′ 8″	4′ 5″	5′ 1″		
CN19 X	50	8′ 3″	4′ 4″	4′ 11″	1250	1814	5′ 5″	4′ 10″	5′ 4″		
CN37 X	120	9′ 8″	4′ 9″	5′ 6″	2326	3284	6′ 5″	5′ 4″	5′ 7″		
CN61 X	250	11′ 6″	5′ 6″	7′ 5″	3724	5230	8′ 10″	5′ 11″	7′ 1″		
CN91 X	450	15′ 11″ Four wheels	6′ 6″	8′ 7″	7392	9660	11′ 2″	6′ 11″	8′ 6″		

*Outputs are for normal used Transformer and Switch Oils.

Models with the prefix C are the latest improved versions of older models without the prefix.

Chassis partially dismantled for packing.

For Particulars of Thermostatic Control see previous page.

Consumption of Electric Power for N & NX Plants.

In cases where sufficient power cannot be obtained to operate the filter at 80°C the working temperature may be reduced to 60°C provided that the amount of moisture to be removed is not excessive.

TYPE	Output Gallons per hour	Heater Consumptions KW Full load (when starting up)	Average load filtering at 80°C	Average load filtering at 60°C	Average consumption of electric motor kw	Quantity of oil in filter system in gallons
N3 & N3X	5	1·5	0·9	0·6	0·2	2
N7 & N7X	15	3·0	2·4	1·6	0·2	7
CN19 & CN19X	50	7·5	7·0	4·9	0·25	16
CN37 & CN37X	120	18·0	16·0	11·0	0·25	44
CN61 & CN61X	250	36·0	32·0	22·0	0·45	100
CN91 & CN91X	450	60·0	55·0	40·0	0·55	150