GL01286

luminum radiators: nitiative pays off

A. A. FIELD, London England

minum radiator production in ly topped 100 million sq ft of heat- surface in 1973 and consumed ,000 tons of alloy.

Some 30 manufacturers make up industry, which has one of the hest growth rates in Italy. In 73, 57 percent of production went other European countries and erseas. Aluminum radiators now mprise about 20 percent of the me market.

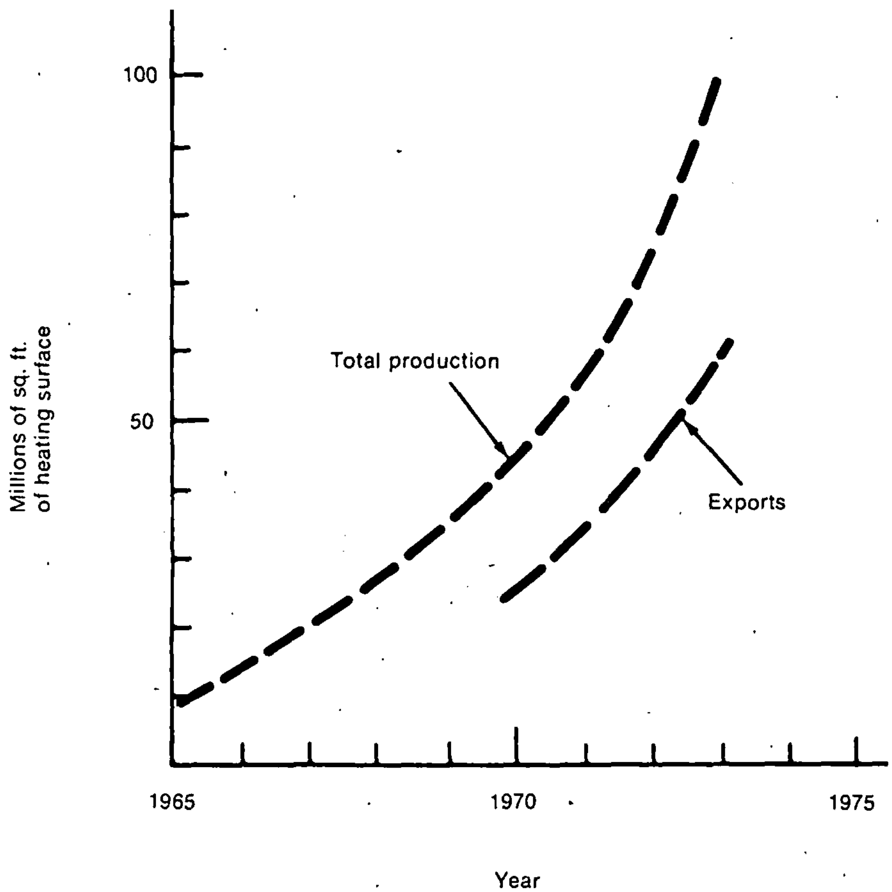
nstruction

Aluminum as a construction dium for radiators is not new, but the last 10 years, improved tech- ques of pressure die casting and rusion have realized the full po- tial of the versatile medium. In essure casting, virtually any con- uration is possible. This hnique is used by most manufac- rers and represents the larger are of the market.

Extruded radiators, on the other nd, are limited to a linear form, hough they can be made larger. ating surface in the form of ribs fins is visible in some makes, but s can be attractive with imagina- e design. The extrusion process es more metal — about 1 lb per sq of heating surface instead of ¾ lb r sq ft in the pressure cast type. n advantage of the extruded sec- n radiator is the possibility of ing higher pressures (about 200), which is useful for tall blocks systems connected directly to trict heating mains.

The pressure cast radiator is gen- lly made to present a flat finished face to the room. It is assembled m sections (in the same way as traditional cast iron radiator, ing screwed nipples), and each ction is generally built to form a nvector stack. The internal configuration is generally integral fins or ribs that are large enough to create separate vertical air channels. The top of the radiator is either left open or slotted or perforated in some way to direct the convected air into the room. The flat front forms a primary radiating surface. Aluminum is a more plastic medium than cast iron, and the die casting technique gives a much smoother finish. Lines can be sharper and finer detail can be produced. In some makes, the basic section is made symmetrical, front to back, so that it can be installed either way round. This eliminates any problems of handling on the finished radiator.

Extruded section radiators are assembled in the same way, using screwed aluminum nipples. The assembled radiator can take various forms from the exposed linear fin section to designs made from flat face sections.



1 Growth of aluminum radiator production in Italy.

Additional information on material covered in What's new in Europe may be obtained by writing to A. A. Field in care of Heating/Piping/Air Conditioning.

All designs aim at producing a high ratio of primary surface, which is directly irrigated by the heated water. Fin efficiency is kept high by using a substantial thickness at the root that tapers out to the edge.

Esthetics

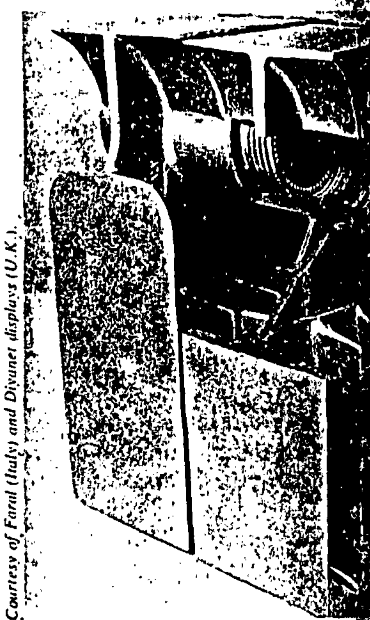
In a recent interview, Camillo Tretti, commercial director of Perani, one of the largest Aluminum radiator manufacturers in Italy, ascribed a large measure of the phenomenal success of the aluminum radiator to its appearance. Architects and interior designers in particular are selecting makes for this reason alone — in spite of the cost disadvantages compared with pressed steel. The Perani design radiator, for example, was selected for display in the Vienna Museum of Modern Art. "Instead of having to search for somewhere to hide the radiator," said Tretti, "architects are beginning to look upon aluminum radiators as part of the decor."

All makes are finished with a stove enamalled surface, or are anodized; most manufactures offer a wide choice of colors. Decorated radiators can also be bought. Designs can be chosen from a standard selection, which includes geometrical patterns, flower designs, classic theme motifs, etc. A screen printing service now offered by a manufacturer allows original design to be created for a particular room. Artificial wood grain finishes are also on the market. Anodized radiators have the advantage of an indefinitely lasting finish, but color range and density are more limited.

The convection outlet on some models is arranged to project the heated air forward. This reduces wall staining behind the radiator and promotes lasting appearance.

Performance and cost

Aluminum radiators weigh less per Btuh emitted than cast iron or steel ones. The difference for cast iron is roughly one-quarter of the weight; and for steel, it is about two-thirds. The actual value depends on the model considered,



Courtesy of Faral (Italy) and Diyanet displays (U.K.)

Cutaway of pressure die cast alumi[num] radiator. Note the conventional nip[ple] jointing technique, and the use of taper finned surface for secondary convection.

whether finned, column, or [mul]tipanel.

On the average, the emissio[n per] square foot of heating surface [is be]tween about 150 to 170 Btuh fo[r ...] F temperature different. This [is in] the same region as a single p[anel] steel radiator and consider[ably] more than the equivalent — al[though] in basic design — in a cast [iron] radiator.

Relating the heat outpu[t to] radiator length is a useful crite[rion] by which to judge room space [taken] up. An aluminum radiator 2[...] high and 4 in. deep would emit a[bout] 4000 Btuh per ft, whereas a do[uble] panel steel radiator would [emit] about 1500 Btuh per ft. An ou[tput] comparable with that of the alu[mi]num radiator would be reached [by a] four or six column cast [iron] radiator.

The question of performance [rat]ing has not yet been standardi[zed.] Most European manufacturers [are] adopting the calorimeter [room] technique in which a basic de[sign] module is tested in terms of real [heat] output and not equated to [de]veloped or fictitious surface[s.] The recently formed trade asso[cia]tion for the industry (Ce[ntro] Italiano Radiatori Alluminio) [has] the subject of standardized ra[ting]

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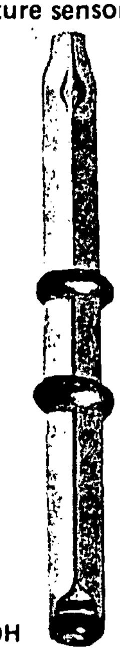

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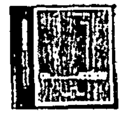

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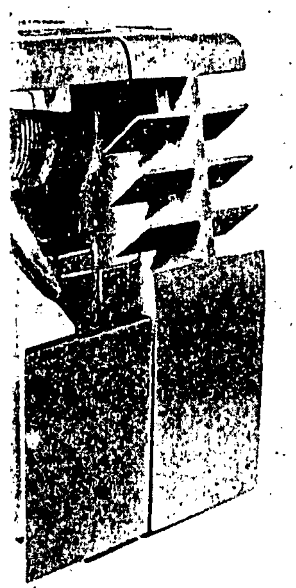

Courtesy of Faral (Italy) and Divanet displays (U.K.).

luminum convector radiator. ıs are deeper in section nary radiator, contain more ;e, and have louvered let.

ts priorities. Unification ·ter room techniques is :nown to lead to a fall in nission if it was derived ıre foot of heating surface ·Although many Italian rers already use standard . such as the well known er, some will have to ac- ngrading when changing put rating.

al, aluminum radiators ıt about 130 to 150 psi for . around 90 to 100 psi. in types of extruded sec- tor, however, working ın reach about 200 psi.

ım radiators are cheaper ıan traditional designs in ›ut still cost more than However, the difference ng as the market builds the traditional cost of ıelling is taken into ac- ıdvantage is already with ıum radiator.

: 15 years or so that alu- iators have been used, no :orrosion have been re- sts on older installations the general opinion that offers a longer life than st iron on closed circuits.

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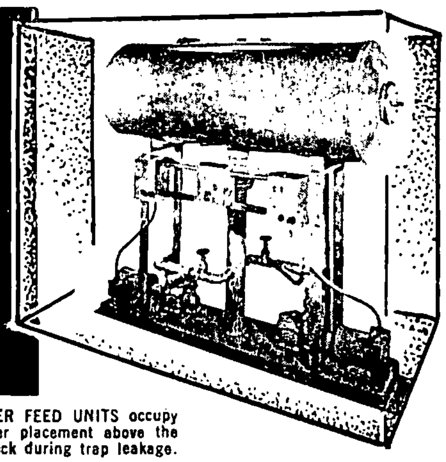

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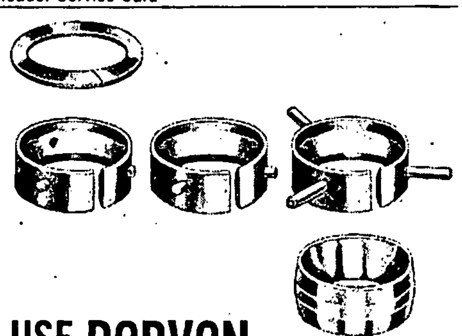

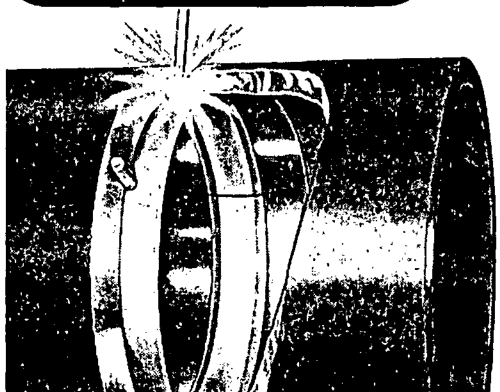

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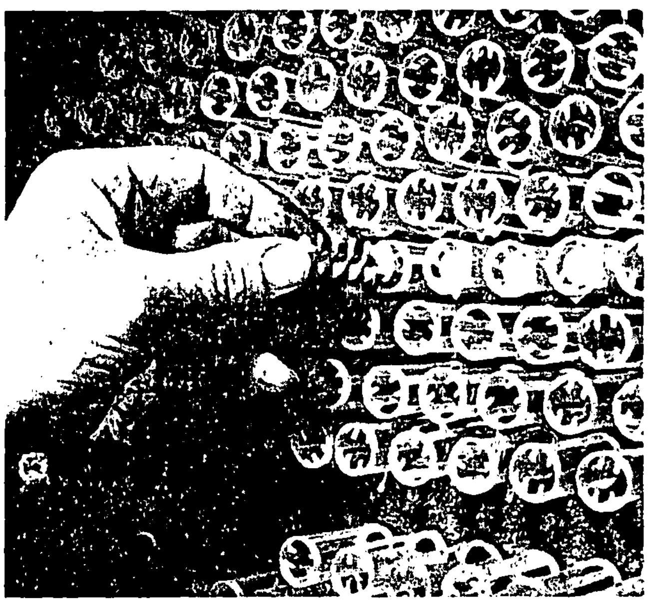
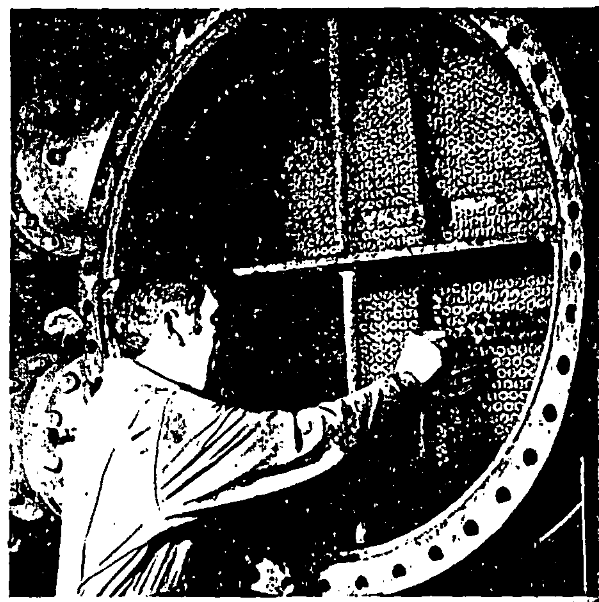
Brush cleaning of condenser tubes saves power, costs

$10,156 investment returns $8639 in power savings the first year and restores chiller to full capacity





By **RICHARD W. KRAGH**, Plant Engineer, 3M Company, Bedford Park, Ill.

Centrifugal refrigeration chillers operate with a small temperature difference between the refrigerant vapor and the leaving condenser water, normally less than 10 F. Any insulation between the refrigerant and the water, such as condenser tube fouling, tends to increase the temperature difference at the expense of more electric power.

By installing an on-line brush cleaning system for the condenser tubes in a 600 ton refrigeration machine — used to clean the tubes automatically three times a day— we were able to save $8639 in electric power the first year. Our total cost was $10,156 ($6156 for the system plus $4000 for installation).

Two 250 ton chillers at the same location have been similarly equipped. The cost and resulting savings are not included in the above figures, however.

The problem

At the Bedford Park plant of the 3M Company, a problem with fouling of the condenser tubes of the refrigeration units had existed for several years. The plant includes three centrifugal chillers, one 600 ton unit and two 250 ton units. These provide all chilled water for both process and building comfort cooling. Heat from the chillers [illegible] rejected to two cooling towers.

The condenser tube fouling [illegible]perienced was in the form of a sl[illegible] deposit that would cling tenacio[illegible] to the insides of the conden[illegible] tubes. It had been the practice [illegible] shut down the chillers for mech[illegible]cal cleaning, sometimes as often [illegible] bimonthly. The result of the sl[illegible] buildup was a loss in heat trans[illegible] coefficient, as shown in Fig. 1. T[illegible] loss in heat transfer not only [illegible]creased the power requirement [illegible] operate the chillers, but more sig[illegible]icantly, the units were unable to [illegible]liver chilled water at the tempe[illegible]ture required for process. When [illegible] temperature increase in the chi[illegible]

...ccurred, it became neces- ...ther to slow down the pro- ...ss equipment or shut it down en- ...ly.

The annual cost of electric power ...sted because of fouled tubes ...639) and the annual cost of labor ...mechanical cleaning of the tubes ...040) totaled $13,679 (as detailed ... in this article.) This cost was ...tively minor, however, com- ...red to the cost of loss of produc- ...n for the entire plant when a chil- ...was unable to maintain the de- ...d chilled water temperature be- ...se of tube fouling. Adding all ...se factors together, we con- ...ded that a system that would ...ntain clean condenser tubes in ...chiller would pay for itself in a ...ter of months!

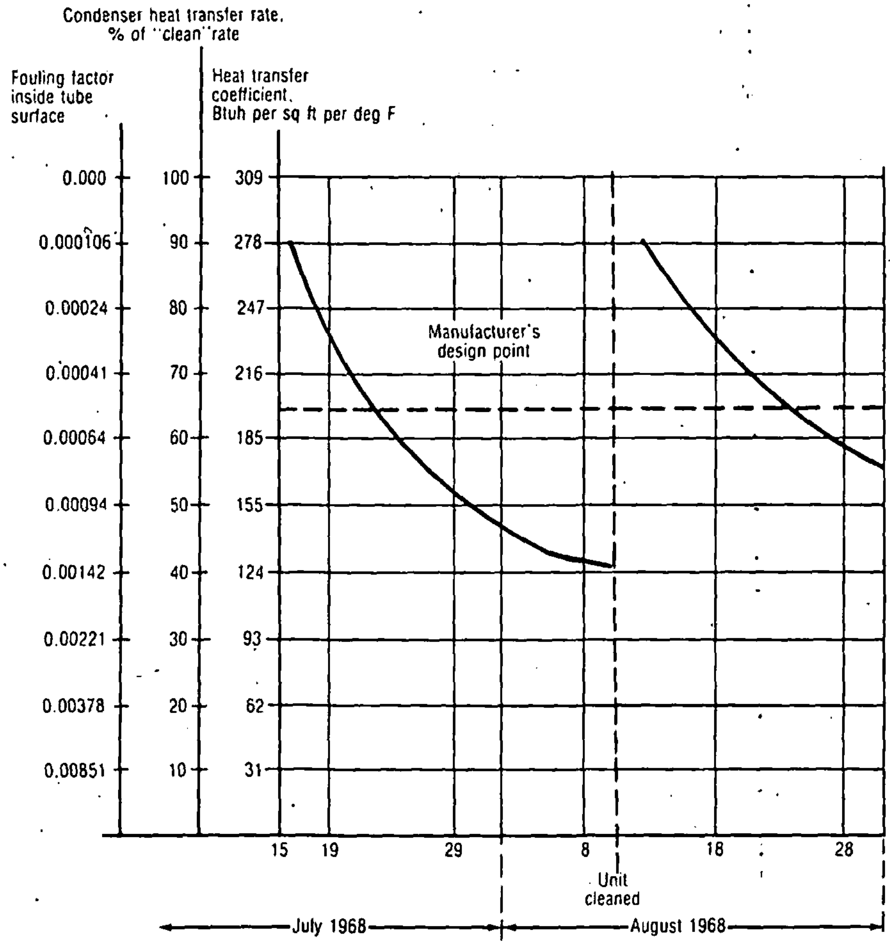
Changes in feedwater treatment ...emicals and formulations pro- ...ed no significant changes in ...ling results. Table 1 presents ...nalysis of the deposits.

After hearing of the successful so- ...on of a similar problem with 24 ...igeration machines[1] through the ...ication of a new type of automa- ...on-line brush cleaning system for ...denser tubes[2], we decided to in- ...igate the possibility of applying ...a system at Bedford Park.

...analyzer test results

Our studies convinced us of the ...ity of the proposed system to ...inate fouling and upgrade operating efficiency in typical chiller plants with normal amounts of condenser tube fouling. But because of the severe fouling at Bedford Park, we decided to carry out a test to determine the rate of fouling and the effectiveness of the brush cleaning system in eliminating such fouling. For the test, we entered into a contract with the supplier for engineering services and the use of a Btu analyzer. The Btu analyzer, shown in Fig. 2, made it possible to determine the fouling rate in chiller condenser tubes using cooling water from the plant cooling tower. The unit consisted of a two-tube condenser in a standard pipe shell.

...., Vern E., "Continuous Cleaning Ups ...r Performance," —*Power*, June 1974.
...Patent No. 3,319,710, Water Services ...America, Inc., P.O. Box 23421, Mil- ...kee, WI 53223

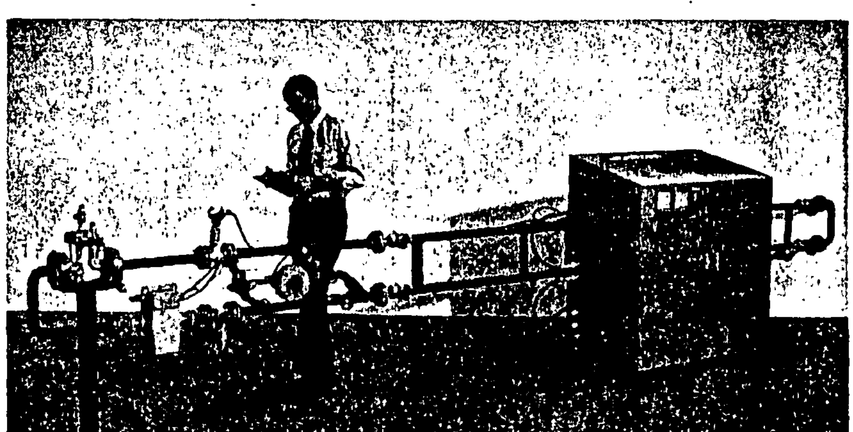


1 Heat transfer coefficient versus time for performance of 600 ton centrifugal chiller prior to installation of condenser brush cleaning system.

...1 — Analysis of sludge ...sits in condenser tubes prior to ...llation of brush cleaning systems.

...osition on ...of elements	Percent
...	43.1
...lum[1]	4.0
...	1.0
...horus[2]	0.8
... (combined)	24.4
...e matter[2]	26.7
...etical combi- ...of elements	**Percent**
...xide	62.1
...phosphate	2.2
...e oxide	6.0
...oxide	2.0
...e matter	26.7

...bly from water treatment chemicals.
...des water of crystalization.



2 Btu analyzer used to determine condenser tube fouling factor.

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v that the inhibition system
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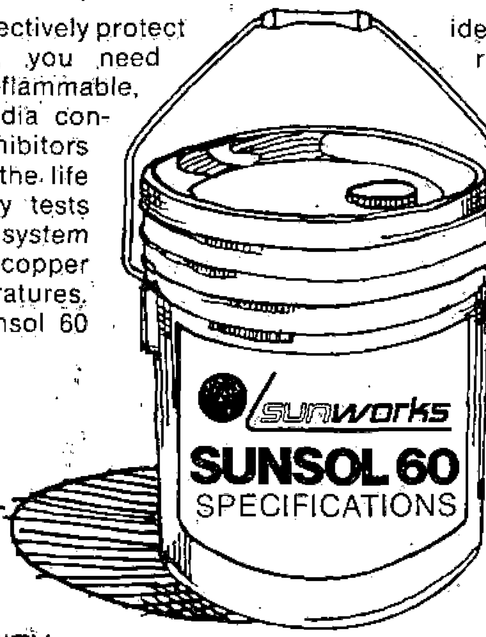
Sunsol 60 will protect against freezing to −55°F in its undiluted state. For areas where minimum winter temperatures are higher, water may be added as noted in the table.



SPECIFIC GRAVITY:	8.7 lbs/gallon
VISCOSITY:	0°C ... 40 cps
	20°C ... 10 cps
	40°C ... 4 cps
SURFACE TENSION:	25°C ... 42.5 dynes/cm
VAPOR PRESSURE:	20°C ... 12 mm Hg
SPECIFIC HEAT:	25°C ... .808
	50°C ... .833
	70°C ... .857
BOILING POINT:	1000 mm ... 116°C ... 240°F
	760 mm ... 109°C ... 228°F
	300 mm ... 82°C ... 180°F
FLASH POINT:	NONE
TOXICITY:	Non-toxic; contains no hazardous ingredients

MINIMUM TEMPERATURE	SUNSOL 60	WATER	FINAL SOLUTION VOLUME
−55°F	5 gal		5 gal
−40°F	5 gal	0.5 gal	5.5 gal
−20°F	5 gal	1 gal	6 gal
0°F	5 gal	1.75 gal	6.75 gal
10°F	5 gal	5 gal	10 gal
20°F	5 gal	10 gal	15 gal

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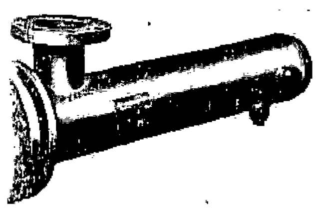

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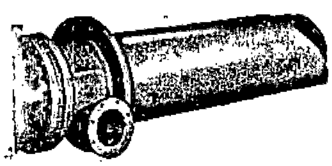

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storage tanks so liquids may be
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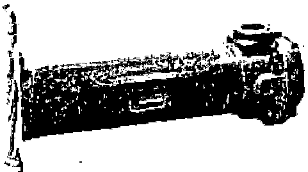

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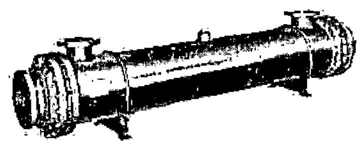
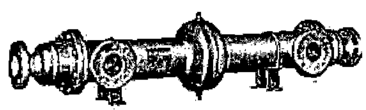
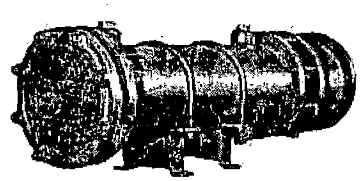
Ideal where heavy fouling fluids are inside tubes and light fouling fluids in the shell.



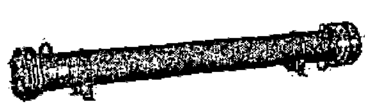
B&G "OC" Straight Tube Removable Tube Bundle
For wide range of applications involving transfer of heat between fluids or vapors.



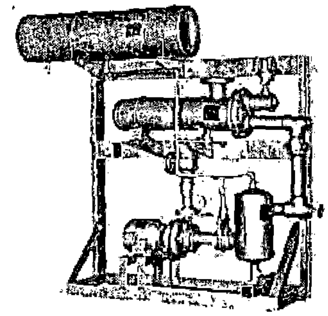
B&G "OE" Series Fixed-Tube Sheet with Expansion Joint
Straight tube heat exchangers have expansion joint of flanged and flued or bellows type construction.



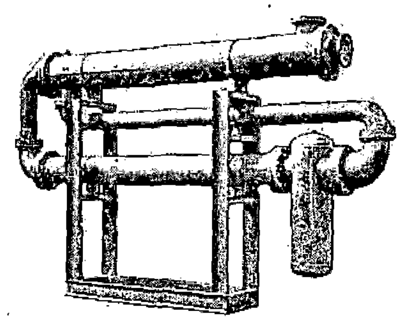
B&G "GC" Gas Cooler
Using cooling water, these units are adapted to cooling of gases entering tubes at 1000°F or lower.



B&G "MEA" Liquid Cooler
Same as "OC" units with steel or stainless steel tubes. Used for heating or cooling monoethanolamine solutions.



Process Liquid Heating & Cooling Packages
Complete unit comes pre-piped and pre-assembled on steel support frame. Can be designed to heat or cool only or to heat and cool as process requires.



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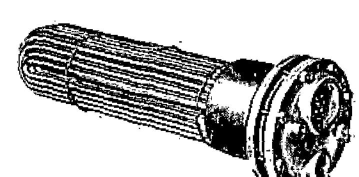

†B&G Types "TCW," "TCS," and "TCY" Tank Heaters
2-pass, U-bend heat exchangers. Heads furnished with tappings for steam condensate, vacuum breaker and vent connections.

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†"RCF" Straight Tube Condenser
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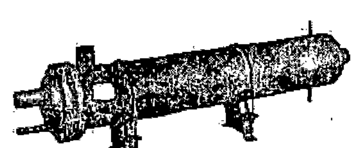

†"REFA" Evaporator
U-bend constructed and rolled into serrated tube sheet. Internal fins 7-star design, triples evaporative heat transfer area.

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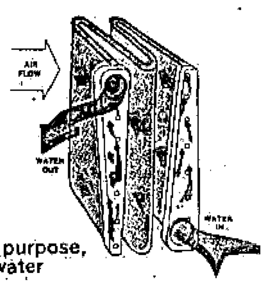
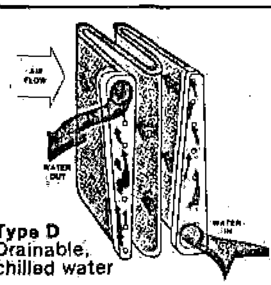
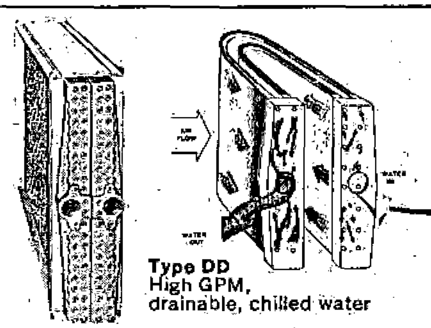


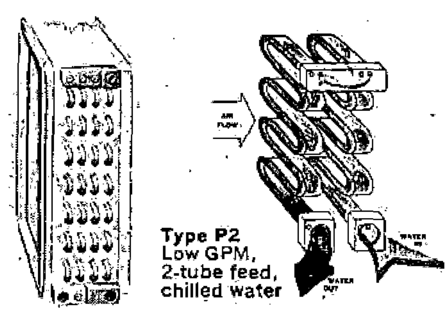
Type W
General purpose,
chilled water



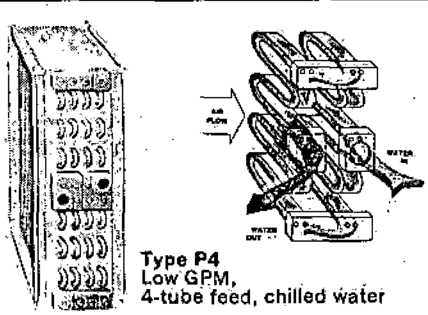
Type D
Drainable,
chilled water



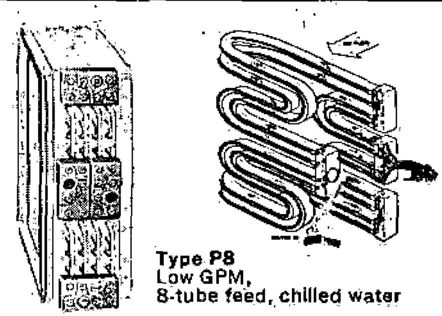
Type DD
High GPM,
drainable, chilled water



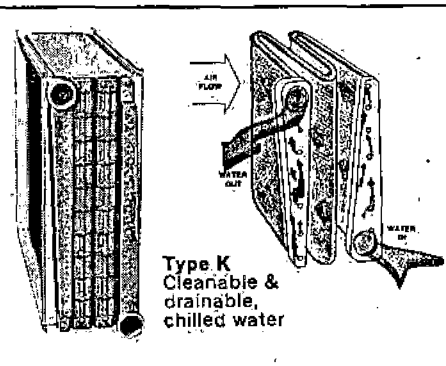
Type P2
Low GPM,
2-tube feed,
chilled water



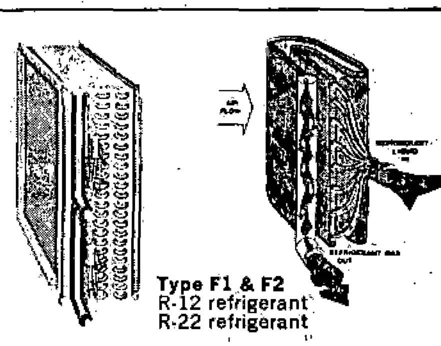
Type P4
Low GPM,
4-tube feed, chilled water



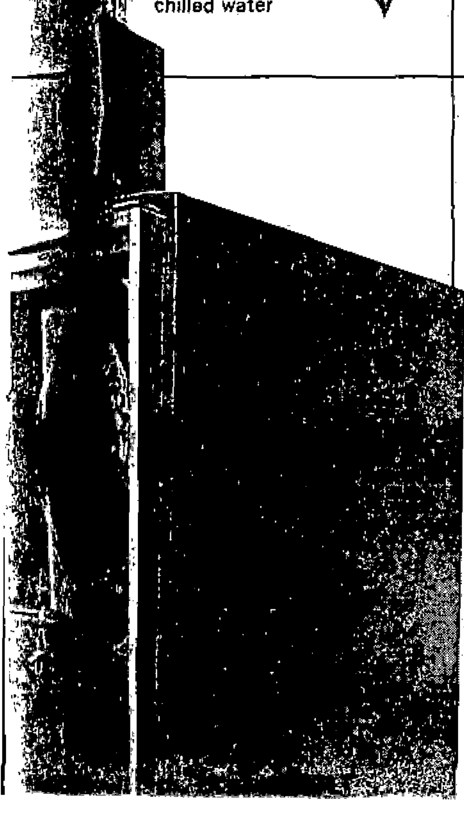
Type P8
Low GPM,
8-tube feed, chilled water



Type K
Cleanable &
drainable,
chilled water



Type F1 & F2
R-12 refrigerant
R-22 refrigerant



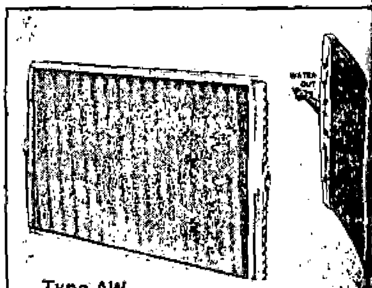
Heating o

Trane's computerized coil selection progr

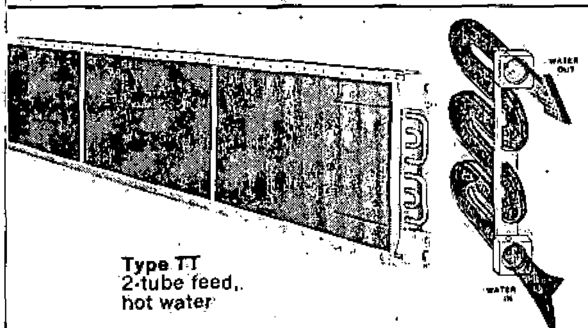
A no-charge TRANE service, coil selections based on these computer programs can reduce initial or operating costs in built-up or central station systems.

For example, for a typical chilled water cooling system, the computer selects ten different COIL/GPM combinations, ranging from few rows with high GPM to more rows with low GPM. Some selections will produce higher first cost and lower energy requirements, others offer lower first cost and higher energy consumption. With the data from a TRANE computerized coil selection, significant operating or initi savings are possible on most applicatio

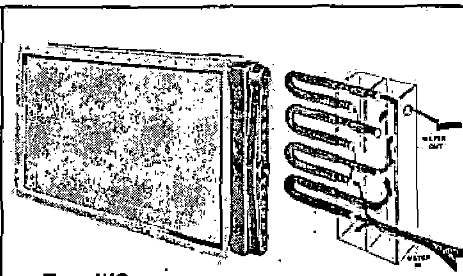
This service is as close as your local office. Once your performance specificatio been transmitted to our computer at La coil selections are made and returned within 48 hours.



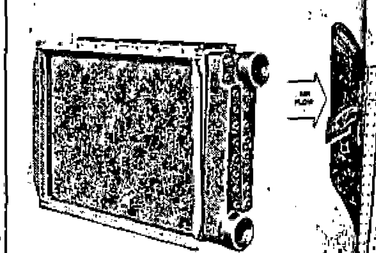
Type AW
Hot water



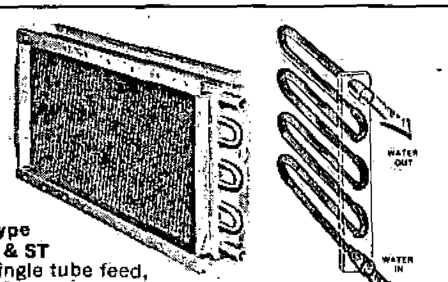
Type TT
2-tube feed,
hot water



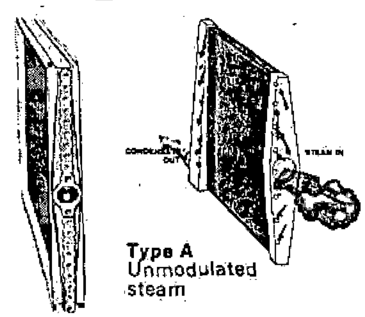
Type WC
Hot water



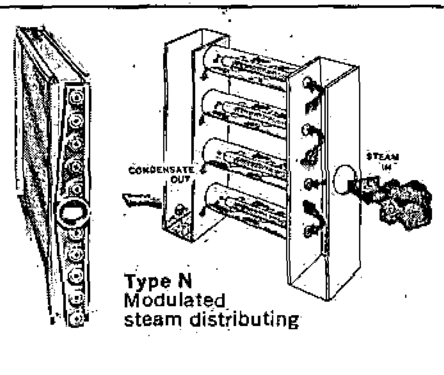
Type W
Hot water



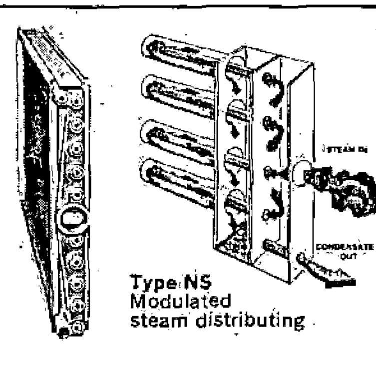
Type
T & ST
Single tube feed,
hot water or steam coil with
slip flange (ST) or flat face flange (T)



Type A
Unmodulated
steam



Type N
Modulated
steam distributing



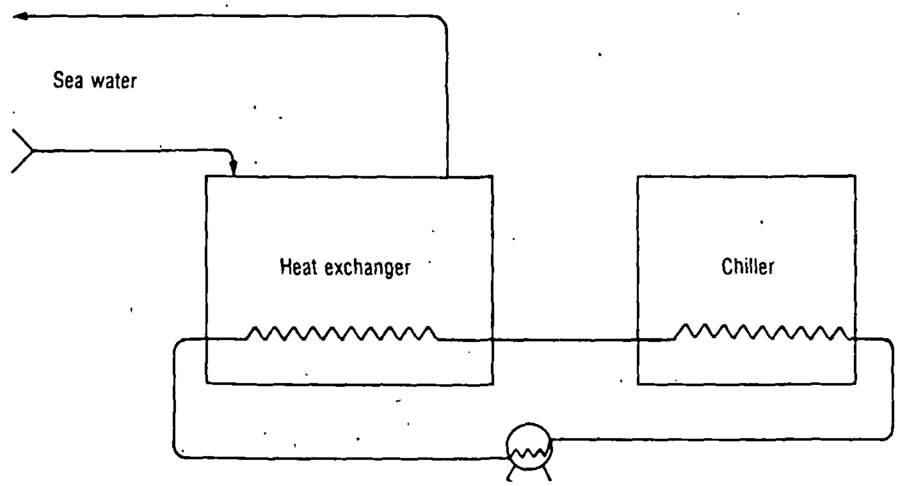
Type NS
Modulated
steam distributing

Condenser tube materials to withstand sea water

Sea water can pose complex corrosion problems when used as a cooling medium

By ALBERT I. CHO, PE, Director, Mechanical Engineering, Skidmore, Owings & Merrill, Chicago, Ill.

Several of our recent projects involved the use of sea water as the once-through cooling medium for condensers in large centrifugal water chillers in air conditioning systems. As a result, we evaluated various materials that would prevent and/or minimize corrosion of the tubes by sea water. Some of these materials and alternate methods of application are discussed in this article.



1 Plan 1—Centrifugal water chiller of standard construction with an intermediate heat exchanger installed in order to avoid direct contact of sea water with the unit's condenser tubes.

Plan 1

The simplest method of protecting the condenser tubes from sea water corrosion is to provide a heat exchanger in combination with a water chiller of standard construction (copper tubes). The heat exchanger would be fabricated from 90/10 cupro-nickel.

There are some disadvantages to this plan, however, and these are as follows:

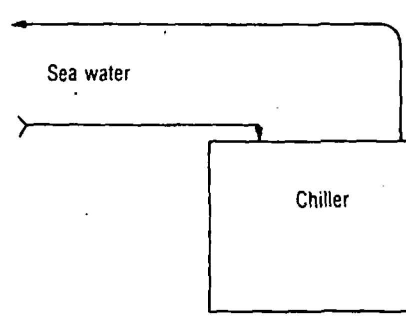
- Chiller operation would be less efficient. There is a 6 to 10 deg F higher condenser water temperature loss from the supplemental heat exchanger. This increases energy consumption to approximately 1.3 KW per ton compared to 1.03 KW per ton for a system without a supplemental heat exchanger.
- Additional cost is a factor also. Secondary pumping power to transfer the cooling water from the heat exchanger to the chiller amounts to 0.03 KW per ton. In addition, the cost of the supplemental heat exchanger, secondary pumps, additional wiring and controls, and additional piping would be incurred.
- Finally, the plan requires more mechanical space. An additional 500 sq ft is needed to accommodate a 2000 ton unit.

On the other side of the ledger, the plan has some good points also. These include:

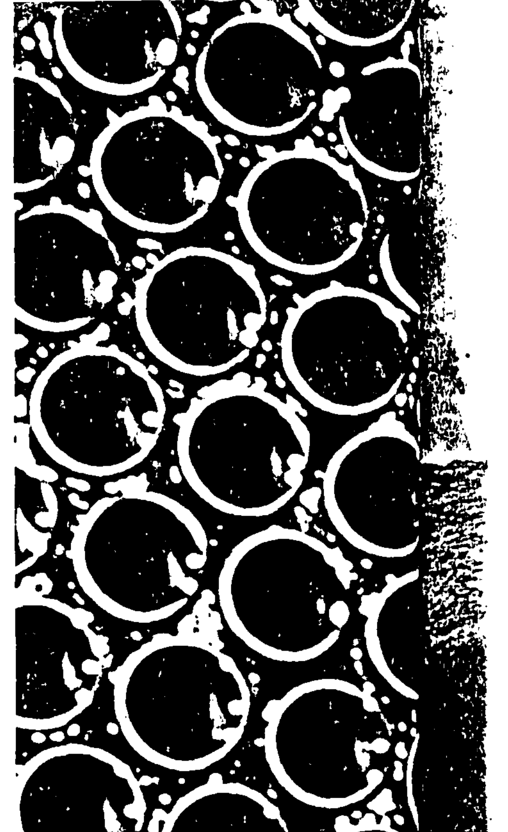
- The positive isolation of the chiller from the sea water circuit would prevent corrosion of the tubes, and there would be no chiller downtime due to tube failure. If a spare heat exchanger is provided, the chiller can be switched over in the event the original one fails.
- If the heat exchanger fails, the chiller condenser would be contaminated with sea water, but the evaporator and compressors would be kept free of sea water contamination.

Plan 2

A second method—the conven-



2 Centrifugal chiller with condenser tubes, tube sheets, and head boxes fabricated from cupro-nickel. Sea water is pumped directly through condenser. Automated butterfly valve isolates condenser from evaporator and compressor in the event of condenser failure.



tional and more practical method—is to eliminate the supplemental sea water heat exchanger and the secondary recirculating pumping circuit. The sea water would be pumped through strainers into the chiller condenser. In this plan, the tubes, tube sheets, and head boxes would be fabricated of cupro-nickel.

To prevent sea water from contaminating the evaporator and compressor in case of condenser failure, an automated butterfly valve, which would be controlled by pressure and a moisture sensor in the condenser, would be installed to isolate the condenser from the evaporator and compressor.

There are some disadvantages inherent in this plan also. These are as follows:

- The chiller must be specially fabricated. A longer lead time is needed, and chiller cost is higher. For a unit below 2000 tons, the lead time increases from 60 working days to 90 working days.
- If the condenser fails, damage to the evaporator and compressor is possible if the automated butterfly isolation valves should fail simultaneously.
- There would be shutdown and repair costs if the condenser tubes fail. The principal cause of tube failure would be sea water corrosion.
- Cupro-nickel has a slightly lower heat transfer coefficient. Efficiency is approximately 4 percent less for the same heat transfer area.

Some of the plan's advantages are as follows:

- No additional equipment and associated appurtenances are needed for secondary pumping.
- No additional energy is consumed by secondary pumping. Power consumption for the chiller would be in the range of 1.03 KW per ton-hour.
- Also, less mechanical space is required.

Plan 2A

A modification of this conventional installation is to provide tubes made of titanium (ASTM B-338, Grade 2) having a wall thickness of 0.028 in. The tube sheets and water boxes would be fabricated from monel.

Titanium has some disadvantages, however; these are:

- It has a higher first cost than either cupro-nickel or copper.
- Service people with experience on large titanium condenser tubes may be hard to find.
- Titanium also has a slightly lower heat transfer coefficient than either cupro-nickel or copper (wall thickness equal to 0.049 in.). Efficiency loss is approximately 12 percent more than a copper tube with the same heat transfer area. However, a common practice is to use 0.028 in. wall thickness with 30 percent more fin area to overcome the heat transfer deficiency.

On the plus side, Plan 2A offers the following advantages:

- No additional equipment is required for secondary pumping.
- And no additional energy is needed for secondary pumping. Power draw will be in the range of 1.03 KW per ton.
- Less mechanical space is needed.

Sea water composition

In both Plans 1 and 2 and the modified arrangement, Plan 2A, the composition of the sea water is an important factor. The average characteristic of sea water is approximately as shown in Table 1.

The composition of sea water in many harbor locations can show a maximum increase of approximately 10 percent in the values listed. Sea water can also show a decrease in these values, which can be caused by the discharge of surface runoff water and domestic sewage into the harbor. The action of tides and currents within the harbor can also affect the chemical physical characteristics of the sea water.

The economics and cost effectiveness of the three systems (Plans 1 and 2 and the modification of Plan 2) using sea water on a once-through, noncontact basis can be tabulated as shown in Table 2.

When comparing the first cost and service life, it seems from reviewing Table 2 that the use of titanium tubed condensers (as outlined in the modification plan) is an advantageous approach.

The discharge of domestic sewage and contaminated runoff into the harbor can create a serious corrosive condition that causes the production of two gases in the water. These gases are the result of decomposition of the fouling organic matter. They are:

- Hydrogen sulfide (H_2S)—In trace amounts in sea water, it is very active in promoting pitting type corrosion of copper and cupro-nickel.
- Ammonia (NH_3)—It promotes general (uniform) corrosion of copper and cupro-nickel.

Any organic debris—even sea life—settling out of the sea water in a system can cause localized corrosion.

The application of chlorine (Cl_2) has been considered to chemically remove (by oxidation) any hydrogen sulfide, ammonia, and organic matter present in sea water that could contribute to corrosion. If the dosage of chlorine is greater than required by the chlorine demand of the sea water, the excess chlorine could have a deleterious effect on the condenser tubes of the chillers.

Application of a positive action condenser tube cleaning system may prevent deposits—organic and inorganic—on the tubes. Such a system uses a positive action of a brush passing through each tube periodically, or continuous, random recirculation of sponge rubber balls may be the cleaning medium. A sig-

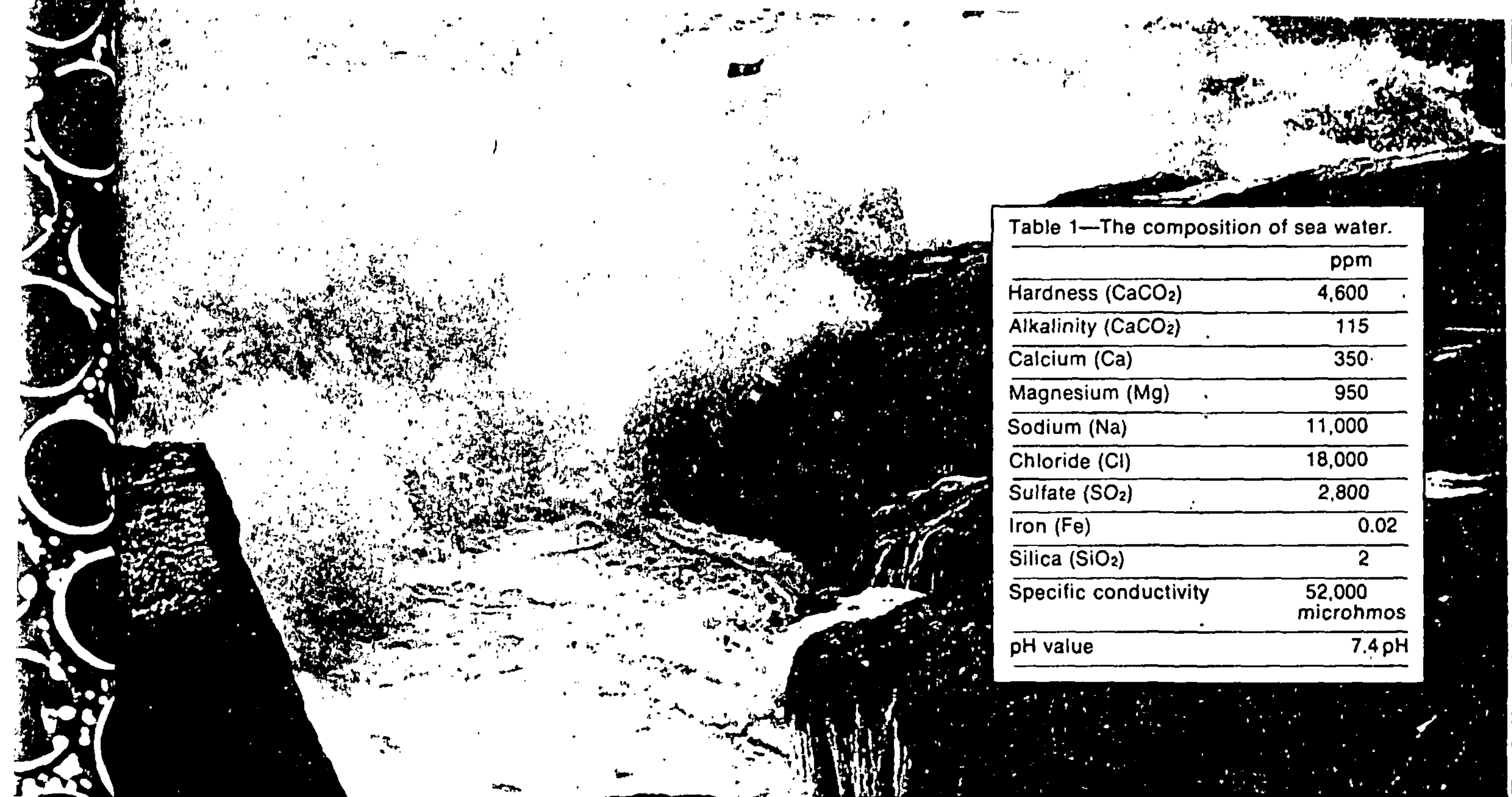


Table 1—The composition of sea water.

	ppm
Hardness ($CaCO_2$)	4,600
Alkalinity ($CaCO_2$)	115
Calcium (Ca)	350
Magnesium (Mg)	950
Sodium (Na)	11,000
Chloride (Cl)	18,000
Sulfate (SO_2)	2,800
Iron (Fe)	0.02
Silica (SiO_2)	2
Specific conductivity	52,000 microhmos
pH value	7.4 pH

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nificant benefit of these cleaning systems is that any debris is continually removed from the tube surfaces. This improves heat transference substantially and reduces the fouling factor to the design level.

In making these corrosion studies, it is evident that we have departed from detailed measurements, facts, figures, etc. The causes of corrosion are not always readily or easily evaluated. Moreover, the causes of corrosion in different environments may not be related. It is not possible to reduce these various causes of corrosion to a series of chemical symbols or reactions or equations.

The causes of corrosion and the failure of condenser tubes by contact with sea water are very broad, and many times they are interrelated. Some causes of corrosion are chemical, some are physical, others are electrical, and still others are mechanical. To these various causes of corrosion, authorities have ascribed many examples of corrosion and failure of condenser tubes, such as: general attack, localized pitting (pinholes), stress cracking, fatigue cracking, intergranular cracking, electrolysis/galvanic action, crevice attack, cavitation effect, erosion attack, impingement effect, dealloying chemicals (ammonia, hydrogen sulfide, the presence/absence of oxygen, high or low pH values, etc.), vibration, split fins, scale/debris in tubes, velocity/temperature effects, non-homogeneity of the metal, presence/absence of a suitable uniform protective oxide film.

Some causes of sea water corrosion are chemical, some are physical, others are electrical, and still others are mechanical

When any of the preceding causes of corrosion of condenser tubes by sea water is present or absent, the selection of the tubes best suited should be carefully considered with attention to the life cycle cost of the equipment and the vulnerability against shutdown of the plant.

The author wishes to express his appreciation to Mr. E. T. Erickson, PE, for his courtesy and assistance in determining the effects of sea water on the various materials considered.

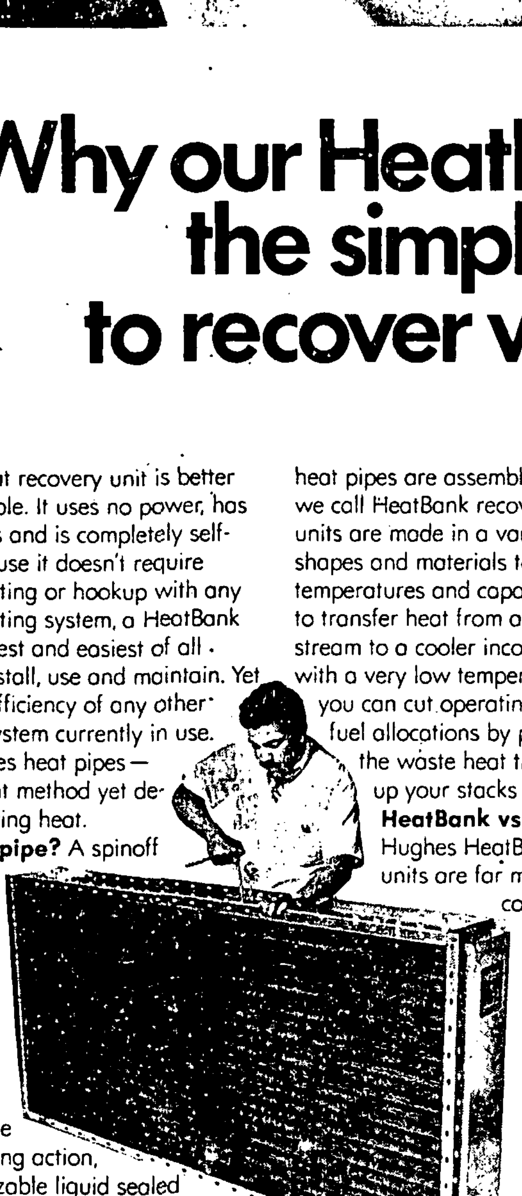
Table 2—Comparison of plans.

Plans	Chiller cost per ton of capacity, $	Estimated tube life, years*
Standard copper tubes	135	1 to 6
Plan 1: water chiller of standard construction plus heat exchangers	185	10 to 20
Plan 2: Cupro-nickel tubes, tube sheets, and head boxes (supplemental sea water heat exchanger and the secondary recirculating pumping circuit are eliminated).	148	10 to 20
Plan 2A: Titanium tubes with monel water boxes and tube sheets.	180	Over 20

*Estimated life of tubes based on use of nonpolluted sea water

Why our HeatBank™ units are the simplest way to recover waste BTUs

A HeatBank heat recovery unit is better because it's simple. It uses no power, has no moving parts and is completely self-contained. Because it doesn't require complicated ducting or hookup with any kind of recirculating system, a HeatBank unit is the simplest and easiest of all equipment to install, use and maintain. Yet it matches the efficiency of any other heat recovery system currently in use. The secret: it uses heat pipes — the most efficient method yet developed for moving heat.



What's a heat pipe? A spinoff of aerospace technology, the heat pipe was developed to dissipate heat from electronic components in space vehicles and satellites. Through a simple boiling-condensing action, a special vaporizable liquid sealed inside the heat-pipe transfers heat from one end to the other with very little temperature difference.

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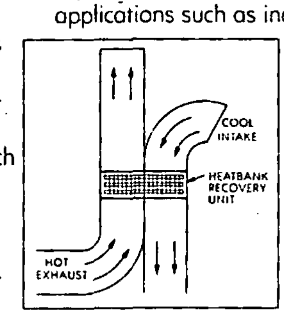

Easy to apply. Hughes can provide a standard or custom-designed HeatBank recovery unit to fit any industrial application. Send your specific requirements to us. We'll recommend the best combinations of sizes, shapes and materials for your application. To find out how HeatBank Recovery Units can put more of your BTUs back to work, contact Hughes Electron Dynamics Division, Thermal Products, 3100 W. Lomita Blvd., Torrance, CA 90509, (213) 534-2121, ext. 2451; or call our Dayton office at (513) 434-7794.

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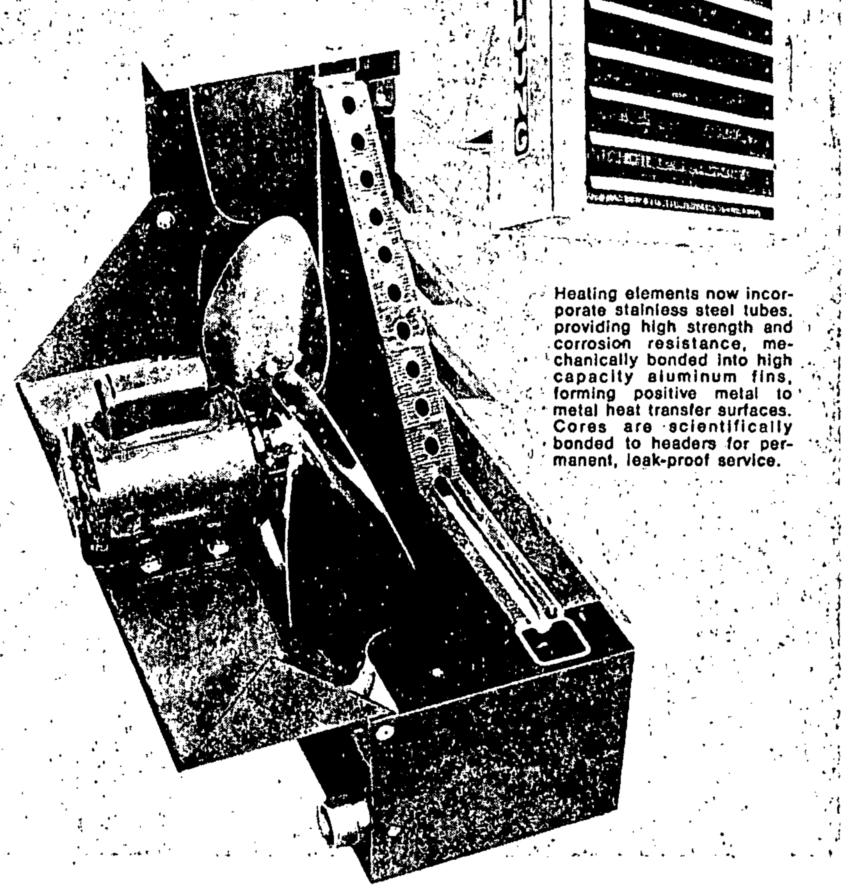

Heating elements now incorporate stainless steel tubes, providing high strength and corrosion resistance, mechanically bonded into high capacity aluminum fins, forming positive metal to metal heat transfer surfaces. Cores are scientifically bonded to headers for permanent, leak-proof service.

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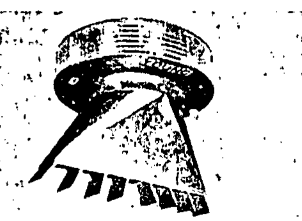

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Equipment developmer

continued from page 140

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Controller replaces massive amour wiring that would be required betw operator input devices and various puts such as starters, solenoids or lights. It is designed to furnish remot put, output signal processing from production floor. — *Reliance Electric*

Write 211 on Reader Service Car

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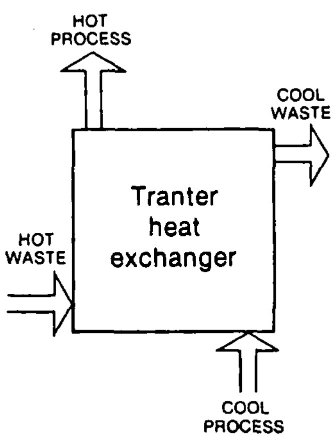
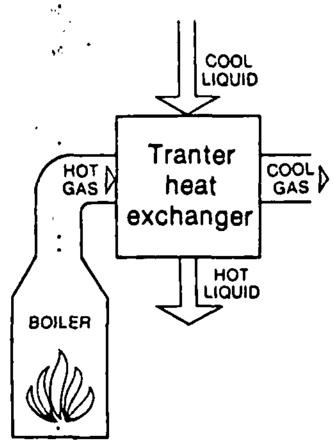


GAS-TO-LIQUID HEAT RECOVERY



Our SUPERCHANGER heat exchanger, for example, delivers more "U" value in far less space than shell and tube exchangers and usually costs less. It captures up to 95% of the heat from waste water for reuse in manufacturing processes or to preheat boiler feedwater. The Kentube Retromiser installed in the stack works much the same way, recovering heat from flue gases and putting it where it will do some good. Those are just two cases in point. We have lots more.

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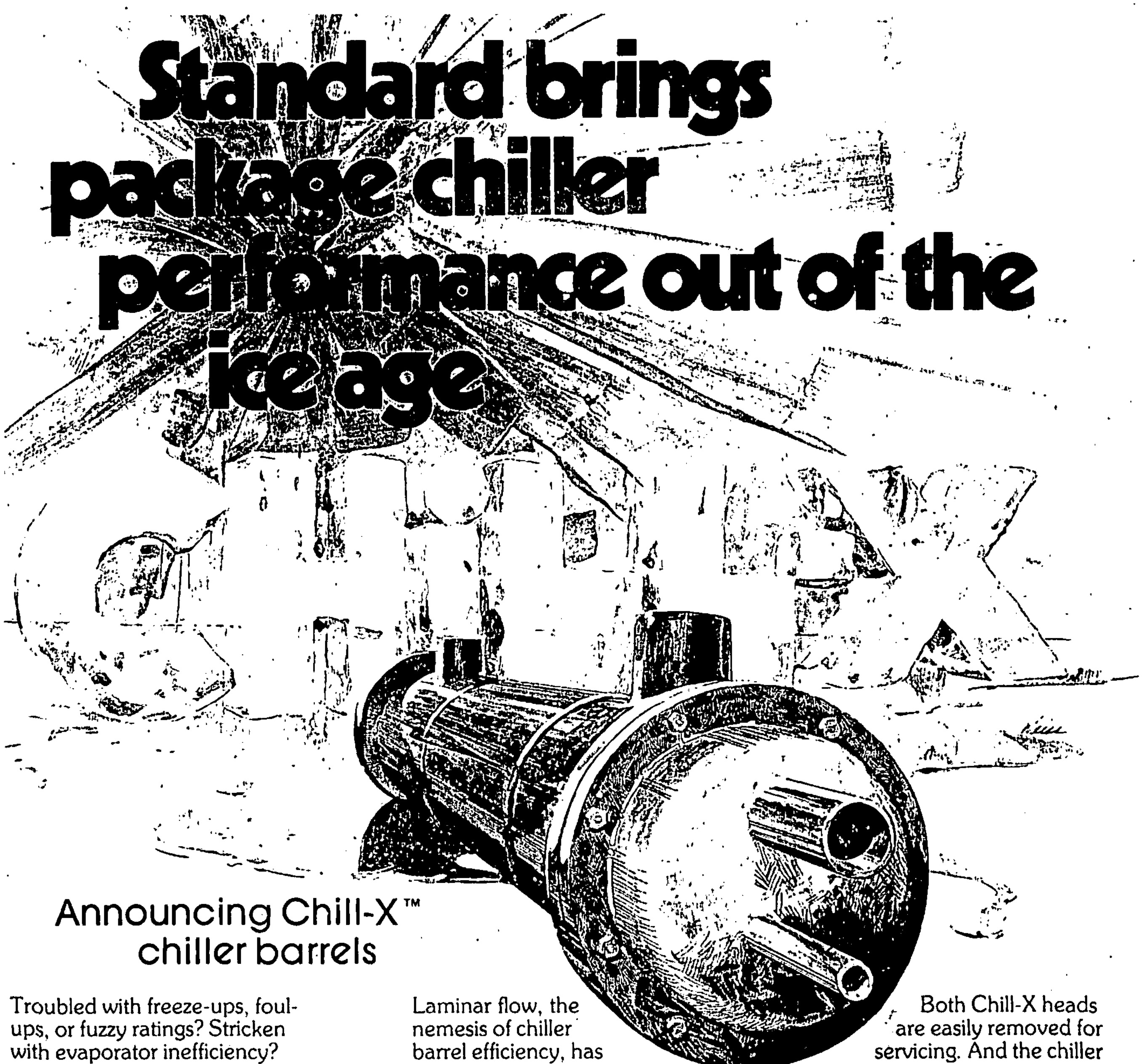
Standard brings package chiller performance out of the ice age



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Laminar flow, the nemesis of chiller barrel efficiency, has been artfully eliminated in designing both the coolant and refrigerant circuits.

Standard's extraordinary spiral fin tube construction features smooth surfaces to reduce fouling, high column strength to reduce freeze-up damage, and excellent heat transfer efficiency. Heavy, .049 tube wall offers far greater protection against corrosion and impingement damage.

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Stocked locally at Standard wholesaler or branch warehouse locations, Chill-X is quickly available for fast replacement service.

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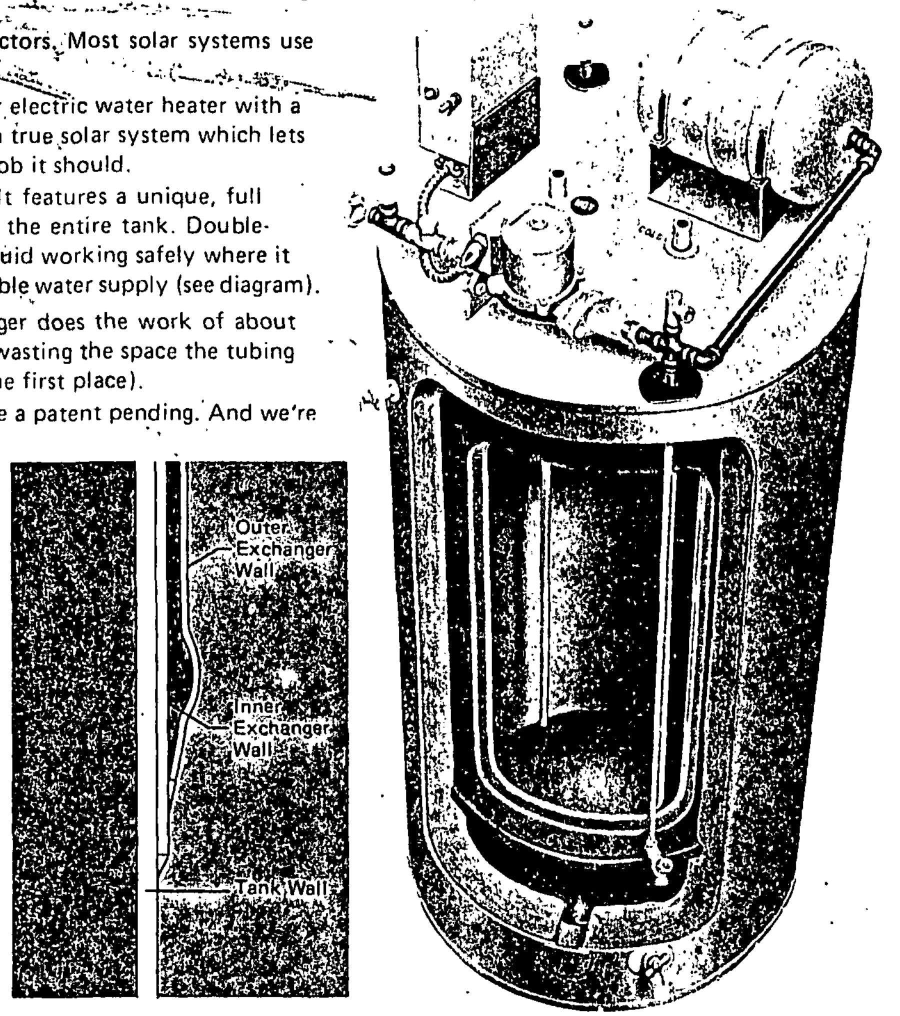
But we didn't want to build just another electric water heater with a little help from the sunshine. We designed a true solar system which lets the electrical element do only the backup job it should.

Solarstream® is a totally new system. It features a unique, full surface heat exchanger that wraps around the entire tank. Double-wall construction keeps the solar heating fluid working safely where it belongs. The fluid cannot mix with the potable water supply (see diagram).

On an 82-gallon tank, our heat exchanger does the work of about 172 feet of ½-inch copper tubing without wasting the space the tubing would take (if you could squeeze it in in the first place).

The whole design is so advanced we have a patent pending. And we're UL-approved.



Our solar collectors are also the best – Reynolds aluminum, made to our specifications with a tough, shatterproof Tedlar face.

It's the kind of approach you expect from the leader who manufactures in excess of 1,000,000 gas and electric water heaters per year.

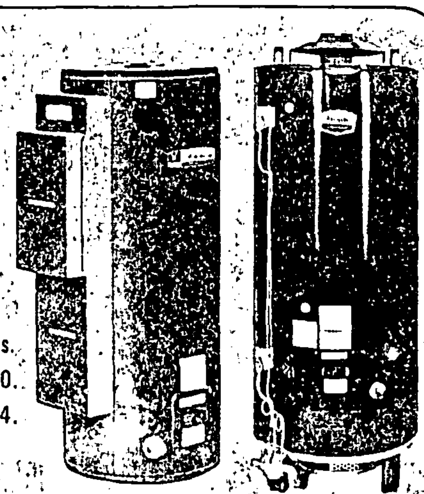
Solarstream® can be installed in almost any home by plumbing or mechanical contractors according to local codes. It's tomorrow's energy source today and that's why we designed a true solar energy water heater.

We serve you with 15 warehouses strategically located throughout the United States. Write or call today for complete details and specifications.

COMMERCIAL WATER HEATERS

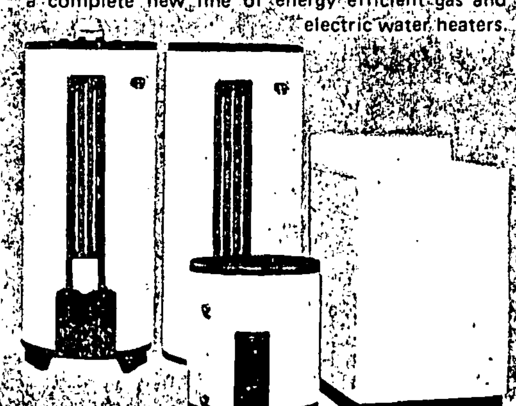
Mor-Flo and American offer a large selection of gas and electric glasslined storage water heaters for almost every commercial, industrial and institutional application. Most models feature large, hand hole clean-outs for easier maintenance.

TANK CAPACITY: 6 to 120 gallons.
BTUH: 50,000 to 525,000.
KW: 3 to 54.



RESIDENTIAL WATER HEATERS

Mor-Flo and American also set the standard with a complete new line of energy efficient gas and electric water heaters.



For Further Information, call Toll Free 800-321-9342 • In Ohio Call 800-362-2612

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