DESCRIPTION OF THE RUSKA MODEL 2400
DEAD WEIGHT GAGE

The Ruska Model 2400 Dead Weight Gage was designed as a laboratory reference of pressure.

High operating range and mechanical durability are features that have been made possible by the use of a secondary piston of relatively large diameter. With this arrangement, the measuring piston may be made small in area without the hazard of damage from accidental misuse. A measuring piston whose area is small permits measurement of rather high pressures with weights of the size that may be conveniently handled by one person.

A circular table (termed "weight table"), on which the weights are placed, is attached to the secondary piston (table support). Referring to the accompanying cross sectional diagram of the Model 2400 Dead-Weight Gage, the table support (22) rests directly on the upper end of the measuring piston and is guided axially by a bushing (15) located within the bore of the pressure housing (2400-006-0).

A hardened steel thrust plate attached to the top end of the measuring piston accommodates the weight load when there is no pressure in the housing. A similar plate, on the lower end of the piston, prevents the assembly from being forced out of the cylinder when the pressure becomes too great. The thrust in each case is transmitted to the faces of the cylinder through suitable ball bearings (13) and (52). The gage may be safely operated with a full load of weights and with no pressure, or it may be fully pressurized without weights. The arrangement satisfies the condition necessary for performing hysteresis measurements in which the selected pressures are approached from below and above without appreciable overpressure.

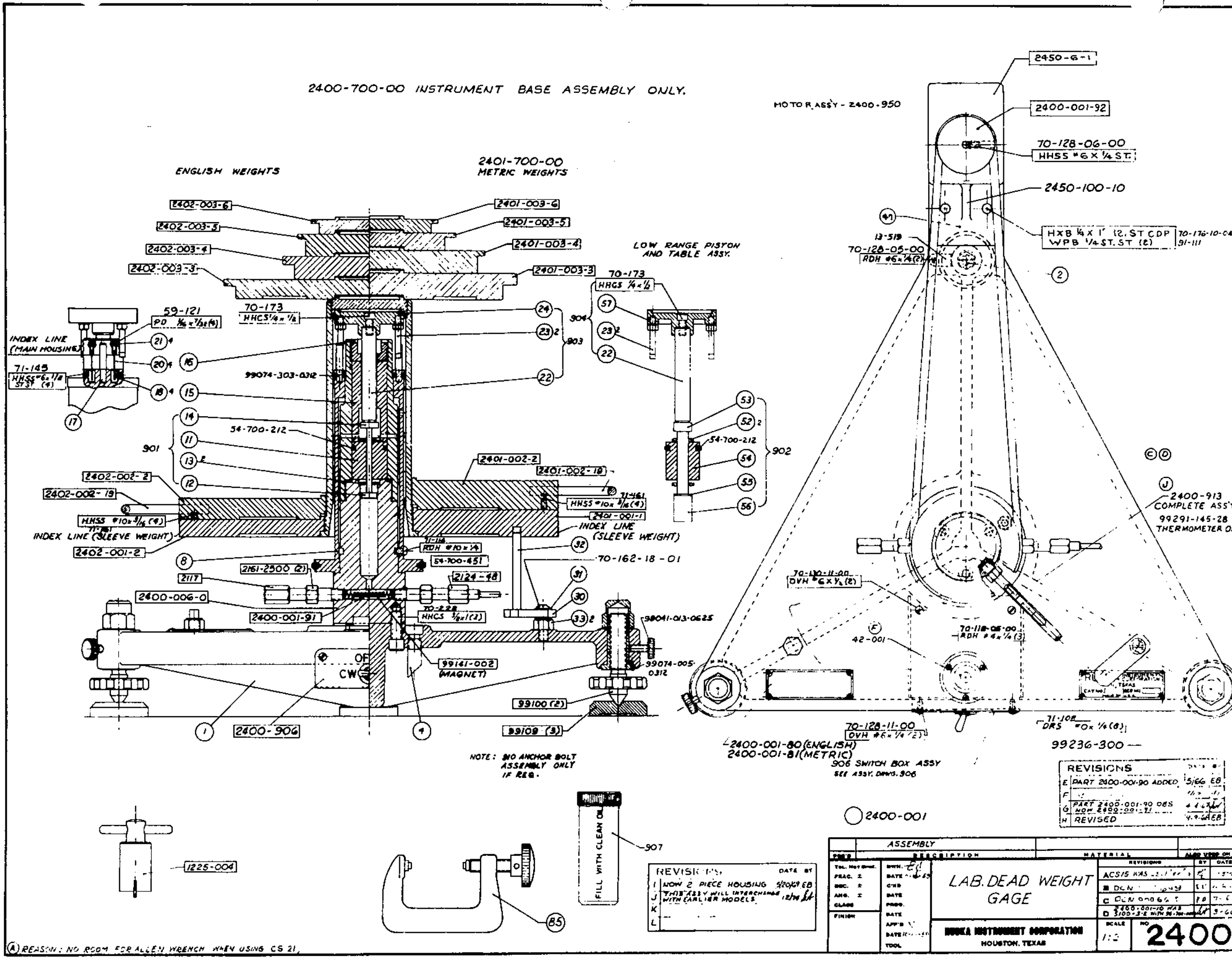
The combined weight of the weight table assembly and piston assembly constitutes the tare weight of the gage. When the tare weight is divided by the effective area of the piston, the quotient is the tare pressure--the minimum pressure which the gage is capable of measuring and a pressure which is a part of every measurement made with the gage.

The cylinder is of re-entrant design and operates over the entire range of pressures without excessive leakage.

The Model 2400 gage is provided with a post carrying an index line which indicates a particular floating position of the piston. This position is usually near the center of the total displacement. The position of the pressure reference plane for each piston is reported with respect to the top surface of the weight-loading table. A line is cut in the periphery of the sleeve weight platter (No. 1 Weight) which, when placed in alignment with that of the index post, indicates the correct piston floating position. The true location of the pressure reference plane is determined by subtracting the distance shown on the test report from the dimension of the sleeve weight corresponding to the vertical distance from the peripheral line to the internal surface that rests on the weight-loading table.

A second pair of index lines is located on the main housing and weight table drive pins. When the pressure on the dead-weight gage is less than that requiring the sleeve weight, the position of the piston is determined by the second set of index marks.

The pressure at any point in the system may be determined by measuring the vertical distance of the point from the reference plane of the dead-weight gage. The pressure at the point will be the vertical distance from the pressure reference plane multiplied by the density of the oil in the appropriate units.



2400-700-00 INSTRUMENT BASE ASSEMBLY ONLY.
MOTOR ASS'Y - 2400-950
ENGLISH WEIGHTS
2401-700-00
METRIC WEIGHTS
2402-003-6
2402-003-5
2402-003-4
2402-003-3
2401-003-6
2401-003-5
2401-003-4
2401-003-3
LOW RANGE PISTON AND TABLE ASSY.
70-173
HHCS 1/4 x 1/2
59-121
INDEX LINE (MAIN HOUSING)
71-145
99074-303-0312
54-700-212
901
902
903
904
2401-002-2
2401-002-19
2402-002-2
2402-002-19
INDEX LINE (SLEEVE WEIGHT)
2402-001-2
2401-001-1
70-162-18-01
2161-2500 (2)
2117
2124-48
2400-006-0
2400-001-91
70-228
99141-002 (MAGNET)
98041-013-0625
99074-005-0312
99100 (2)
99109 (3)
2400-906
NOTE: 910 ANCHOR BOLT ASSEMBLY ONLY IF REQ.
FILL WITH CLEAN OIL
907
1225-004
2450-G-1
2400-001-92
70-128-06-00
HHSS #6 X 1/4 ST.
2450-100-10
13-519
70-128-05-00
2400-913
COMPLETE ASS'Y
99291-145-28
THERMOMETER ONLY
42-001
70-128-11-00
2400-001-80 (ENGLISH)
2400-001-81 (METRIC)
906 SWITCH BOX ASSY
SEE ASSY. DWG. 906
99236-300
2400-001
REVISIONS
E PART 2400-001-90 ADDED 5/66 EB
H REVISED
REVISIONS
I NOW 2 PIECE HOUSING 5/20/69 EB
J THIS ASSY WILL INTERCHANGE WITH EARLIER MODELS.
ASSEMBLY
LAB. DEAD WEIGHT GAGE
HOUSTON, TEXAS
2400
(A) REASON: NO ROOM FOR ALLEN WRENCH WHEN USING CS 21

When the piston gage is used as a standard of pressure for calibration of secondary pressure sensors, integral values of pressure are precalculated to the extent possible. These pressures are valid only at the pressure reference plane of the piston. A procedure for transferring these integral values to other positions within the system is described elsewhere in these instructions.

DESCRIPTION OF THE WEIGHTS

All weights are constructed of Type 303 stainless steel. They are entirely machined from rolled stock or forgings, and the removal of any metal is performed in such a way as to maintain balance about the centerline. Final adjustment is accomplished by drilling a symmetrical pattern of holes concentric with the axis.

INSTALLATION OF THE GAGE

The dead-weight gage must be erected on a pier or heavy table. The two leveling screws and the leg at the rear of the base casting are supported by the foot plates furnished with the instrument. The gage must be leveled and the leveling screws locked.

REMOVAL OF TRAPPED AIR FROM HAND PUMP

Before mounting the hand pump, it should be filled with oil and checked for the presence of air. All air should be removed from the pump before attaching it to the dead-weight gage. Normally, all hand pumps are shipped free of air from the factory and require no bleeding before installation. However, it is always possible for a valve to have been opened by accident while packing or unpacking the pump, thereby admitting some air.

The presence of air in the pump may be detected by opening a valve and advancing the plunger enough to remove the slack in the spindle nut and then closing the valve. As the pump handle is turned slowly, the dial pointer of the bourdon gage will begin to rise from the zero position. If the handle is turned less than one eighth revolution to raise the pointer a perceptible amount, the quantity of air remaining in the pump is insignificant and can be removed completely by raising the pressure for a time and letting the air dissolve in the oil.

If the remaining air is more than should be tolerated, the pressure should be raised one or two thousand psi and the bleed screw in the socket of the dial gage* opened and some oil-air solution allowed to escape. It may be necessary to repeat the operation several times.

Further bleeding is possible by inverting the pump and, while resting the dial gage on a pad, alternately expanding and compressing the trapped air by working the plunger in and out of the cylinder. Usually the air will migrate to the cylinder, where it can be removed by standing the pump on the spindle and opening the valve or removing the pipe plug at the rear of the cylinder. Several attempts may be necessary to drive out all the entrapped air.

The pump must then be secured to the table adjacent to the dead-weight gage and interconnected by means of the appropriate tubing.

It is convenient to attach the test system to the hand pump instead of directly into the dead-weight gage. The disadvantage of having a longer connecting line with intervening components is offset by the opportunity to bleed and test either the dead

* or in the tip of the bourdon tube

weight gage or the remaining system independently. After all components have been interconnected and pressure-tested for leaks, the dead-weight gage is isolated from the system by closing the valve and a pressure of several hundred psi applied to the remainder of the system and allowed to stand for a period. The remaining traces of air will dissolve and diffuse throughout the oil and eventually be carried out with the oil that is pumped out of the system. When the system is not in use, it may be kept under a few atmospheres to keep the air dissolved.

EXCHANGING PISTONS IN THE DEAD-WEIGHT GAGE

When it is necessary to exchange the piston assemblies, the dead-weight gage must be partially disassembled and some of the components laid by until later. Upon removal of the internal components, a degree of hazard is involved because of the possibility of exposing the parts to harmful dirt, corrosive fingerprints, and to the opportunity of being dropped to the table or floor. Needless to say, the small, brittle carbide measuring piston will not survive an accidental drop. The remainder of the components, if dropped, will surely be damaged to the extent of sustaining raised burrs and will require the attention of a mechanic before reassembly.

Each manual operation that is performed on a mechanical device is accompanied by a finite degree of damage. The damage, however small it may be for the individual operations, is cumulative. It results from the imperfect execution of each manual operation. After a given length of time, the device may be expected to fail because of performance deterioration beyond the level of tolerance. It is important, therefore, to perform the manual operations with the greatest possible skill in order to keep the harmful side effects at a minimum.

There are two types of contamination that affect not only the performance of a piston pressure gage but also the mechanical state of the critical components. One contaminant is the ordinary hard particle of matter that scratches and abrades the finely-finished surfaces as it becomes entrapped between two closely-fitting members. The scratches invariably result in raised edges from the displacement of the metal and spoil the original relationship of the members. The second type of contaminant is of a chemical nature and produces harmful effects by attacking the finished metallic surfaces in a corrosive manner. Ordinary fingerprints contain water-soluble, acidic salts, having extremely high corrosive activity with the metals of the critical instrument parts. Since these parts must necessarily be handled in making a piston exchange, they may be protected from exposure to both types of contaminants by the use of clean paper wipers. Even though the parts may be completely covered with oil, salts will be deposited on the metal surfaces if they are handled with bare fingers.

There are a number of industrial paper wipers available that are relatively free of lint. After a little practice, the corrosion-sensitive parts may be safely handled with these wipers instead of with the bare fingers. Even when using the wipers as insulators, the hands should first be washed and thoroughly dried before commencing the disassembly.

The space allotted to the discussion of cleanliness is not intended to imply to the technician the impossibility of performing the job correctly, but rather to give him reassurance that the results will be quite satisfactory if he follows a common-sense procedure of eliminating contaminations by technique alone.

Being forewarned of the hazards, the technician should wipe the bench and all instrument surfaces in the vicinity of the dead-weight gage before starting disassembly operations. A wad of wipers slightly wetted with a mild, non-toxic solvent will help to pick up the heavy oil film that invariably accumulates near the gage. Because of its tackiness, a wad so treated gathers and retains most of the accumulated dust and lint that has settled in the area.

DISASSEMBLY

The drive belt is removed from the motor pulley and is pulled toward the forward part of the gage. To insure that the belt has not been left off after the gage has been loaded with weights, it is advisable to leave the drive belt encircling the housing, Part 2400-006.

With the belt forward and out of the way, the area between the housing and motor drive serves as a space to lay the parts as they are removed from the housing. A new, clean piece of paper is placed on the base surface to keep the parts clean. The heavier type industrial wipers serve for this purpose.

After preparing the gage and bench for removal of the piston assembly, the operator should wash and thoroughly dry his hands.

Referring to the diagram for 2400C, the weight table, Part 24 or 57, is constructed of Type 303 stainless steel and may be safely handled with the bare fingers. The table support, Part 22, to which the table is securely attached, is made of heat-treated alloy steel and should not be touched with the fingers.

It may be seen from the drawing that the weight table assembly, 903 and 904, rests directly on the measuring piston, and is guided by the table support bushing, 15. To remove the weight table assembly, it is necessary only to grasp the table with the fingers and lift upward. The mating surfaces of the table support and top thrust plate of the piston, Parts 14 and 53, are quite flat and square with the axis. After having been loaded, the surfaces usually stick together, and should be separated by an upward snap of the weight table. When the joint is broken, the weight table assembly may be lifted out, with care being taken to prevent striking the lower end of the table support against the retaining nut, 16. The weight table is then inverted, placed on the paper, and covered with a paper wiper. Another wiper is temporarily stuffed in the remaining hole in the top of the housing.

The retaining screw, CS4 #10x1/4, is removed from the drive sleeve, Part 8, and the sleeve lifted off and set aside. The seal clamp, 75, is placed over the housing and adjusted to stop off the two overflow holes shown just above the cylinder, Part 11.

Before inserting the special wrench, 1225-4, into the retaining nut, 16, the wrench should be cleaned so that no dirt will drop in the housing during withdrawal of the retainer. The externally threaded nut is made of Type 416 heat-treated stainless steel and is usually coated with a light film of oil; it is not considered a critical part and may be safely handled with the fingers. The nut and wrench are placed on the paper.

By pumping oil into the housing, the guide bushing and piston-cylinder assembly, 901 or 902, may be forced upward and out of the housing. Approximately six strokes of the hand pump are required to force the assemblies out. When the guide bushing, 15, is projecting approximately 3 inches above the top of the housing, it will be seen to tip over several degrees as the pumping is in progress. The tipping action indicates that the bottom of the cylinder, 11 or 54, has cleared the bore, and has entered the enlarged threaded section.

A wiper is wrapped around the projecting bushing and the joint between bushing and cylinder broken by bending the bushing to one side. The bushing, in its wrapping, is placed on the clean paper.

Another wiper is folded and placed over the top of the piston assembly so that the thrust plate, Part 14 or 53, may be grasped with the fingers and lifted upward. The measuring piston will be pulled upward and the cylinder will recede slightly into the housing. While the piston is held in this position, a little oil is added with the pump, and the whole assembly may then be lifted out. All of the parts of the piston-cylinder assembly should be protected against finger prints by immediately wrapping the assembly and placing it on the paper. When wrapping or examining the piston-cylinder assembly, it should be held over, and near, the table to reduce the hazard of breakage from being accidentally dropped.

At first, it may seem a little awkward handling the parts with pieces of paper, but with a little practice, the technique soon becomes routine.

CHANGING O-RINGS

The O-ring gaskets on the cylinders are inexpensive and should be changed frequently. It is good practice to change the O-ring each time a cylinder is removed from the gage--particularly on the high range cylinder. If the O-ring is not changed, it should at least be inverted on the cylinder before being used the second time. It should not be used the third time without careful examination of the surface with a loupe for rough spots.

In removing an O-ring from the cylinder, a hard, sharp object, as a screwdriver, should not be used because of the danger of scratching the bottom of the O-ring groove. A small, clean wood, brass, or aluminum rod that has been pointed may be used without fear of scratching the surface. Always work over a table top.

The new O-ring should be cleaned with a mild solvent before assembly to the cylinder.

REASSEMBLY OF THE GAGE

Assuming that a different piston assembly is to be placed in the gage, the second piston is removed from its container, in much the same way that the first one was removed from the housing. Since the second piston is covered with oil, the assembly will be a little more difficult to remove from the container. The assembly must be moved from side-to-side in the container while gently lifting by the upper thrust plate in order that the air may enter beneath the cylinder. After removal, the top surface of the cylinder is wiped with a paper to remove any accumulated lint.

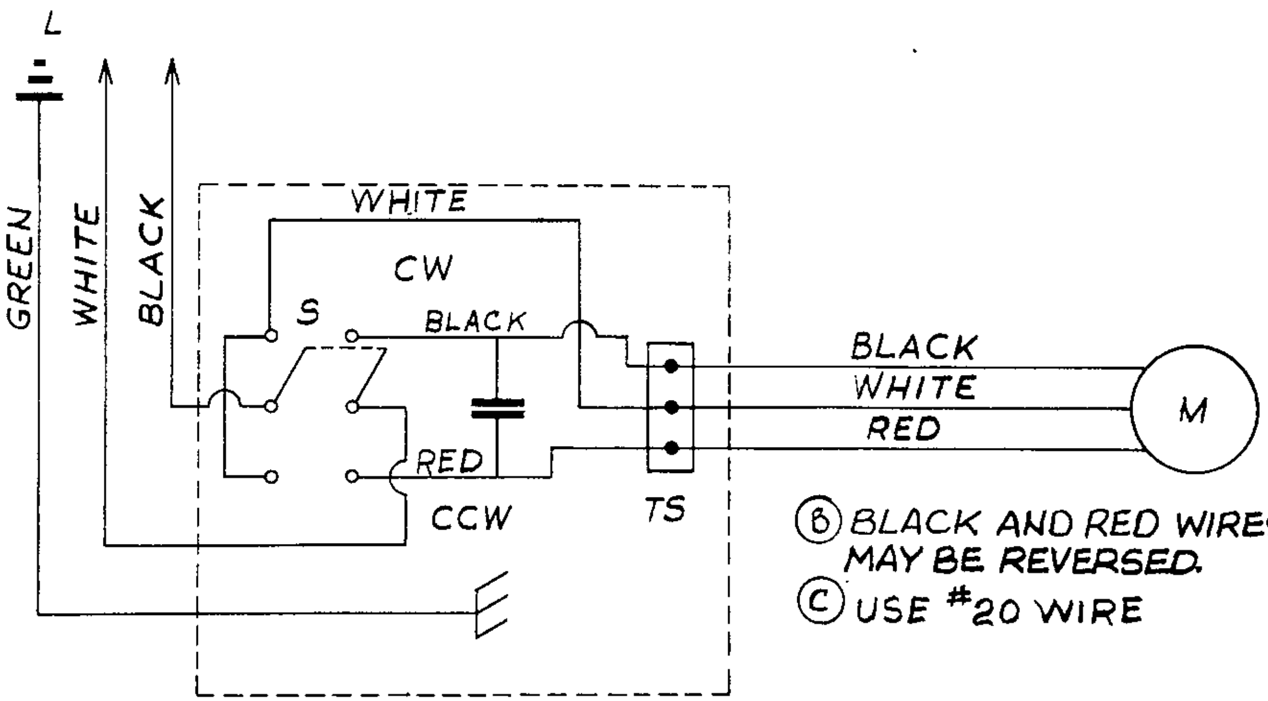
It is possible to assemble the functional parts of the Model 2400 with most any relative orientation. It has been found that, if the parts are assembled to the pressure housing in a particular manner, an improvement in the performance is observed. With the parts having a certain relative orientation, the effects of small dimensional variations are cancelled and the alignment of the parts improved. Whenever such improvement is observed during the tests of the gage, the parts are marked and their relationship recorded in the test report.

Orient the mark on the cylinder in the direction indicated by the report and slowly lower the assembly into the bore of the pressure housing. The assembly is supported by the top piston thrust plate, grasped with the fingers which are insulated with a double thickness of paper wiper. When the bottom of the cylinder (which is relieved to assist entrance to the bore) is in position for entrance, the assembly is released and permitted to rest. The oil level is raised to overflow, in order to force most of the air out which may be trapped beneath the cylinder. It will be noticed also that, when observing the cylinder from directly above, the top of the cylinder may not be centered in the housing--that it may it may be cocked a little to one side. After opening the supply valve to the reservoir, the cylinder may be carefully centered by tipping it straight in the housing. It will be seen to slowly settle into the housing by its own weight. After it has settled down 1/8" or so, a clean piece of folded paper is placed over the top, and the assembly pressed down into the housing with the finger pushing against the top thrust plate, 14 or 53.

When the O-ring is in position to enter the bore, somewhat more force may be required to compress the ring into the bore. After the O-ring has entered completely, the lower surface of the guide bushing, Part 15, is wiped free of lint and the bushing placed on the cylinder. A folded paper is placed on top of the bushing, and the components slowly pushed into the housing until the top of the bushing is within 1/2 inch of the top of the housing. At this point, the seal ring is removed, the supply valve closed, and some oil is added with the hand pump until a quantity of oil flows out the overflow holes, carrying with it the remainder of the trapped air.

The components may now be seated completely in the housing, and the retaining nut replaced. When the components are in proper position, the top of the retaining nut and the top of the housing are approximately flush. The retaining ring should not be secured tightly, but it should be backed off and reseated. lightly after the initial tightening.

A wad of clean paper is placed in the bore to prevent droppings from entering while replacing the drive sleeve. The table support of the weight table assembly is wiped lightly free of lint, and a very light film of oil is allowed to remain for lubrication. After the table support is inserted into the bushing and the drive belt replaced, the instrument is ready for use.



Ⓑ BLACK AND RED WIRES MAY BE REVERSED.

Ⓒ USE #20 WIRE

SYMBOL	PART NO.	REQ.	DESCRIPTION
L	16-065	1	CORD WITH GROUNDING CIRCUIT TYPE SJ 18/3
M	47399-259-001	1	MOTOR H-C/ 5844-110V, 50CY, 60 CY, 28 RPM W/1.0 mfd CAPACITOR
S	88-833-7	1	TOGGLE SWITCH DP DT 115V, 6 AMP; 230 V, 3 AMP
TS	79-759	1	TERMINAL STRIP - 3 CONTACT

REQ'D	DESCRIPTION	MATERIAL
	WIRING DIAGRAM	

TOLERANCES NOT SPECIFIED: .X ±.030; .XX ±.010; .XXX ±.005

FINISH

DWN. EAB
DATE 11/16/66
C'KD BM
DATE
PROD.
DATE
APP'D
DATE
TOOL

LAB. DEAD WT. GAGE DRIVE MOTOR CIRCUIT

REVISIONS		BY	DATE
A	NOTE REMOVED; 50 CYC. ADDED.	EB	3-73
B	ADDED NOTE	JS	1-75
C	ADDED NOTE WIRE COLOR	JC	2-75
D			

RUSKA INSTRUMENT CORPORATION
HOUSTON, TEXAS

SCALE —

NO. 2400-200

POST 1500 175H 4-65