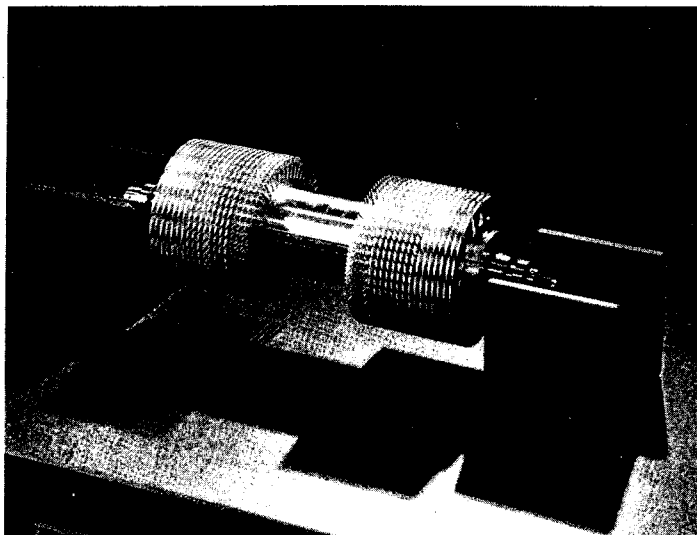


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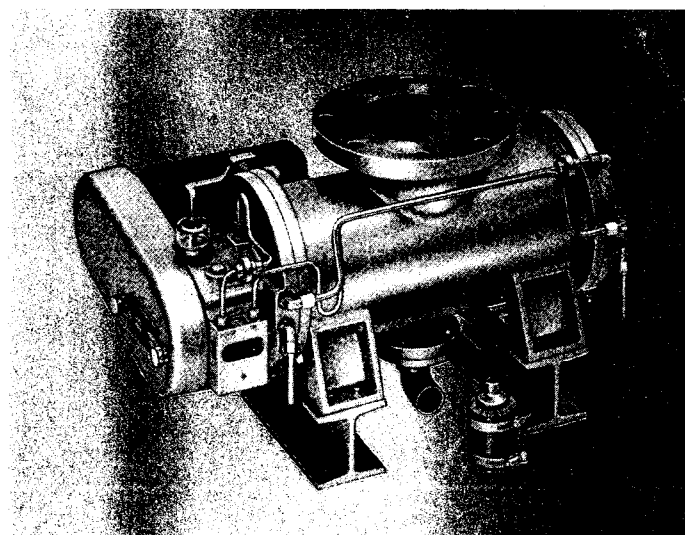
NEW, IMPROVED TURBO-MOLECULAR VACUUM PUMPS FROM WELCH....

HAVE 260 LITER/SECOND CAPACITY!
PROVIDE $1 - 2 \times 10^{-9}$ TORR BLANK-OFF PRESSURE!

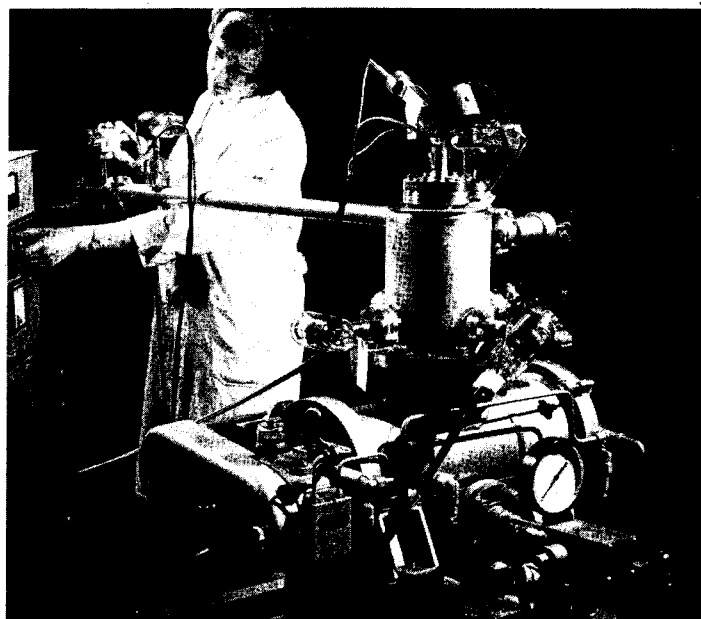
Vault



THIS 19-STAGE TURBINE ROTOR IS THE HEART OF THE NEW WELCH TURBO-MOLECULAR PUMPS. UNSEEN AND QUIET - IT ROTATES AT 16,000 RPM—DEVELOPS A COMPRESSION RATIO FOR AIR OF OVER 1 MILLION TO 1.



THREE MODELS OF TURBO-MOLECULAR PUMPS ARE OFFERED. IF A SUITABLE FOREPUMP IS ON HAND, MODELS 3102B OR 3102C CAN BE PURCHASED. A WIDE CHOICE OF WELCH FOREPUMPS MAY BE SELECTED FOR SPECIFIC APPLICATIONS.



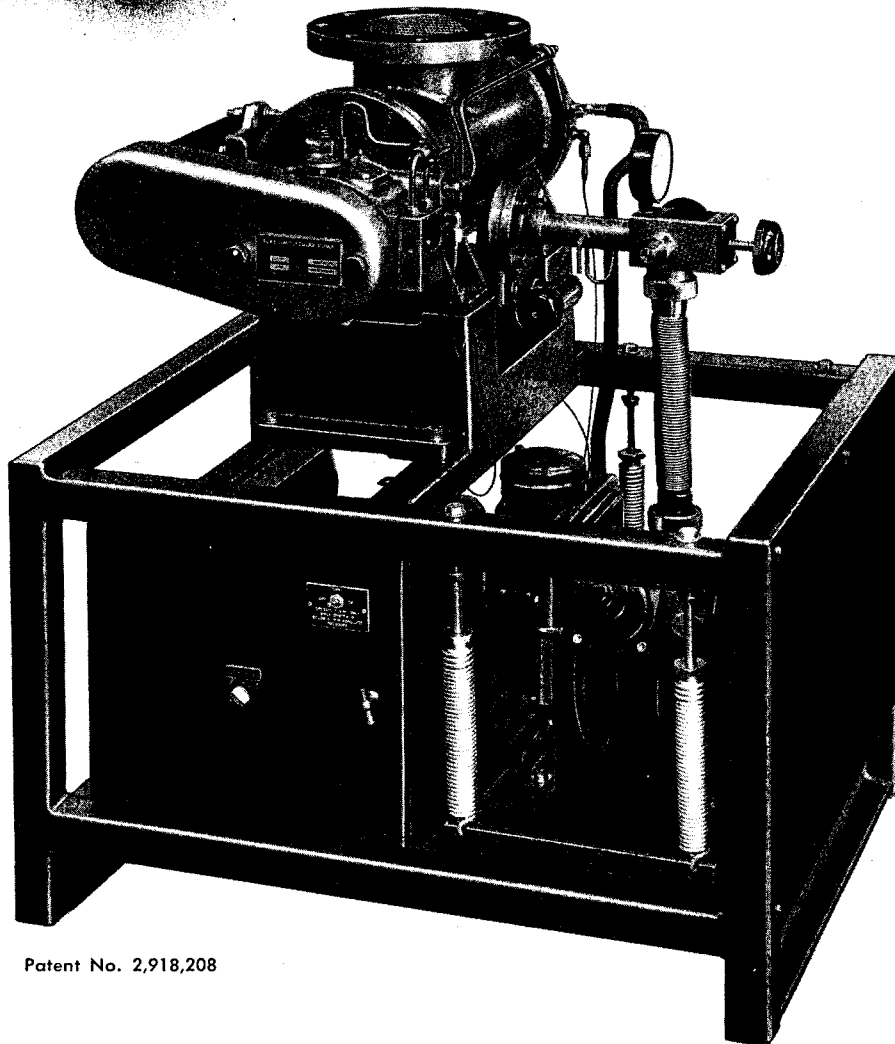
THE MODEL 3102A TURBO-MOLECULAR PUMP IS USED HERE WITH VACUUM GAUGE ACCESSORIES FOR MEASUREMENT OF PUMPING SPEED IN 10^{-9} TORR RANGE BY THE CONDUCTANCE TUBE METHOD. ANALYSIS BY MASS SPECTROMETER OF RESIDUAL AND FLOW TEST GAS IS EASILY MADE. NOTE ABSENCE OF LIQUID NITROGEN BAFFLES.



THE RUGGED MECHANICAL PUMPING ELEMENT MAKES THE TURBO-PUMP FOOLPROOF AND SIMPLE FOR THE POPULAR 10^{-6} - 10^{-7} TORR PRESSURE RANGE. SHOWN ATTACHED TO THE MODEL 3102A IS A TYPICAL UNBAKED ELASTOMER GASKETED BELL JAR. THE BELL JAR CAN BE ROUGHED DIRECTLY THROUGH THE TURBO-MOLECULAR PUMP.

WELCH High-Speed, Ultra-High Vacuum Turbo-Molecular Pumps

MODELS 3102A, 3102B, 3102C



Patent No. 2,918,208

MODEL 3102A

Complete Welch Turbo-Molecular Pumping Assembly, ready to plug in and operate. (See pages 8 & 9 for complete description.)

The new Welch Turbo-Molecular Pumps are clean, *hydrocarbon-free*, purely mechanical pumps for attaining high and ultra-high vacuum (manufactured under exclusive license from Arthur Pfeiffer Co.). They embody a major advance in molecular pump design, permitting running clearance as much as ten times that of previous designs. Welch turbo-molecular pumps are, therefore, practically immune to damage from sudden inrushes of air and other gases, or thermal shock.

APPLICATIONS

Welch Turbo-Molecular Pumps will have application wherever *hydrocarbon-free* high vacuum is required. Their

inherent cleanliness and their capability to rapidly pump down atmosphere to normal working pressures makes them most valuable for production uses as well as for research.

TYPICAL USES

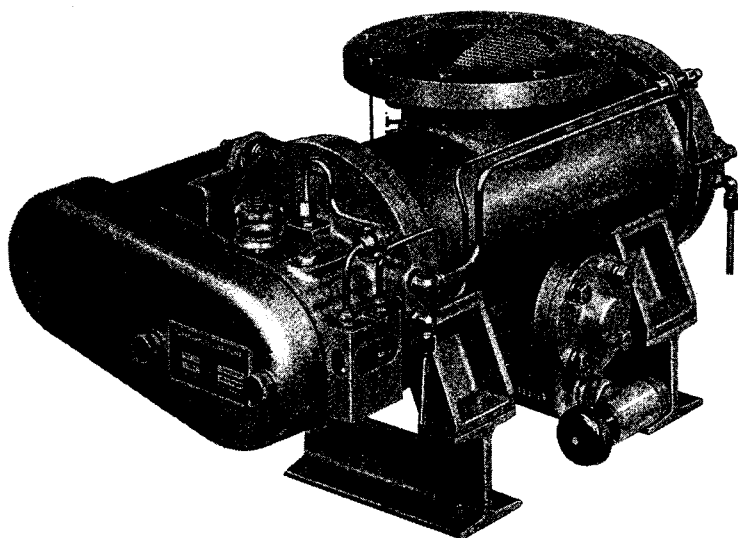
Typical uses are solid state and surface studies, semiconductor production, thin-film metallizing, purification of metals such as silicon and germanium, optics coating, separation of gases of different molecular weights, space simulation chambers, mass spectrometers, ion gauge calibration, roughing ion pump systems, particle accelerator and target chamber evacuation, and evacuation of power tubes and x-ray tubes.

BLANK-OFF PRESSURE:

$1 - 2 \times 10^{-9}$ torr or lower

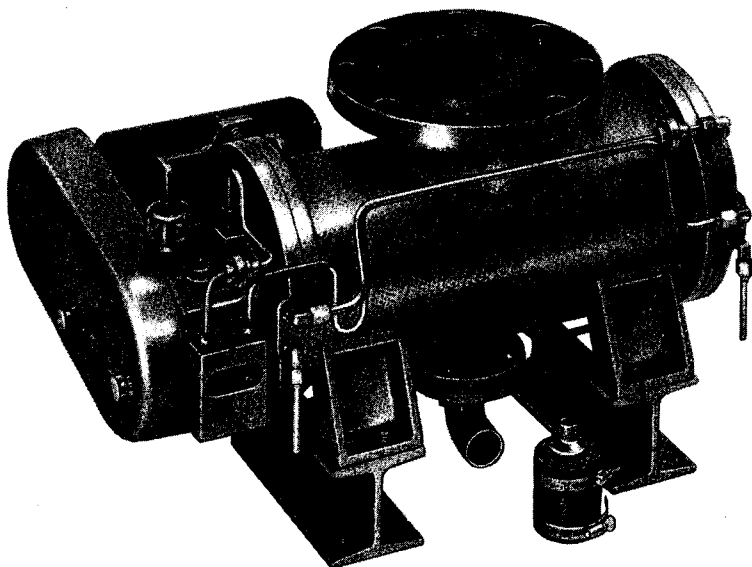
SPEED (AIR):

260 liters/second over a range
of 1×10^{-2} to 1×10^{-8} torr



MODEL 3102B

Welch Turbo-Molecular Pump with fore line manifold — requires fore pump and coolant for operation. (See pages 6 and 7 for complete description.)



MODEL 3102C

Welch Turbo-Molecular Pump without fore line manifold. Fore pump connection is made at elbow at bottom of pump — requires fore pump and coolant for operation. (See pages 6 and 7 for complete description.)

CHECK THESE**PLUS****FEATURES!**

- ☐ **NON-CONTAMINATING . . . SELF-CLEANING** turbo-molecular pumps do not use pumping fluid and do not permit back-streaming during operation. They do remove hydrocarbons from the system in unlimited quantities, without use of cold traps.
- ☐ **PUMPS NOBLE GASES** with exceptionally high efficiency.
- ☐ **PUMPS ALL GASES WITHOUT SELECTIVITY** — Turbo-molecular pumps can pump air, acetylene, helium, argon, benzene, and many other gases at any point within operating range.
- ☐ **RELIABLE** — If the turbo-molecular pump rotor is spinning, it is pumping. It will not become "saturated" or "overloaded" . . . does not "bury" gases, so cannot re-eject them into the system.
- ☐ **EASY LEAK DETECTION** — Pumps helium from 10^{-2} to 10^{-9} torr. No false signals by re-ejecting the helium.
- ☐ **SIMPLIFIES ROUGHING PROBLEMS** — Roughing is done directly through the turbo-molecular pump . . . eliminates the need for roughing lines and valves. The turbo-molecular pump begins to take over the pumping action long before the fore pump effectiveness drops . . . no "dead regions" in the transition from viscous to molecular flow . . . no migration of fore pump fluid vapors into the system.
- ☐ **SAFETY** — Turbo-molecular pumps neither use nor produce extremely high voltages.
- ☐ **NO OPERATIONAL PROBLEMS** — Turbo-molecular pumps are not damaged by, and they will recover rapidly from exposure to high pressure. They have no hot fluids to be thermally cracked, with resultant downtime.

Typical mass spectrogram readings demonstrate the speed and efficiency of Welch Turbo-Molecular Pumps to pump noble gases (argon) and hydrocarbons (acetylene), reducing their partial pres-

FIGURE 1

Background gases present at 7.5×10^{-8} torr, immediately before the introduction of argon into the turbo-molecular pump. Water and nitrogen peaks are obvious.

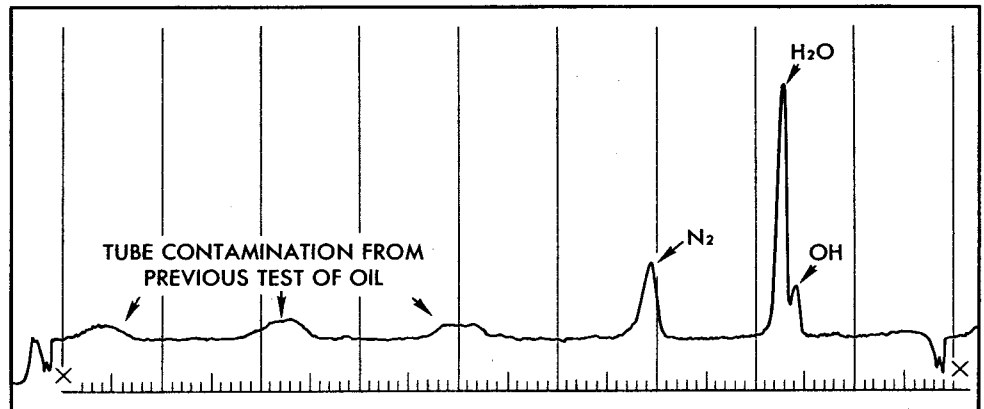


FIGURE 2

Spectrum for argon which was leaked into the pump at a rate sufficient to raise the pressure to 5×10^{-6} torr. This leak was continued for thirty minutes.

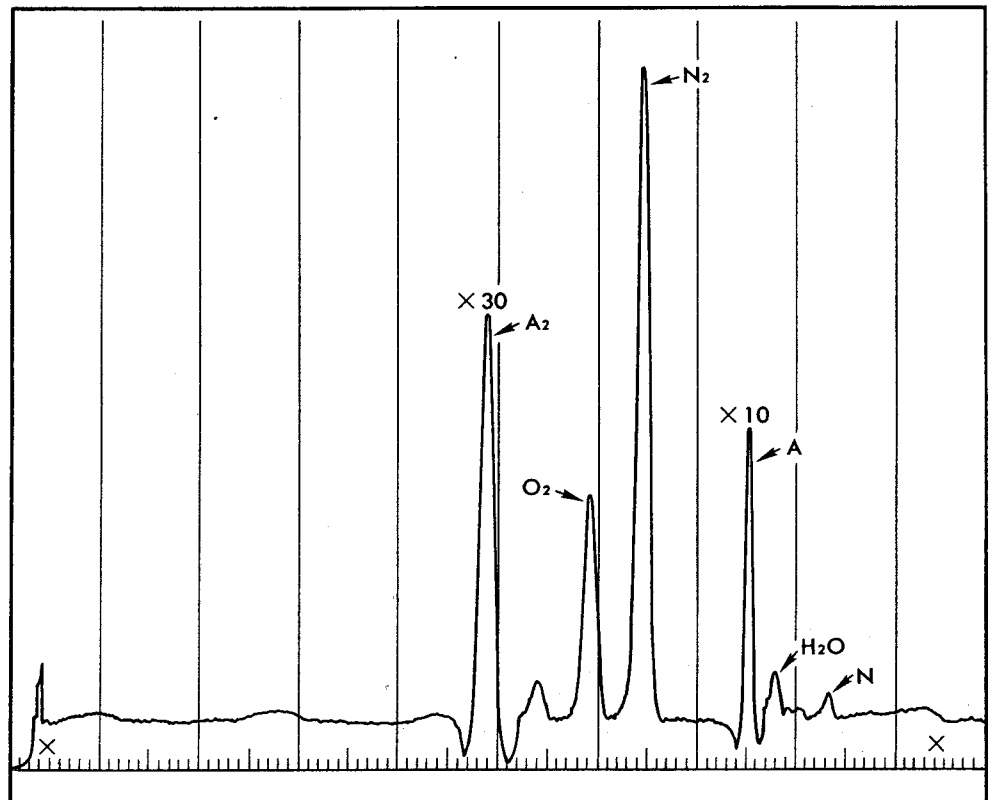
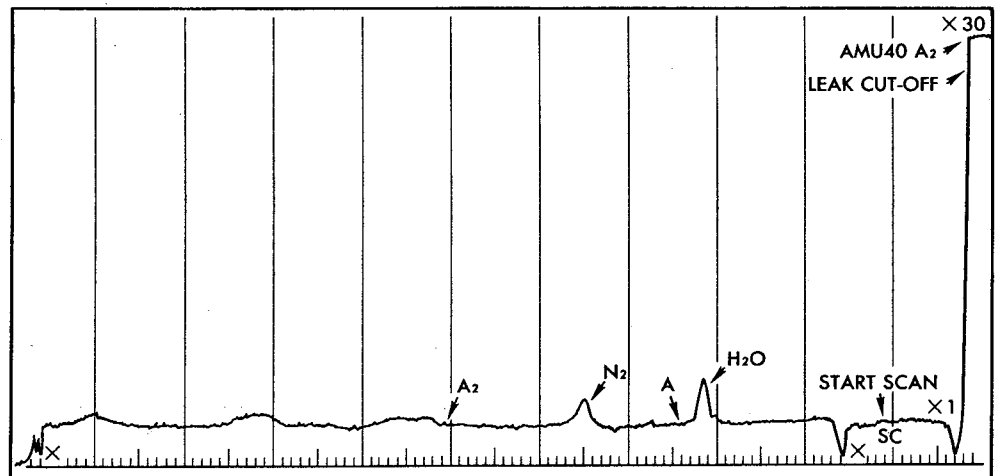


FIGURE 3

Monitoring of mass 40 peak at the far right, both before and after the leak was closed. At SC the mass spectrometer was switched to scan the entire spectrum. The absence of argon at M20 and M40 is spectacular because the time lapse since the closure of the argon leak is less than five minutes and the sensitivity for argon is one division/ 3.5×10^{-9} torr. The N₂ peak in Figure 3 is three divisions high.



tures below readable values. The time for each scan is six minutes. Total pressures were read with an ionization gauge.

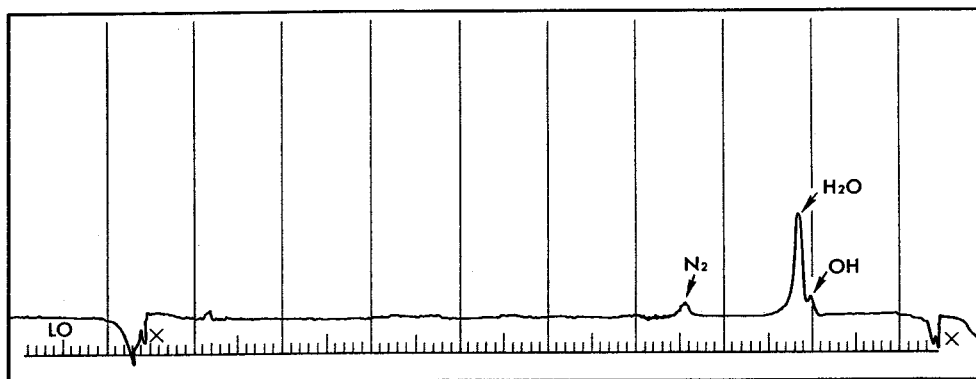


FIGURE 4

Background gases present at 9×10^{-8} torr, immediately before the introduction of acetylene into the turbomolecular pump. At the far left, at "LO", is the portion of the scan which would show hydrogen, if present.

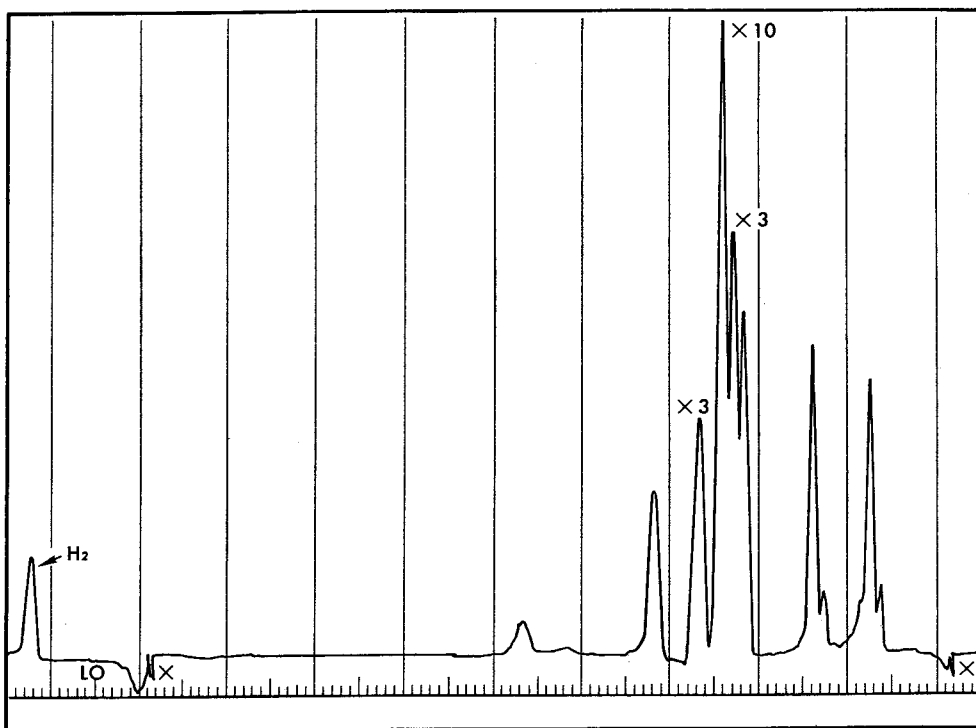


FIGURE 5

Spectrum for acetylene, which was admitted at a leak rate sufficient to raise the pressure to 5×10^{-6} torr. This leak was continued for 20 minutes. The hydrogen peak in the "LO" scale is evident, as are many hydrocarbon peaks.

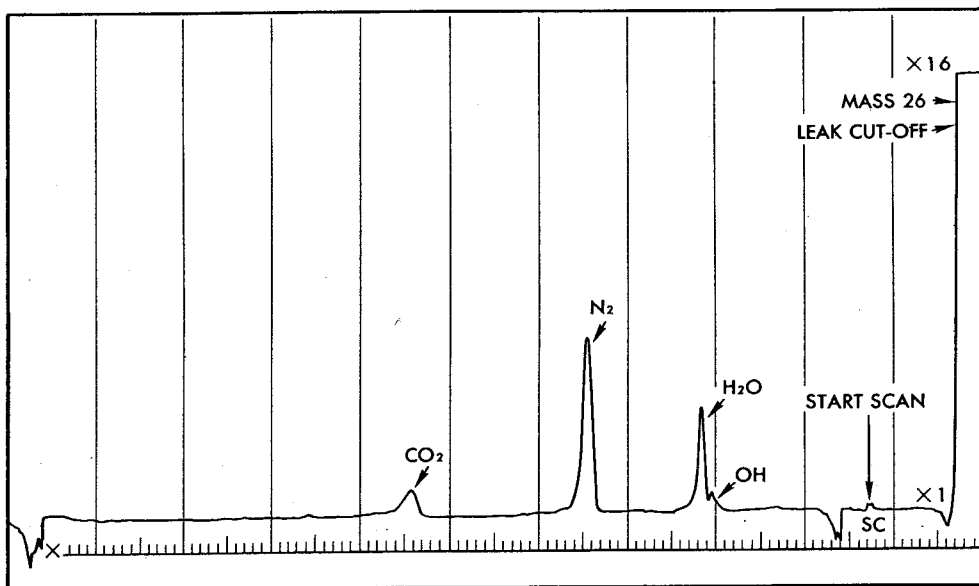


FIGURE 6

Shows the monitoring of the acetylene peak at mass 26 during leak closure, and the immediate scan of the entire spectrum.

PRINCIPLES OF OPERATION

Turbo-molecular pumps obtain their pumping action through relative velocities between gas molecules and moving and stationary slotted discs resembling stages of a turbine. Thus, the gas is mechanically driven from the inlet to the exhaust port with resulting compression ratios of 1,000,000 to 1 for air and even higher for oil. The rotor speed in the turbo-molecular pump is 16,000 r.p.m. Figure 7 is a schematic of the turbo-molecular pump. Oblique slotted discs are arranged alternately in the housing and on the rotor, so the pumping action is from the center toward both ends (fore vacuum) of the pump. Each of the moving and stationary discs form a pressure stage. The oblique slots are designed so the acceleration is forcibly imparted to the gas molecules in an axial direction, with optimum relationship between

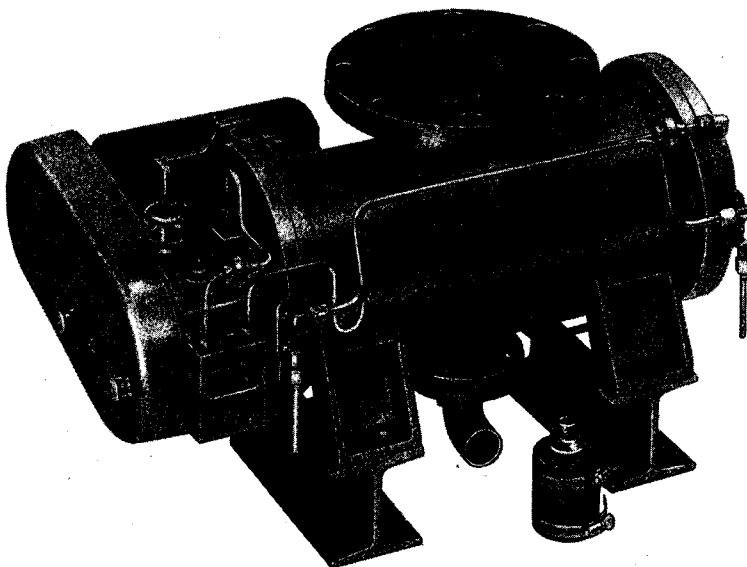
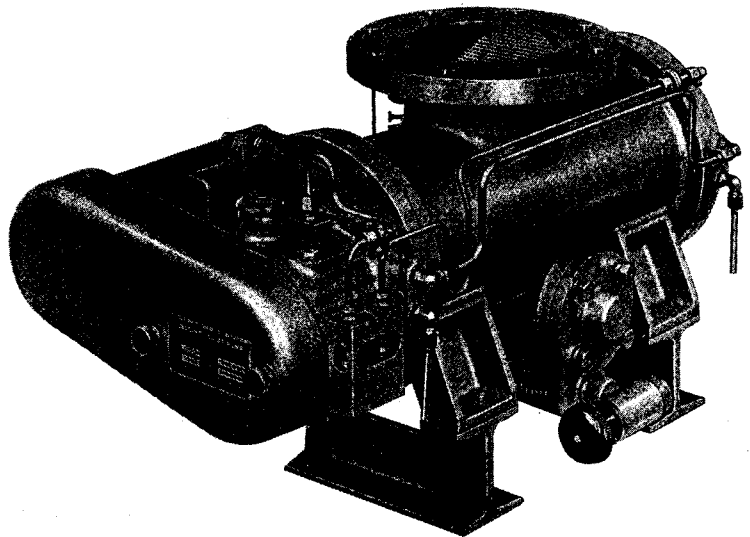
THREE MODELS TO CHOOSE FROM

Just see pages 6 and 7

MODEL 3102B

260 liter/second, ultra-high vacuum turbo-molecular pump equipped with a flanged fore line manifold and $\frac{3}{4}$ " bellows sealed valve with O ring sealed compression fitting for connection of leak detector or gauge. Includes $\frac{1}{2}$ h.p., 230/440 volt, 3-phase, 60 cycle motor with clutchless drive, and copper wire inlet gasket. Coolant must be brought into pump at coolant connections. Pump rests on modified "H" beams for base.

Model 3102B complete \$3,850



MODEL 3102C

Identical to Model 3102B except it is not equipped with a fore pressure manifold. Fore pump connection is made at $1\frac{1}{2}$ " O.D. elbow at bottom. Two stepdown size adapters with hose clamps are furnished for connection to fore line.

Model 3102C complete \$3,600

pumping speed and pressure ratio. The multiple slots in each stage comprise parallel channels of high total conductance.

The turbo-molecular pump is driven by a 3450 r.p.m., 3 phase, $\frac{1}{2}$ horsepower motor with new clutchless drive; however, full horsepower is used only during the acceleration period. The motor is protected against overload during the acceleration period. The rotor is driven by an oil-immersed, toothed belt, and spins on lightly loaded, elastically supported ball bearings. The belt and bearings have an anticipated minimum life expectancy of 10,000 hours. The replacement costs of these items are nominal.

The cross sectional area of the turbo-molecular pump passages and the fore pump inlet connection are about equal. The unit can therefore be rapidly roughed directly through the turbo-molecular pump.

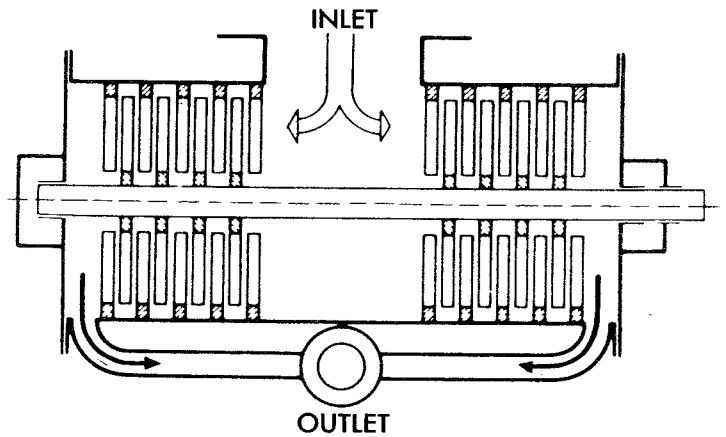
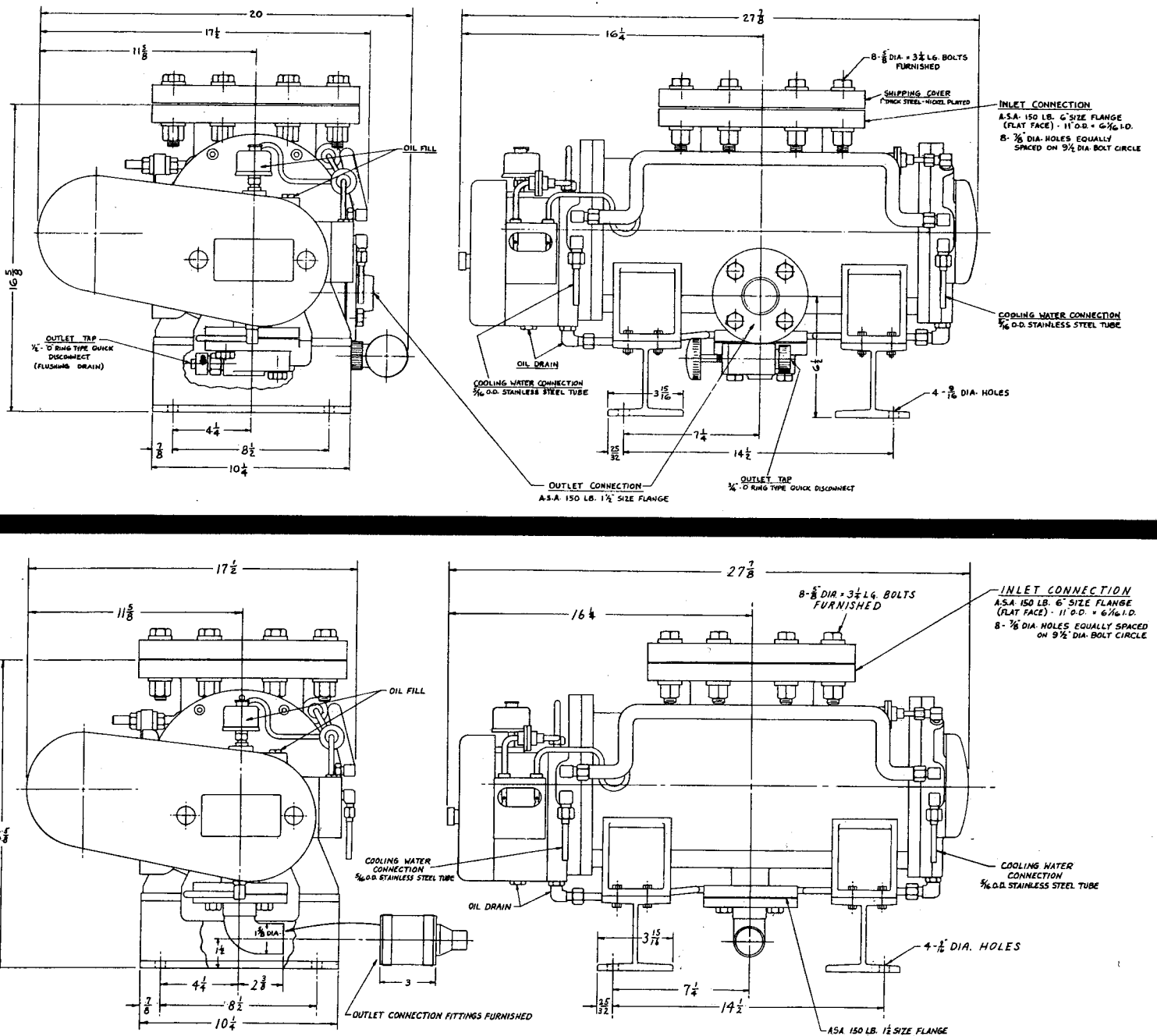
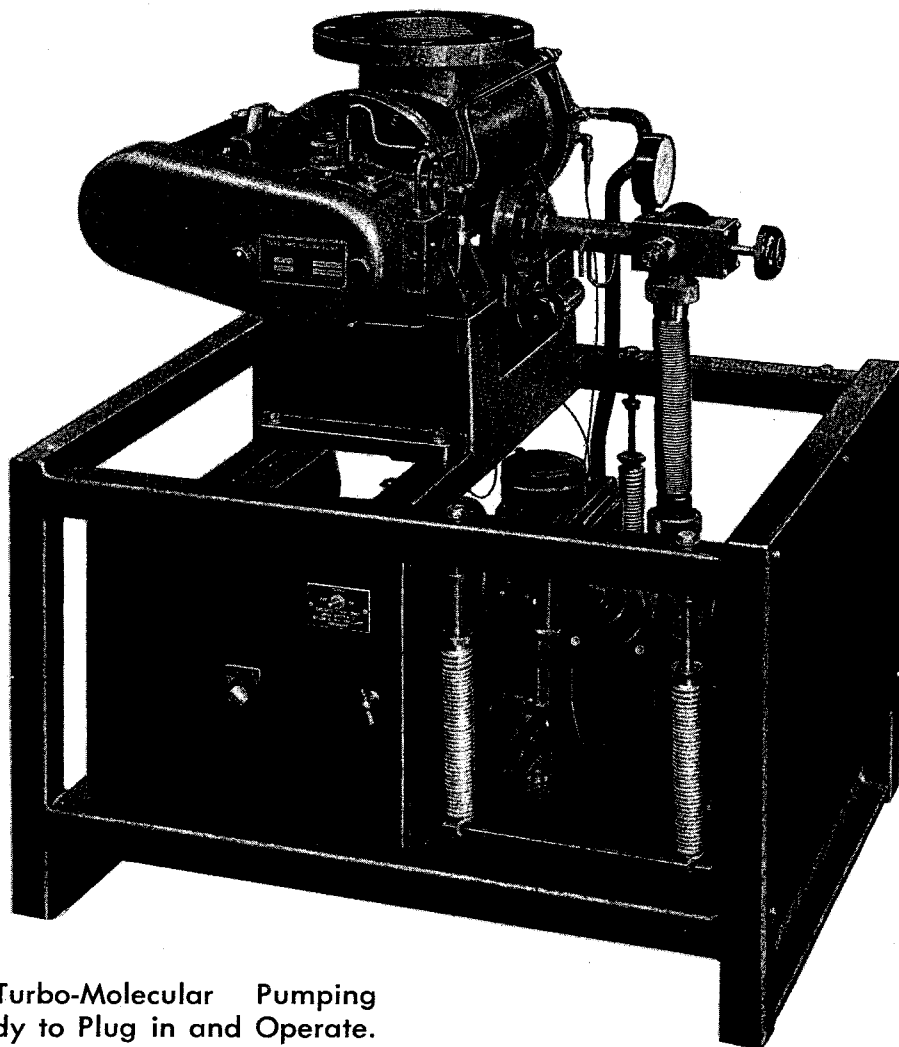


Figure 7 - Schematic Cross-Section of Turbo-Molecular Pump





MODEL 3102A

Complete Turbo-Molecular Pumping System, Ready to Plug in and Operate.

Consists of a 260 liter/second, No. 3102 Turbo-Molecular Pump, a No. 1397 "Duo-Seal" Fore Pump and all necessary equipment mounted in a sturdy, compact unit.

The Welch "Duo-Seal" No. 1397 Fore Pump is suspended on springs which isolate its low frequency vibrations from the rest of the structure. A flexible bellows connects it to the turbo-molecular pump through a manually operated valve. This valve can be closed to isolate the turbo-molecular pump from the fore pump. A valved $\frac{3}{4}$ " O ring type connection is provided at the turbo-molecular pump outlet to attach a leak detector or forepressure gauge. A $\frac{3}{4}$ " unvalved O ring type connection is provided at the fore pump inlet for testing the fore pump only when the isolation valve is closed. A small adjustable valve to slow evacuation, when necessary, is also provided.

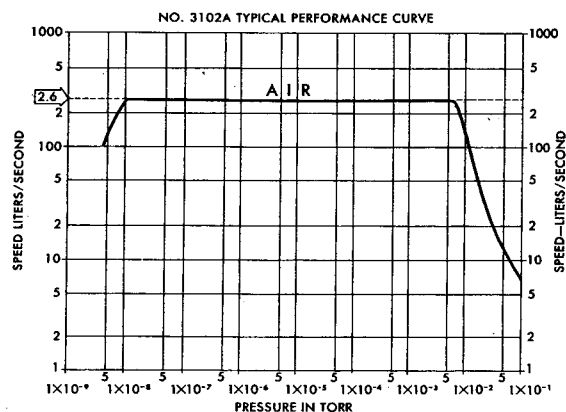
Model 3102A includes a closed system mechanical refrigerator for continuous cooling of the ends of the turbo-molecular pump which house the bearings. They are maintained below room temperature, even during bake out. This eliminates the need for external connections to water coolant and possible corrosion problems.

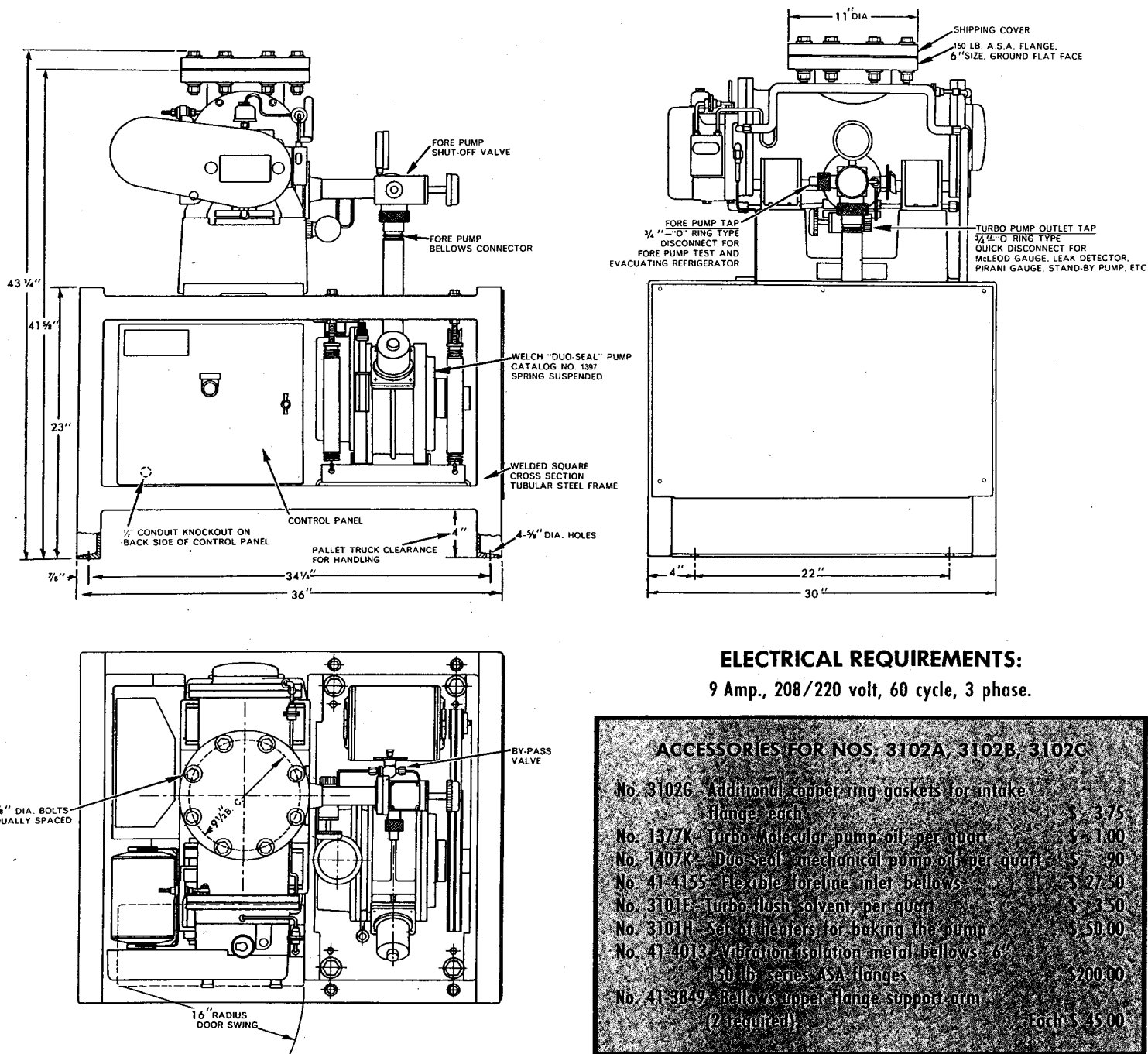
The pumping unit frame is constructed of $1\frac{1}{2}$ " square steel tubing with approximately $\frac{1}{8}$ " wall thickness. The open frame construction permits easy servicing of all the pumping unit's components. The frame is raised 4" from the floor to permit use of a standard pallet truck or fork truck for moving.

The electrical system includes motor contactors for the fore pump and for the turbo-molecular pump. The fore pump is started first and when the system is rough pumped to about ten millimeters of mercury absolute, the turbo-molecular pump is manually turned on. Motors on both pumps have thermal overload protection. Auxiliary contacts are provided for an alarm or automatic backfill of inert gas in case of motor failure.

Before shipment, each No. 3102A Unit is thoroughly leak-checked, out-gassed, and pumped to below 2×10^{-9} mm Hg (torr). To prevent atmospheric contamination, the unit is back-filled with dry gas and sealed.

Model 3102A Complete.\$5,300.00





ELECTRICAL REQUIREMENTS:

9 Amp., 208/220 volt, 60 cycle, 3 phase.

ACCESSORIES FOR NOS. 3102A, 3102B, 3102C

No. 3102G	Additional copper ring gaskets for intake flange, each	\$ 3.75
No. 1377K	Turbo-Molecular pump oil, per quart	\$ 1.00
No. 1407K	Duo-Seal mechanical pump oil, per quart	\$.90
No. 41-4155	Flexible foreline inlet bellows	\$ 27.50
No. 3101F	Turbo-flush solvent, per quart	\$ 3.50
No. 3101H	Set of heaters for baking the pump	\$ 50.00
No. 41-4013	Vibration isolation metal bellows, 6" 150 lb. series ASA flanges	\$ 200.00
No. 41-3849	Bellows upper flange support arm (2 required)	Each \$ 45.00

INSTALLATION

As the turbo-molecular pumping system No. 3102A is an integral unit, installation is very simple. The unit is placed on any floor and electrical connections made.

Connection to the vacuum system can be made directly. A valve between the pumping system and chamber is not required because the system can be roughed directly through the turbo-molecular pump. Connecting lines should be as short and as large in diameter as practical. Copper gaskets are furnished for the 6", ASA, 125 p.s.i. series intake flat face flange.

FORE PUMP SELECTION FOR MODELS

Welch Turbo-Molecular Vacuum Pump Models 3102B and 3102C are available for incorporation into systems designed to specific geometric requirements. They also permit the advantage of an ultra-high vacuum, non-contaminating turbo-molecular pump at a comparatively low cost.

The choice of a fore pump to be used with either of these models is dependent on several conditions: The volume of the vacuum chamber, outgassing of the systems components and gas loads incidental to the process being performed are conditions which usually cannot be altered; however, pumpdown time, ultimate vacuum and speed of recovery from gas bursts can be controlled by the fore pump. Figure 12 illustrates the comparative pumpdown capabilities for several Welch "Duo-Seal" pumps used to evacuate various volumes of air to 200 millitorr (microns). This is the highest forepressure at which the turbo-molecular pump can operate at full speed.

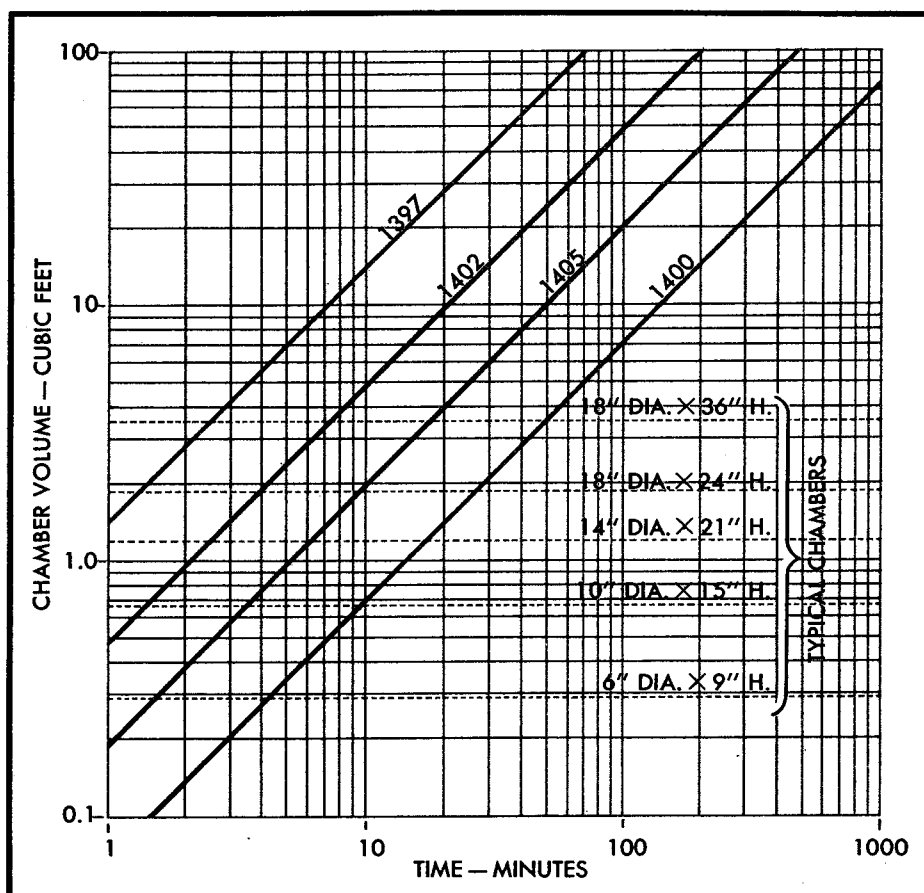
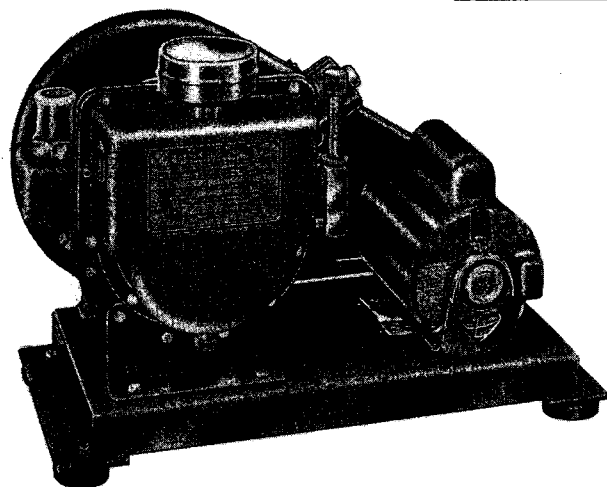


Figure 12



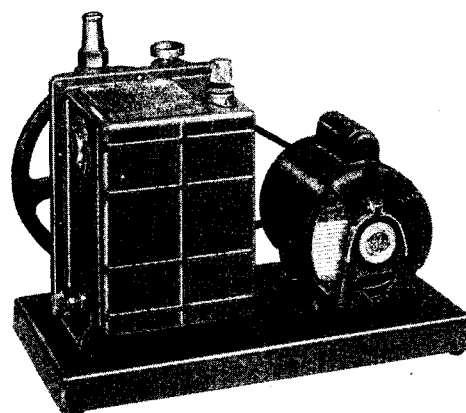
WELCH "DUO-SEAL" No. 1397B

A fast, two-stage, oil-sealed rotary vacuum pump with vented exhaust. Ideally suited as a fore pump for Nos. 3102B and 3102C turbo-molecular pumps.

SPECIFICATIONS AND FEATURES

Guaranteed ultimate vacuum (with vent closed), 0.1 millitorr; free air displacement, 425 liters/min.; pump speed 365 r.p.m.; motor, 1 H.P. 1725 r.p.m., 115V, 60 cycle; dimensions, 25 $\frac{1}{2}$ " L x 13 $\frac{1}{2}$ " W x 18 $\frac{3}{4}$ " H; shipping weight, 240 lbs.

- No. 1397B — complete with oil, two matched belts, belt guard, motor switch, cord and plug.\$645.00
- No. 1397C — for operation on 230V., 60 cycle.\$645.00
- No. 1397 — less base, motor and belts.\$525.00



WELCH "DUO-SEAL" No. 1402B

Two-stage, oil-sealed rotary vacuum pump with vented exhaust. Well suited as a fore pump for Nos. 3102B and 3102C turbo-molecular pumps.

SPECIFICATIONS AND FEATURES

Guaranteed ultimate vacuum (with vent closed), 0.1 millitorr; free air displacement, 140 liters/min.; pump speed, 525 r.p.m.; motor, $\frac{1}{2}$ H.P., 1725 r.p.m., 115V, 60 cycle; dimensions, 19 $\frac{1}{2}$ " L x 11 $\frac{1}{2}$ " W x 15 $\frac{1}{2}$ " H; shipping weight 133 lbs.

- No. 1402B — complete with oil, belt, cord with line switch and plug.\$325.00
- No. 1402C — for operation on 230V, 60 cycle.\$325.00
- No. 1402 — less base, motor and belt.\$255.00
- No. 1405G — Belt Guard (encloses belt and two pulleys).\$ 17.50

3102B AND 3102C TURBO-MOLECULAR PUMPS

Figure 13 illustrates pumping speed versus inlet pressure for different fore pumps combined with Welch turbo-molecular pumps. Note that these speeds are all equal over the 10^{-4} to 10^{-8} torr range, where much vacuum work is done. There is, however, substantial difference in the pumping speeds at high pressures (atmosphere to 10^{-4}). This determines the time required to reach a working vacuum. Also, at the low pressure section of the curves, it can be seen that the fore pump does have

a direct bearing on the ultimate vacuum.

The curves make it obvious that a Welch "Duo-Seal" No. 1397 mechanical pump operates best as a fore pump with the turbo-molecular pump; however, if a relatively small vacuum system with a small gas load is being evacuated, and time is not overly important, the small Welch "Duo-Seal" No. 1400 mechanical pump will serve amply well over the 10^{-4} to 10^{-8} torr range.

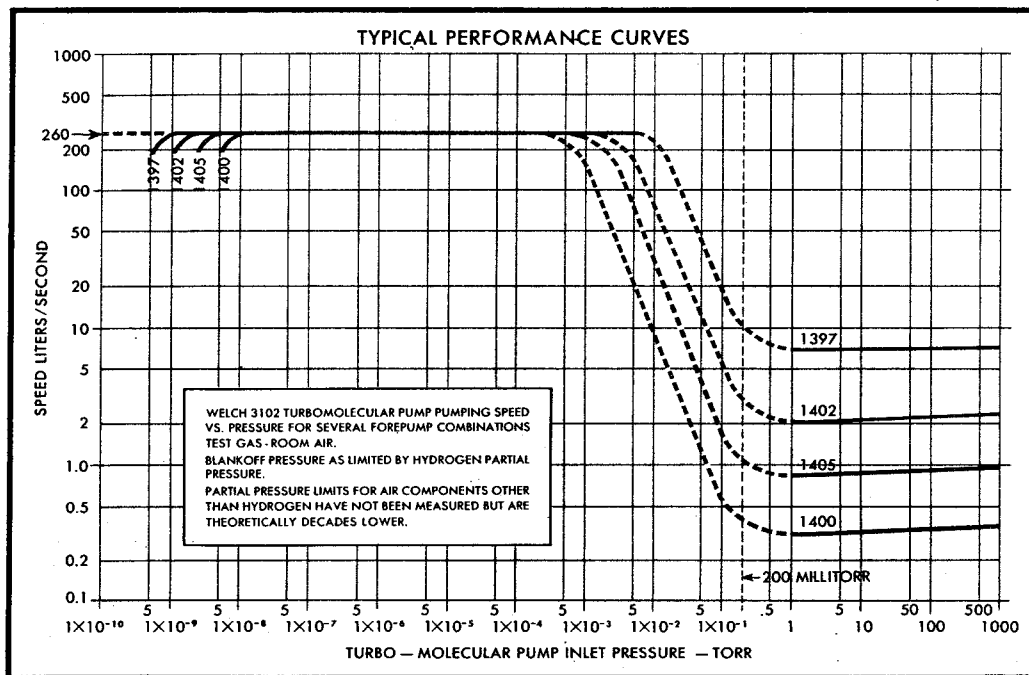
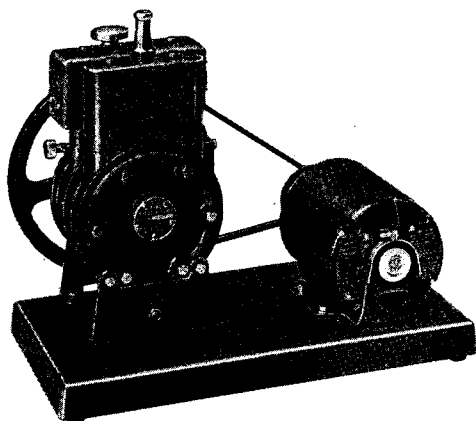


Figure 13



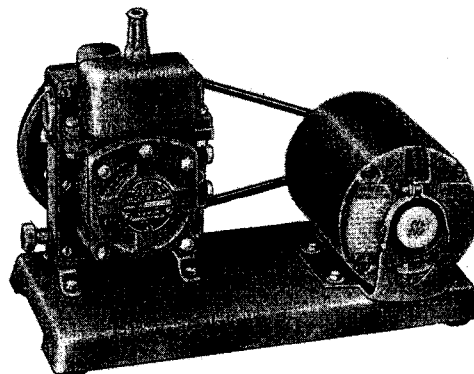
WELCH "DUO-SEAL" No. 1405B

Two-stage, 58 liter/minute, oil-sealed rotary vacuum pump. Can be used as fore pump for Nos. 3102B and 3102C turbo-molecular pumps.

SPECIFICATIONS AND FEATURES

Guaranteed ultimate vacuum, 0.1 millitorr; free air displacement, 58 liters/min.; pump speed, 525 r.p.m.; motor, 1/2 H.P., 1725 r.p.m., 115V, 60 cycle; dimensions, 19 5/8" L x 11 1/2" W x 16 3/4" H; shipping weight, 108 lbs.

No. 1405B — complete with oil, belt, cord with line switch and plug.	\$255.00
No. 1405C — for operation on 230V, 60 cycle.	\$255.00
No. 1405 — less base, motor and belt.	\$180.00
No. 1405G — Belt Guard (encloses belt and two pulleys).	\$ 17.50



WELCH "DUO-SEAL" No. 1400B

Two stage, 21 liter/minute, oil-sealed rotary vacuum pump. Can be used as fore pump for Nos. 3102B and 3102C turbo-molecular pumps.

SPECIFICATIONS AND FEATURES

Guaranteed ultimate vacuum, 0.1 millitorr; free air displacement, 21 liters/min.; pump speed, 450 r.p.m., motor, 1/3 H.P., 1725 r.p.m., 115V, 60 cycle; dimensions, 16 3/4" L x 9 1/2" W x 12 3/4" H; shipping weight, 70 lbs.

No. 1400B — complete with oil, belt, cord with line switch and plug.	\$143.00
No. 1400C — for operation on 230V, 60 cycle.	\$145.00
No. 1400 — less base, motor and belt.	\$110.00
No. 1400G — Belt Guard (encloses belt and two pulleys).	\$ 15.00



THE WELCH FINAL ASSEMBLY AND TEST SECTION FOR ALL TURBO-MOLECULAR PUMPS. MORE THAN A DOZEN PUMPS WERE UNDER TEST AT THE TIME THIS PHOTOGRAPH WAS TAKEN. DURING TEST, TURBO-MOLECULAR PUMPS ARE RUN CONTINUOUSLY FOR MORE THAN 100

HOURS. ALL PUMPS ARE REQUIRED TO ACHIEVE A VACUUM OF $1-2 \times 10^{-9}$ TORR BEFORE BEING BACK-FILLED WITH DRY GAS, SEALED, AND SHIPPED TO OUR CUSTOMERS.

THE WELCH SCIENTIFIC COMPANY

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