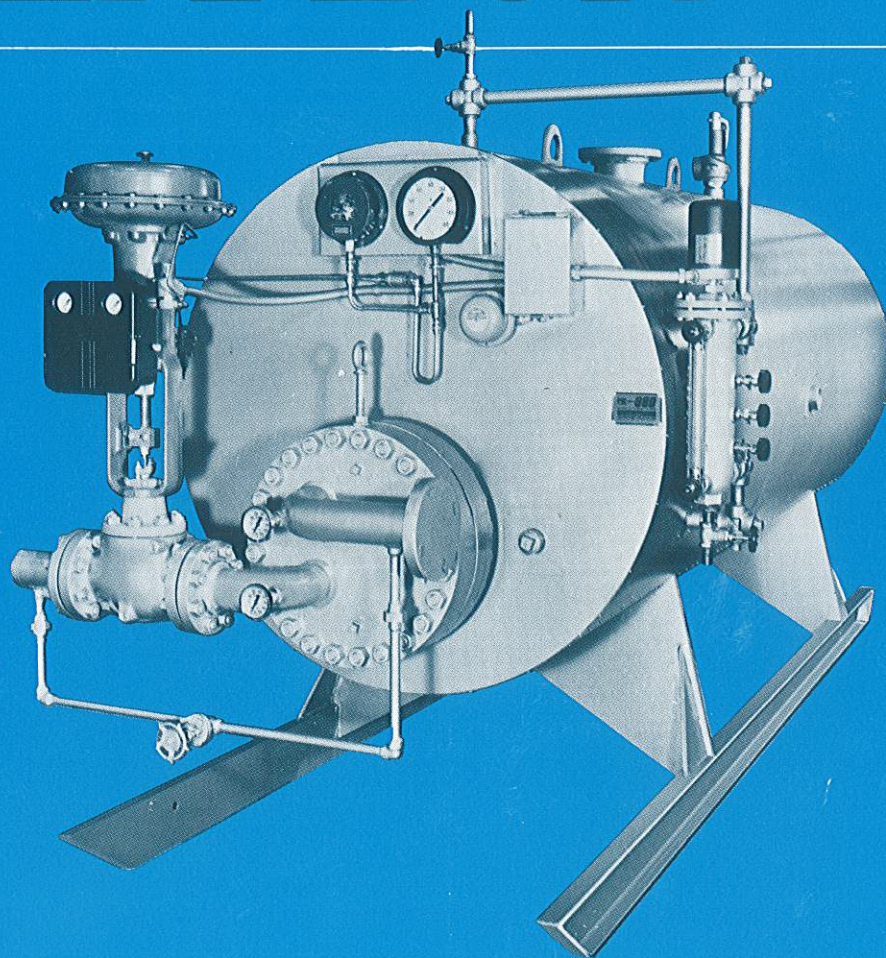


PK SERIES 380

PACKAGED UNFIRED STEAM GENERATOR



*Use boiler steam
or high-temperature
water as a heat source
...supply clean steam
safely, economically*



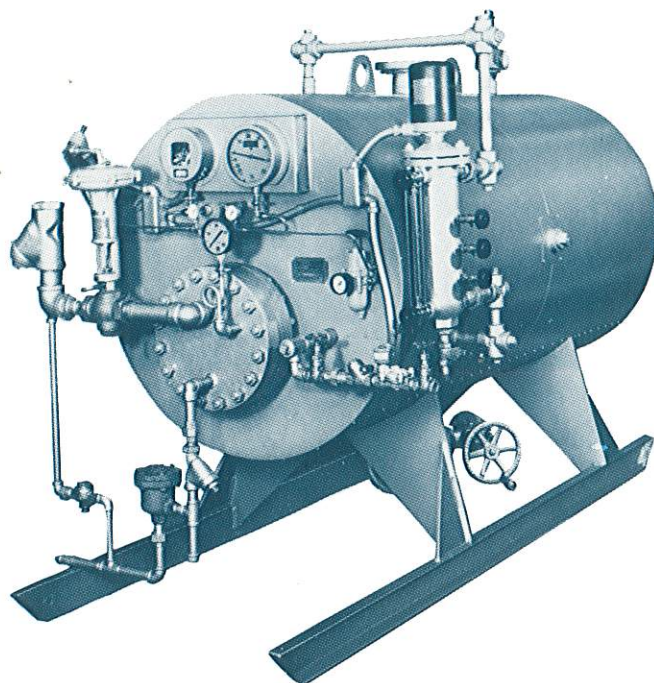
PATTERSON-KELLEY CO.

Division of HARSCO Corporation
East Stroudsburg, PA 18301

(717) 421-7500
Telex: 84-7313



Water heaters • boilers • heat exchangers • blenders • dryers • fractionation internals • protective linings



STEAM-TO-STEAM

2,000 lb./hr.
of 25 psig steam
with supply steam
at 100 psig

GUARANTEE

WE GUARANTEE EACH P-K SERIES 380 UNFIRED STEAM GENERATOR TO PERFORM AT RATED CAPACITY. THE PATTERSON-KELLEY COMPANY FURTHER GUARANTEES ALL MATERIALS, COMPONENTS AND WORKMANSHIP IN THE CONSTRUCTION OF EACH P-K SERIES 380 TO BE OF THE HIGHEST QUALITY. IF ANY PART SHOULD PROVE DEFECTIVE WITHIN ONE YEAR AFTER START-UP, A NEW PART WILL BE SUPPLIED WITHOUT CHARGE, F.O.B. EAST STROUDSBURG, PENNSYLVANIA.

Section



SELECTION



UNFIRED
STEAM
GENERATORS



APPLICATIONS



QUALITY
ENGINEERING



STRAIGHTFORWARD SELECTION

Series 380 package sizes, standard construction and special materials

While P-K assembles Series 380 Unfired Steam Generators from standard components, the packages themselves are not stock items. Each unit is designed for a specific duty with provisions for its individual installation.

Yet selection and application are not difficult.

PACKAGE SIZE

Table 1 lists standard Series 380 sizes in terms of output steam capacities. Shell size, which determines package size, often works out the same over a wide range of output steam pressures. While a high pressure may require space inside the shell for a relatively large heat-transfer bundle, a lower pressure will mean more steam volume per pound, and ample disengaging area must be provided at the water surface to prevent entrainment.

Patterson-Kelley engineers recommend that Series 380 Unfired Steam Generators be applied with a reasonably large temperature differential across the heat transfer surfaces. The difference between temperature of incoming high-temperature water or steam and the saturation temperature of output steam influences package size. Units for smaller temperature differentials than those indicated by Table 2 or the graph on page 3 can certainly be designed and built. However, they require extra-large heat-transfer sections, and they usually must have larger shells than those listed in Table 1.

Only when a small temperature differential justifies a relatively high initial investment is this type of design advocated. Consult your Patterson-Kelley representative on these special Series 380 applications.

Principal dimensions of each standard Series 380 package are shown in Tables 3 and 4. They may need to be modified somewhat to meet individual requirements, but these standard dimensions should serve well for preliminary planning and allocation of space in building design.

The code significance of P-K's model numbers may be of interest. Series 380 packages are listed by shell size. The first pair of digits indicates nominal shell diameter in inches. The next digit or pair of digits gives nominal shell length in feet. Prefix letters S or H designate whether the heat source is steam or high-temperature water.

S	36	9	H	60	10
heat source, S for steam	shell diameter, inches	shell length, feet	heat source, H for H.T.W.	shell diameter, inches	shell length, feet

OPERATING DATA

In order to design the heat-transfer section and to select controls and auxiliary equipment, Patterson-Kelley engineers will need the following operating data for the application you have in mind:

STEAM-TO-STEAM

- Steam capacity, pounds per hour
- Output operating steam pressure, psig
- Steam supply pressure, psig and degrees of superheat, if any
- Available makeup water pressure, psig, min.
- Lowest feedwater or makeup water temperature, degrees F.

(Continued on Page 4)

**TABLE No. 1
P-K SERIES 380 PACKAGE SELECTOR**

for Generating Steam Pressures from 10 to 100 psig
(For 5 psig, select at next larger Model No.)

Output Steam Capacity Lb./Hr.	Model Number	
	H.T.W. to Steam	Steam to Steam
250	H245A	S245A
500	H245B	S245B
1,000	H305	S305
1,500	H307	S307
2,000	H366	S366
3,000	H369	S369
4,000	H3610	S3610
5,000	H4210	S4210
7,500	H4810	S4810
10,000	H5410	S5410
12,500	H6010	S6010
15,000*	H6012	S6012

**TABLE No. 2 – MINIMUM HEAT SOURCE REQUIREMENTS
FOR TABLE No. 1 OUTPUT RATINGS**

Output Steam Pressure, psig	High-Temperature Water Source		Steam Source		
	Minimum Inlet Temperature, Degrees F	Minimum Outlet Temperature, Degrees F	Minimum Steam Pressure, psig	Lb./hr. Condensed per Lb./hr. Generated	
				180°F Feedwater	40°F Feedwater
10	350	260	40	1.11	1.26
15	360	270	57	1.12	1.28
25	370	285	72	1.14	1.30
35	380	297	84	1.16	1.32
45	380	309	95	1.17	1.33
55	380	317	104	1.18	1.34
65	380	326	113	1.19	1.35
75	380	333	122	1.20	1.36
85	380	341	131	1.20	1.39
100	380	352	145	1.21	1.38

*Note: Steam capacities range up to 200,000 lb./hr., depending on operating conditions.

**H.T.W.-TO-STEAM
EXAMPLE:**

With high-temperature water at 390°F, generate 6800 pounds per hour of steam at 75 psig from feedwater at 40°F.

Package size

From Table No. 1, opposite 7500 Lb./hr., select Series 380 size H4810.

Check Table No. 2 for minimum inlet water temperature. Opposite 75 psig see 380°F, so that 390°F is satisfactory.

H.T.W. requirements

See graph below for 40°F feedwater. For 75 psig and 390°F incoming water, read 20.0 Lb./hr. of H.T.W. per pound of steam generated. Multiplied by 6800, this

indicates 136,000 Lb./hr. of H.T.W.

From Table No. 4, a 4-inch connection will be required for the H.T.W. inlet and outlet.

Using the conversion graph on page 4, the factor for converting to gallons per hour at 390°F is 432. Dividing 136,000 by 432 yields 315 GPM at temperature.

**STEAM-TO-STEAM
EXAMPLE**

With steam at 100 psig, generate 4000 pounds per hour of steam at 25 psig from feedwater at 180°F.

Package size

Referring to Table No. 1, opposite 4000 Lb./hr., select Series 380 size S3610.

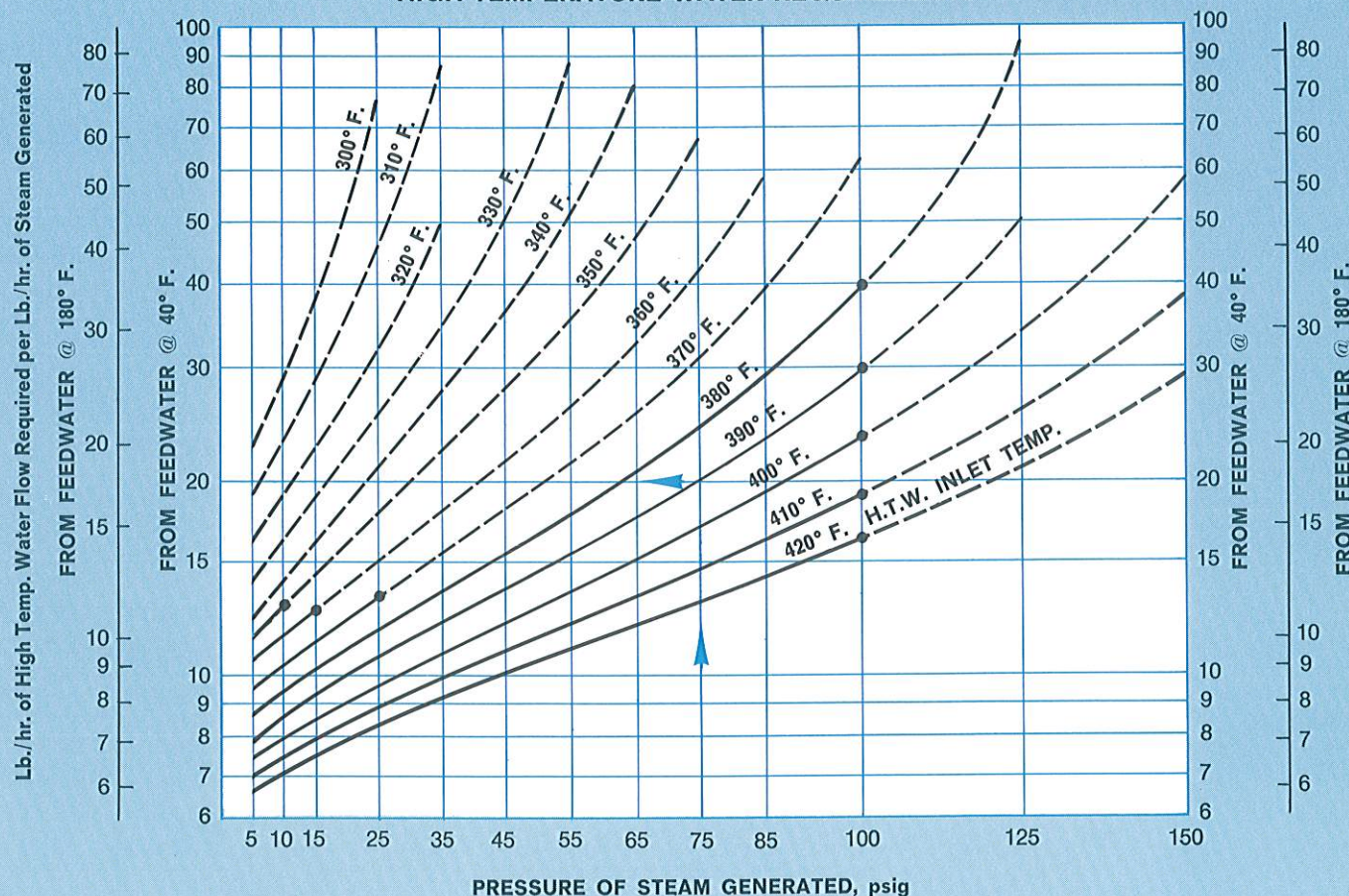
Check on Table 2 and see that minimum source

steam pressure for 25 psig is 72 psig. Therefore 100 psig is satisfactory.

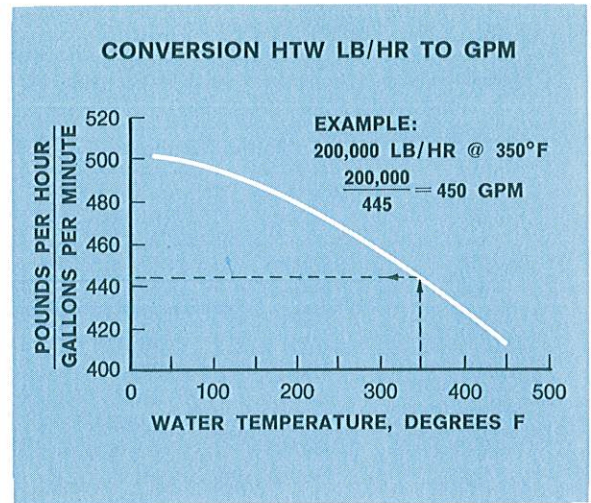
Steam requirements

From Table No. 2, read opposite 25 psig, under 180°F, that it takes 1.140 Lb./hr. of steam to generate one Lb./hr. of steam. Multiplying 4000 by this factor yields a requirement of 4560 Lb./hr. of steam at 100 psig.

HIGH-TEMPERATURE WATER REQUIREMENTS



NOTE: Combinations of output steam pressure and H.T.W. inlet temperature that fall on solid portions of curves can be handled with standard Model 380 packages. Consult P-K for combinations that fall on dashed portions of curves.



- Percentage of makeup water to return condensate
- Analysis of makeup water
- Material requirements if they differ from steel shell and copper tubing — as an example, stainless steel for deionized steam or for special sterilizer service, etc.

HTW-TO-STEAM

- Steam capacity, pounds per hour
- Output operating steam pressure, psig
- Heat-source HTW water temperature, degrees F., Min.
- Pressure of HTW supply, psig, max.
- Available makeup water pressure, psig, min.
- Lowest feedwater or makeup water temperature, degrees F.
- Percentage of makeup water to return condensate
- Analysis of makeup water
- Material requirements if they differ from steel shell and 90/10 Cupro-nickel tubing — as an example, stainless steel for deionized steam or for special sterilizer service, etc.

HEAT EXCHANGER SECTION

Patterson-Kelley will select a standard tube bundle to deliver the capacity you specify under the operating conditions you anticipate.

An ample fouling allowance is used in computing the Series 380 tube bundle for your particular requirement. Please note that P-K asks for the percentage of makeup water compared with the quantity of return condensate if a return system is used. If no condensate is to be returned, indicate 100% makeup water.

P-K engineering department also asks for an analysis of makeup water so that the fouling factor can be based on both percent makeup and its mineral content.

Series 380 Packaged Generators are supplied with ASME tandem blow-off valves. Regular periodic blowdown of any piece of steam-generating equipment must be performed to maintain its peak capacity. Frequency of blowdown will be dependent upon the percentage of raw makeup and its mineral content. Of course, if deionized or mineral-free water is fed to the Series 380, the blowdown requirements are minimal.

CONSTRUCTION MATERIALS

Standard shell construction is welded steel, SA 285 Grade C or SA 212 Grade B.

Standard bundle construction utilizes $\frac{3}{4}$ -inch O.D. tubing, parallel roller-expanded with electronic control into close-fit, double serrated tube holes. Tubing is seamless with a minimum wall thickness of 18 BWG (.049 inch). Copper tubing is used in steam heated generators operating up to 150 psig (366°F) supply pressure. 90-10 Cupro-nickel tubing is used in HTW heated generators and for the higher steam supply pressures.

START-UP SERVICE

Patterson-Kelley offers start-up service as an option at extra cost. If specified, we will provide a qualified engineer who will check over the installation of a Series 380, witness start-up, check the performance of all controls, make any needed adjustments and instruct those responsible for care and operation of the equipment.

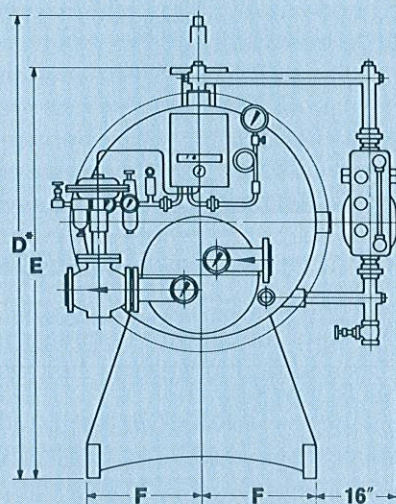
TABLE No. 3 — P-K SERIES 380 STANDARD DIMENSIONS

Model Number*	A	B	C	D	E	F	Feed-Water Inlet	Steam Outlet	
								5 to 25 psig	25 to 100 psig
S or H 245A	24"	60"	84"	54"	48"	12"	1/2"	1 1/2"	1 1/2"
S or H 245B	24"	60"	84"	54"	48"	12"	1/2"	2"	2"
S or H 305	30"	60"	84"	60"	54"	15"	3/4"	2 1/2"	2 1/2"
S or H 307	30"	84"	108"	60"	54"	15"	3/4"	3"	3"
S or H 366	36"	72"	100"	66"	60"	18"	1"	4"	3"
S or H 369	36"	108"	136"	66"	60"	18"	1"	5"	4"
S or H 3610	36"	120"	148"	66"	60"	18"	1 1/4"	6"	4"
S or H 4210	42"	120"	148"	72"	66"	21"	1 1/4"	6"	5"
S or H 4810	48"	120"	148"	78"	72"	24"	1 1/2"	8"	6"
S or H 5410	54"	120"	154"	84"	78"	27"	2"	10"	8"
S or H 6010	60"	120"	154"	90"	84"	30"	2"	10"	8"
S or H 6012	60"	144"	178"	90"	84"	30"	2 1/2"	12"	10"

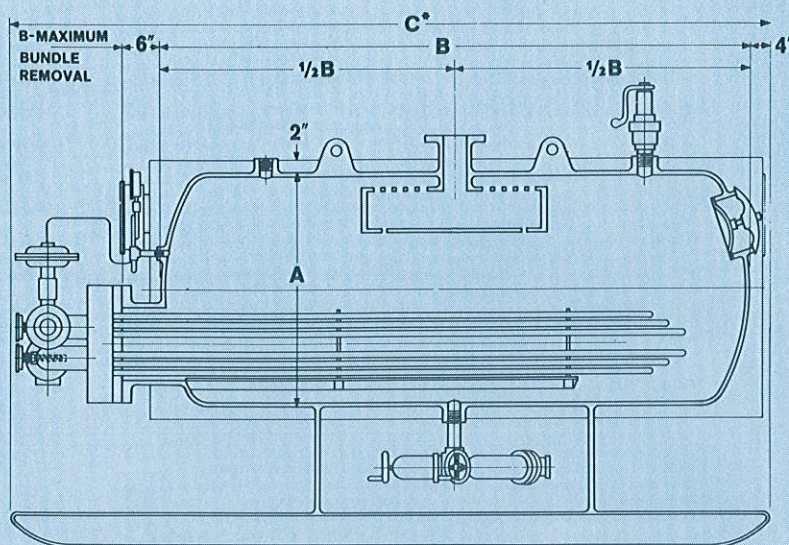
* Model number starts with S for steam heating medium — with H for high-temperature water.

TABLE No. 4 — H.T.W. CONNECTIONS

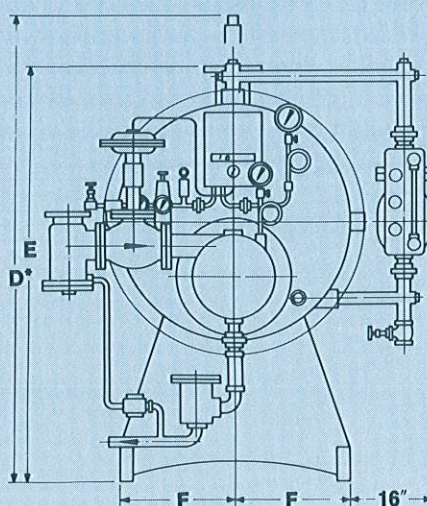
Nominal Pipe Size, Inches	Maximum Flow, Lb./hr.
1/2	4,500
3/4	7,200
1	12,500
1 1/4	20,000
1 1/2	30,000
2	45,000
2 1/2	80,000
3	120,000
4	180,000
5	270,000
6	450,000
8	900,000
10	1,500,000



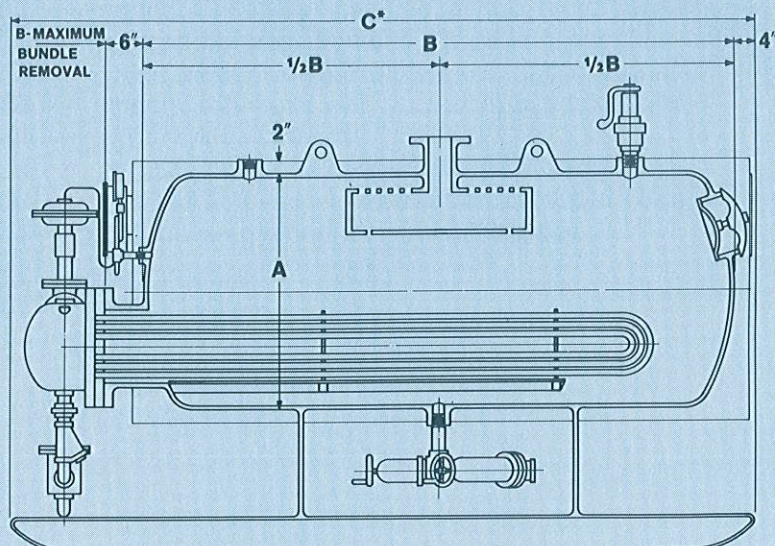
* APPROX.



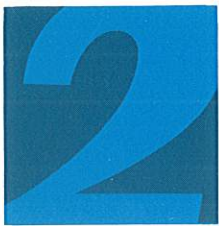
HTW-TO-STEAM



* APPROX.

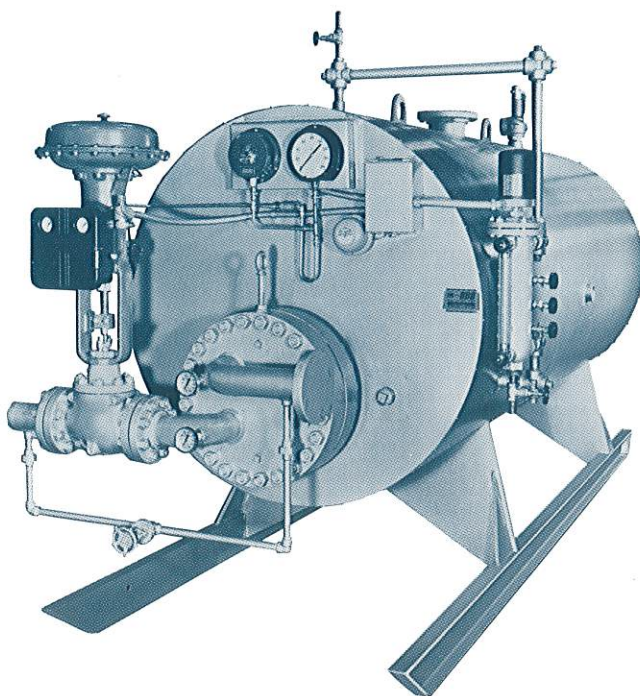


STEAM-TO-STEAM



UNFIRED STEAM GENERATORS

factory-engineered and packaged by P-K



H.T.W.-TO-STEAM

5,000 lb./hr. of 40 psig steam
with 350°F H.T.W.

An old need is now met by Patterson-Kelley's Series 380 Unfired Steam Generators. It is a need that arises with growing frequency today.

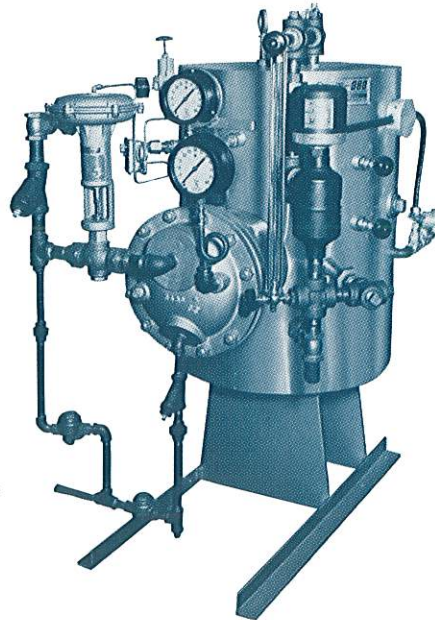
Steam of controlled purity, free of boiler compounds, is supplied at moderate or low pressures by this new package — safely, economically, dependably.

A CHOICE OF FLUID HEAT SOURCES

There is no fire, no burner, no combustion space, no high-temperature problem. You have a choice among several heat sources from existing services.

Steam from a regular boiler may be utilized if its pressure is somewhat higher than that of the desired output steam. There is no cross-contamination between steam supply and steam output. The two systems are completely isolated from each other.

High-temperature water may be the heat source if its temperature is somewhat higher than saturation temperature for the desired output steam pressure. Again, the input and output systems are isolated, and there are no cross-connections.



STEAM-TO-STEAM

Vertical unit generates up to 500 lb./hr. steam.
H.T.W.-to-Steam also available.
All units are 5' high and 3' width and length, including piping.

Process fluids — either liquids or vapors — may serve as heat sources. Thus, a Series 380 Unfired Steam Generator may extract heat from high-temperature oils or such fluids as Dowtherm. It may be used to condense process vapors while reclaiming the heat they carry. Special construction materials are available to take care of most industrial corrosion or compatibility problems.

ADVANTAGE OF LOW TEMPERATURES

All of these fluid heat sources come to the heat exchanger in a Series 380 at temperatures in the hundreds of degrees F — not in the thousands as with direct firing. Consequently there is far less tendency to form hard boiler scale on tube surfaces.

SAFE — LOW WATER NO PROBLEM

Low water in a direct-fired boiler is a classic hazard. That is why carefully-engineered low-water controls are always specified and why the presence of a qualified attendant is justified for such units.

By contrast, an Unfired Steam Generator poses no low-water hazard whatsoever. If a Series 380 runs dry, no damage will be done if

the heating medium should be admitted to the heat-transfer section without any feedwater in the shell at all!

Because it is safe, the Series 380 package can be located almost anywhere. It does not require an operating engineer. No attendant needs to be paid while he supervises its automatic controls.

PRE-ENGINEERED FOR YOUR JOB

Electronic computer calculations performed by Patterson-Kelley assure that the Series 380 package furnished to meet your design requirements will have an ideally-proportioned heat-transfer section. Velocities and areas are translated into bundle sizes, number of passes, pressure drops — all the variables — in optimum balance.

P-K also engineers all controls and auxiliaries. They are installed at the factory and tested before shipment. There is a considerable amount of flexibility here, and our engineers will work with you to fit a package to your specific needs.

But you specify only one item. The package arrives at the job-site ready to operate as soon as the simple connections are made.



WHERE TO CALL FOR a Series 380 Unfired Steam Generator

Situations where an Unfired Steam Generator will meet real needs occur in a variety of construction, industrial and service installations. They can all be grouped generally into three categories.

1. Where another heat source is available and some steam is required, the Series 380 eliminates any need for a fired boiler. It can save money at installation. It can eliminate the continuing cost of attended operation.

2. If cross contamination is to be avoided, the Series 380 is an ideal barrier. It works both ways.

Usually, the need is for steam of controlled cleanliness or purity. A well-designed boiler operated at peak loads beyond its rated capacity may require high water levels, and this often leads to water entrainment. Even non-volatile contaminants find their way into the steam line in such a case. Whatever the contamination in your regular steam supply, the output of an Unfired Steam Generator can be of controlled cleanliness.

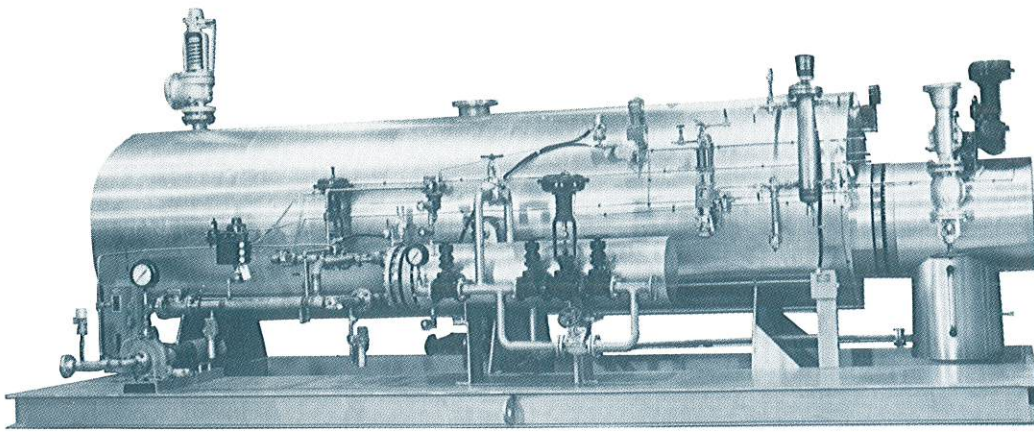
Sometimes the need occurs the other way around. For example, if steam is used to heat process chemicals, it may be essential to keep traces of those products from finding their way back into the main boiler. Any leakage into jackets or coils supplied by a separate Un-

fired Steam Generator can be monitored and can be controlled.

3. If peak steam demands must be met on occasion, a Series 380 Unfired Steam Generator can serve as a buffer or reservoir. Steam can be saved at pressures somewhat higher than required during peak periods. By its design, the Series 380 has a relatively large steam volume above the normal water level. Furthermore, as pressure goes down during a severe demand surge, part of the water in the shell flashes into steam and backs up what has already been generated.

BUILDINGS AND BUILDING COMPLEXES

Groups of buildings in apartment complexes, on college campuses, around industrial plants, at shopping centers, in motel and restaurant establishments, at medical centers and similar multiple-unit enterprises are commonly heated by central high-temperature water systems. Yet the need for steam persists. Very often, existing structures in the group have been equipped for steam heat, and it is economically desirable to use their heating systems without change. Humidifiers of air conditioning systems may require steam. Special services require steam.



Sterile Steam-Generating System produces 20,000 lb./hr. of 50 psig steam from feedwater @ 70°F when supplied with 22,180 lb./hr. saturated steam @ 100 psig to the control valve. Constructed to GMP/FDA standards, the generator has a stainless steel sterile-contact side.

When packaged Unfired Steam Generators are located where that steam is needed, the central high-temperature water system can serve the entire heat energy load. No separate fired boilers are needed.

HOSPITALS

Steam for sterilizing and other services can be provided economically by an Unfired Steam Generator package. Basic heating requirements may be met either with steam or high-temperature water, which also serves as a heat source for steam generation.

FOOD PROCESSING PLANTS – KITCHENS

Wherever steam comes directly into contact with foods during blanching, scalding or cooking processes, it should be meticulously clean. So should steam used for cleaning and sterilizing vessels, piping, conveyors and equipment such as paddles or agitators. A Series 380 package is an ideal source of clean steam for such uses.

LAUNDRIES – TEXTILE CONVERTERS

Relatively large hot-water heaters are the rule where many washing and rinsing operations must be performed. Yet some steam is needed for other operations, and its cleanliness is frequently important. Such a situation suggests

an Unfired Steam Generator operating from an appropriate high-temperature water or steam source in the heat-balance cycle.

LABORATORY RESEARCH

Relatively clean steam may be needed for the ordinary laboratory merely as one more essential support service. Certain kinds of biological research, on the other hand, depend on the use of steam at a very low level of contamination. Deionized steam is used in some kinds of scientific work.

Whatever the specific requirements, a Series 380 Unfired Steam Generator affords a versatile, trouble-free way of meeting them. It avoids all the problems of a separate boiler or a specially-designed steam-generating system.

INDUSTRIAL PROCESSING

In the plant situation, many factors may indicate desirability of an Unfired Steam Generator for specific applications. Convenience, economy of plant layout, avoidance of contamination, reduced corrosion, the economics of heat reclamation – or combinations of these – may tip the choice.

The trouble-free, pre-engineered Series 380 package will be well regarded by the operating and maintenance people responsible for its performance.

A QUALITY PACKAGE

Patterson-Kelley assumes engineering responsibility— assembles integrated control system

The Series 380 steam generator is a skid-mounted unit. It has lifting lugs for hoisting into place, and it can also be moved on rollers or by sliding. It requires no special foundation. Once in place, it needs only to be hooked up.

All controls are connected and pre-tested. The shell is already covered with 2-inch high-density fiber insulation which is protected by a heavy zinc-plated sheet steel jacket. The entire package is painted in a workmanlike manner.

SHELL

The tank or shell is amply proportioned to store a large volume of water at saturated steam pressure. Intermittent feedwater injection has little or no effect on steam output. Plenty of area is available for steam disengagement at rated capacity. Water entrained in emerging steam is removed at the P-K steam separator, which utilizes inertia forces at sharp changes of flow direction.

All shells are designed, constructed and stamped to requirements of the ASME Code, Section VIII, for Unfired Pressure Vessels. Reinforced manholes are provided in all units.

Units operating at 45 psig or less bear the ASME stamp for 50 psig design pressure, but they are constructed conservatively for 150 psig.

Units for service at pressures higher than 50 psig are fully X-rayed and stress relieved

after fabrication. They are ASME stamped for a maximum steam generating pressure of 150 psig.

HEAT TRANSFER SECTION

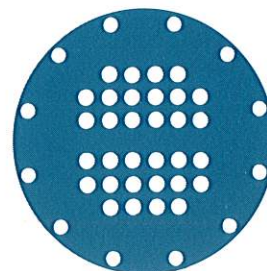
Tube bundles for steam or circulating high-temperature water are all of the single tube sheet U-tube design. They are all capable of operating without damage in event the steam generator is run absolutely dry. They have the complete flexibility to withstand sudden injection of cold feedwater while they are at steam-generating temperature.

P-K uses standard $\frac{3}{4}$ -inch O.D. tubing. It is arranged in a square pattern on 1-inch pitch so that tube exteriors can be cleaned mechanically without difficulty.

Generously thick tube supports maintain tube alignment in the bundle. These full disc supports rest on tracks inside the shell. Whenever the bundle must be pulled for inspection or service, the supports slide on the tracks. The bundle stays properly aligned, and the job of handling it is very much simplified by this convenient arrangement.

STANDARD FITTINGS AND CONTROLS

The Series 380 package is supplied completely equipped with accessory components of proven excellence. Many of them are the same regardless of the heat source.



Heat — transfer Series 380 bundles are built with a square pitch so that tube exteriors are accessible for easy mechanical cleaning.

Connections for steam and water are all standard ASA flanged nozzles in 2-inch size and larger.

The pressure control system delivers a pneumatic or electrical call-for-heat signal to the steam or high-temperature water regulator valve.

A pressure gage is supplied and installed on the front of the shell.

Liquid level controls deliver electrical or mechanical action to the feedwater pump or valve. Because the Series 380 can tolerate wide fluctuations in water level, a modulating feedwater system is not necessary.

If the setting for generated steam pressure exceeds the pressure at which makeup water is available — or is too close to assure adequate flow — a feedwater pump can be added to the package.

Series 380 Unfired Steam Generators are often used in closed-circuit condensing systems that require little or no makeup water. For such an application, a complete return system with receiver and pumps can be incorporated with the Series 380 package.

An ASME gage glass assembly is installed to permit visual inspection of water level.

Thermometers are installed in the high-temperature water or heating medium piping or *steam gages* on steam supply piping to monitor performance of the unit.

Safety valves are provided and installed per ASME Section I Boiler Code.

Blow-off valves in the ASME tandem arrangement are installed on the bottom of the shell.

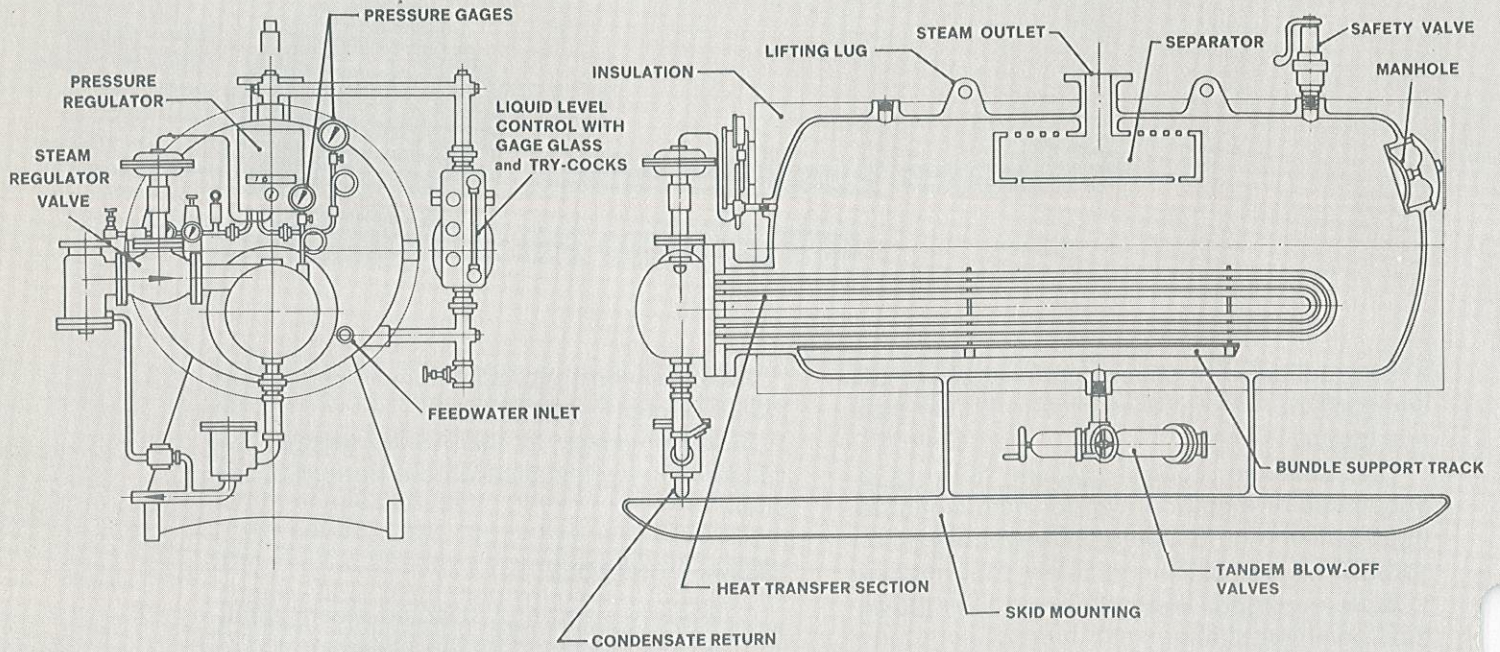
STEAM CONTROLS

A properly sized and selected steam regulator valve is furnished for the system pressure and generator capacity required. It may operate pneumatically, electrically or hydraulically — according to the customer's option. Bypass connections can be installed when requested. Necessary strainers and steam traps are installed.

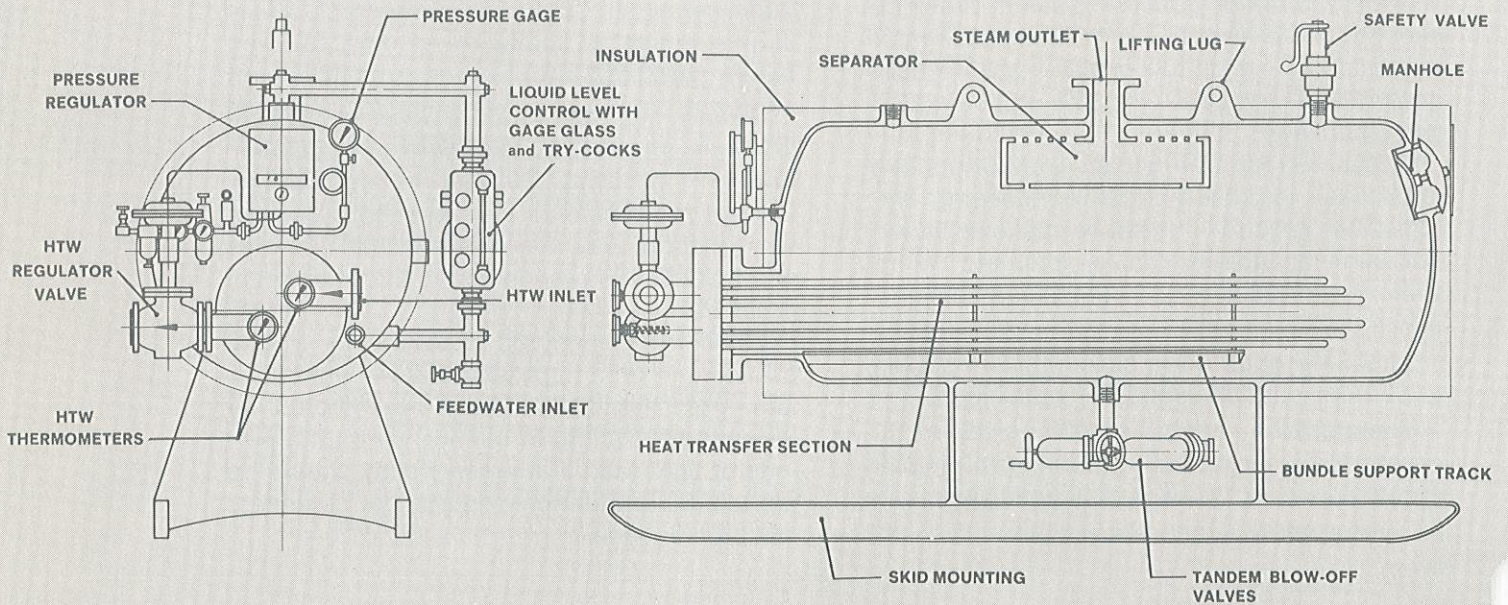
H.T.W. CONTROLS

Usually, high-temperature water is available at ample pressure to take care of circulation through the Series 380 heat-transfer section. Control requirements are satisfied by a two-way or three-way V-port valve that operates automatically in response to generator steam pressure.

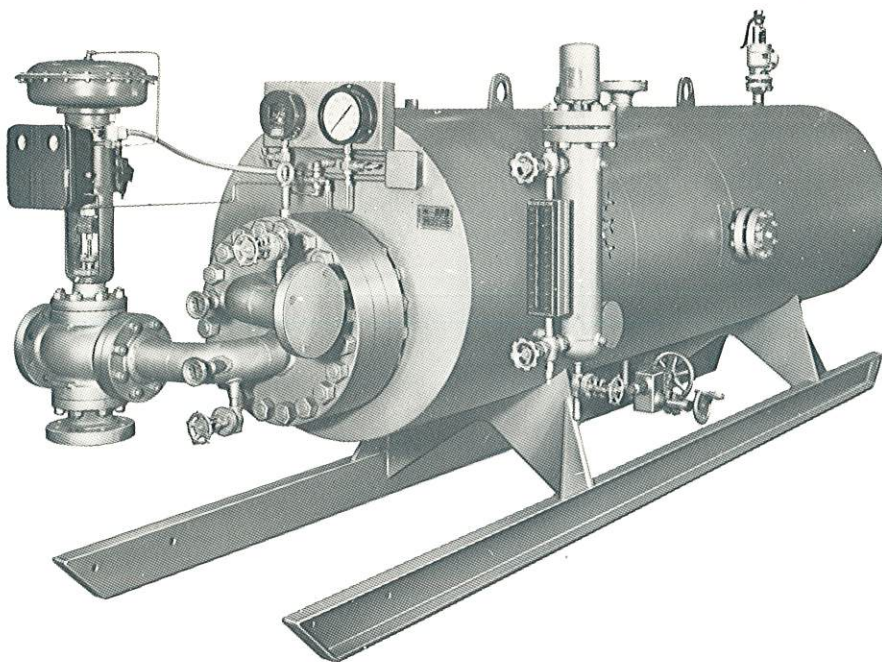
When the Series 380 is served by a long branch line off a high-temperature water system, pressure control may be effected by intermittent cooling in the branch during periods of light load. Patterson-Kelley should be alerted if this situation exists so our engineers can provide for it.



STEAM-TO-STEAM SERIES 380 UNFIRED STEAM GENERATOR



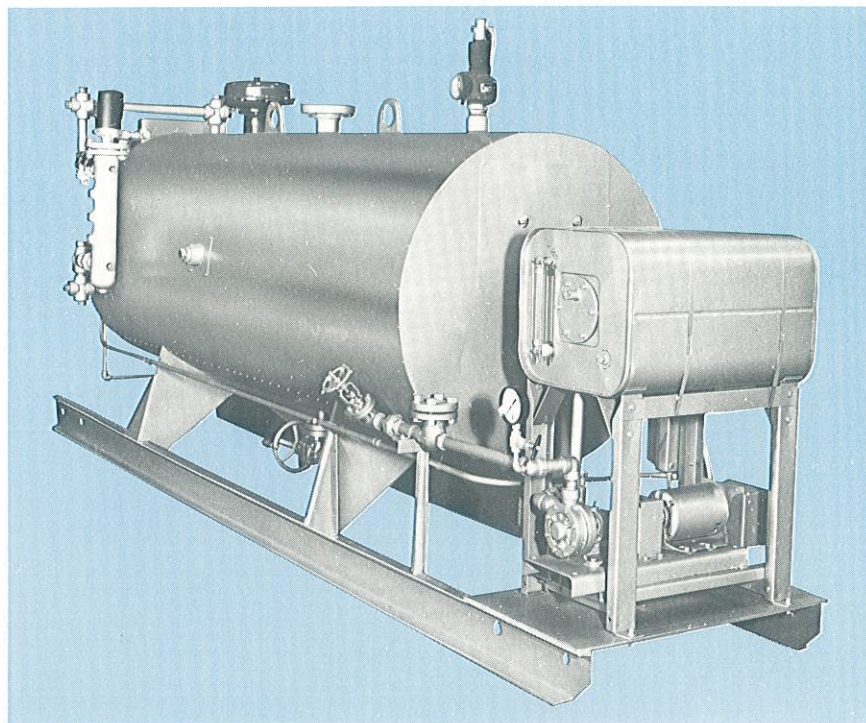
HIGH-TEMPERATURE WATER-TO-STEAM SERIES 380 UNFIRED STEAM GENERATOR



THERMAL FLUID-TO-STEAM

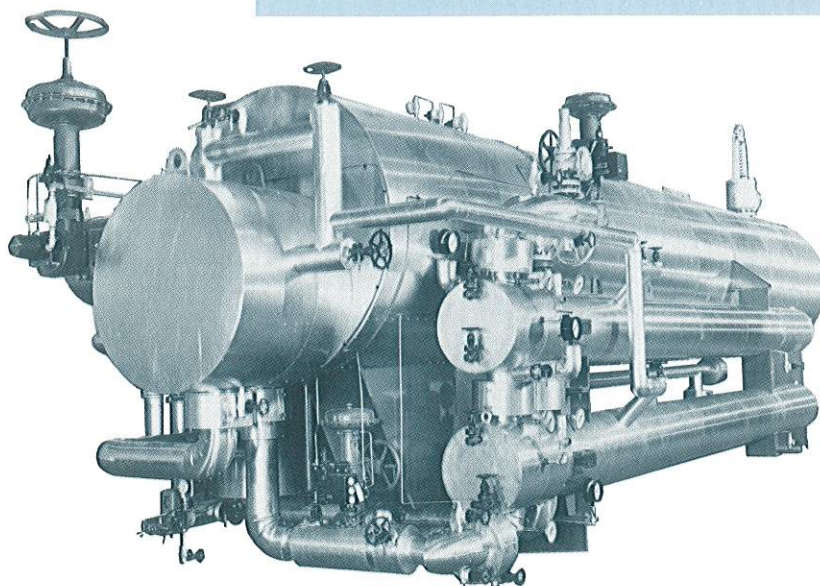
delivers 5,000 lb./hr. of 700 psig steam with thermal fluid at 600°F. Other special units available in steam capacities up to 50,000 lb./hr.

Series 380 with optional boiler feed unit



STEAM-TO-STEAM SYSTEM

generates 85,000 lb./hr. plant heating steam @ 80 psia from superheated turbine cycle steam @ 161 psia. Packaged system includes condensate cooling and feedwater preheating.



P-K QUALITY PRODUCTS

WATER HEATERS/BOILERS

Heat Transfer: Electric, Steam, boiler water, gas and oil-fired water heaters, and hydronic and steam boilers for commercial, institutional and industrial buildings. East Stroudsburg, PA.

AIR-COOLED HEAT EXCHANGERS

Air-x-changers for the natural gas and chemical process industries. Tulsa, OK.

BLENDERS/DRYERS

Process Equipment: Batch and continuous blenders and dryers for producing pharmaceuticals, foods, plastics, powder metals, detergents, ceramics, etc. East Stroudsburg, PA.

FRACTIONATION INTERNALS

Nutter Engineering: Fractionation trays, tower packings and liquid distributors for refining, petrochemical and chemical plants. Tulsa, OK.

PROTECTIVE LININGS

Pocono Fabricators: Corrosion-resistant cements for lining tanks, stacks, ducts, breechings, scrubbers, etc. East Stroudsburg, PA.

Patterson-Kelley Co., is comprised of the five business groups shown above. P-K has two plants in East Stroudsburg, PA, and two in Tulsa, OK. Testing laboratories for P-K's equipment are located in East Stroudsburg and Tulsa. Main offices are located in East Stroudsburg, PA.

P-K Representative:



PATTERSON-KELLEY CO.

Division of HARSCO Corporation
East Stroudsburg, PA 18301

(717) 421-7500
Telex: 84-7313

