

HYDRAULICS II & III

ACTIVITY MANUAL

TM16654-00

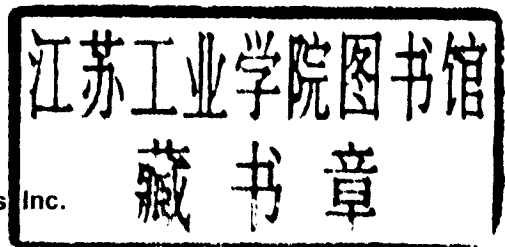
Lab-Volt®

HYDRAULICS II ACTIVITY MANUAL

**Edited and Published by
Lab-Volt Systems/Technical Systems Inc.
Minnesota**

**Activities Written by
Dr. J.R. Daines
University of Wisconsin, Stout
Chris Wright, P.E.**

Second Edition, Third Printing, March 1994



**COPYRIGHT © 1971, 1975, 1978, 1979, and 1983 by Technical Systems, Inc., Minnesota. All rights reserved.
Reproduction in whole or in part without permission is prohibited.**

INTRODUCTION

LAB-VOLT SYSTEMS/TECHNICAL SYSTEMS, INC., is currently producing a number of hydraulic instructional systems. You are using either the Hydraulics II system or Hydraulics III system AT-6022 trainer, the AT-6023 trainer or one of their combinations.

Hydraulics II consists of 18 experimental activities. Hydraulics III consists of activities 19-30 intended to follow Hydraulics II for a total of 30 experimental activities.

We hope you find this course an enjoyable learning experience. Should you experience any difficulty please contact us.

**The Staff of Lab-Volt Systems/
Technical Systems, Inc.**

CONSTRUCTION AND OPERATING FEATURES OF LAB-VOLT/T.S.I. HYDRAULICS BENCHES

If you are using this unit for the first time, please consult the Instructor Guide for **uncrating and set-up instructions**.

1. Each pressure gauge is equipped with two quick disconnect couplers which are common with the gauge. Thus, two hoses connected to a gauge are also connected together.
2. Each disconnect coupler is equipped with a check valve to keep it from emitting oil when it is not connected. In case one of these does leak oil, it is probably caused by foreign material between the check and the seat. This usually can be removed by holding in the check with the pump turned off.
3. The bench includes two manifold areas. One manifold received hydraulic oil directly from the pump and is labeled Supply Manifold. The other goes back to the reservoir through the filter and is labeled Return Manifold.
4. The electric switch contains an overload mechanism which turns the power off if the equipment runs in an overloaded condition for too long. If the power to the bench should go off, wait about 3 minutes for the mechanism to cool. Then push the switch handle all the way down to reset the overload mechanism before pushing it up to start the motor.
5. Do not allow oil temperature to exceed 150°. Do not let oil level go below ½ full.
6. Change oil at least once a year.
7. Change the oil filter once a year. Replacement filters are available through Lab-Volt Representative.
8. Avoid stretching or twisting the hoses. Also, avoid sharp bends which could pinch or weaken the hose.
9. If a hose or component should start to leak, stop the pump and take the leaking unit out of service immediately. Small leaks can develop rapidly at 500 psi.
10. An experiment or a wrong connection can sometimes cause the hydraulic pressure to surge upward and damage a pressure gauge. Therefore, do not operate at above 2/3 of full gauge pressure.
11. One double acting cylinder is mounted on a loading device.
12. There is space for a cam operated valve on the loading device. This is used in the rapid traverse experiment.
13. Labels on valves are P, T, A, and B. These letters stand for Pressure, Tank, A end of cylinder, and B end of cylinder respectively.
14. The single acting, spring return cylinder may be used as a double acting cylinder by installing the male quick-disconnect fitting. Remove this fitting when not in use.

SAFETY INSTRUCTIONS FOR FLUID POWER

The LAB-VOLT/TECHNICAL SYSTEMS INC., Fluid Power Training System has been designed with safety as a primary concern. The components, circuits, and activities have been designed and tested by leading experts in the Fluid Power Industry.

The instructor and student using the fluid power trainer must be aware of certain potential hazards that exist with the use of fluid power equipment.

1. The trainer must be used on a 115V, 50/60Hz, 1 ϕ , 20 amp circuit with safety ground. The ground connection must never be removed from the unit cord end. If the cord does not fit your receptacle contact an electrician. The electric cord should be inspected periodically to insure that the insulation has not deteriorated.
2. The relief valve on the hydraulic power supply, located behind and below the bench, should NEVER be tampered with or readjusted.
3. Hoses, components, and other devices that are not part of the trainer should not be used with the trainer because they may burst and injure the operator.
4. Leaks on fluid power equipment should never be tightened while there is pressure in the system. Stop the unit and release the pressure, then repair the leak.
5. Should a component or a system develop a leak that sprays or shoots a stream of fluid, do not try to cover the leak. Turn off the electric power switch to stop the unit. The reason for this is that high pressure fluid (air, oil, water, etc.) can be forced through your skin and cause serious problems. Numerous fluid power personnel have been injected with fluid. An awareness of this industrial hazard will help you protect yourself and others from injury. Should you be injected with any fluid, get immediate medical attention.
6. Fluid power cylinders and motors produce tremendous forces. Never place the cylinders in a position where they may become wedged or confined between rigid parts of the training unit. Damage to the operator and the unit could result.
7. The hydraulic cylinder with loading device, when used with the cam operated directional control valve, has a natural pinch area for fingers. Don't get your fingers between the cam rod and the roller when using this unit.
8. The hydraulic motor or any rotating device is always a hazard. It is tempting to place one's finger or another object on a rotating part — DON'T DO IT! You can be cut by sharp edges or burrs on rotating parts.

9. When using the flywheel with the hydraulic motor, be sure it is free of sharp edges or burrs. Do not allow the flywheel to turn in your hand. Always wear leather gloves when holding the flywheel. Be sure the flywheel is tight on the shaft.
10. Oil spills on the trainer or on the floor should be cleaned immediately. Use rags or towels. Granular floor-dry should be avoided in the fluid power laboratory because it powders and gets into your equipment.
11. Safety glasses should be worn when using fluid power equipment.
12. The accumulator contains a charge of high pressure nitrogen. Use caution when connecting and disconnecting the accumulator from the system. Be sure the fluid is bled out of the fluid side before disassembling any part of the set-up. Never use air or oxygen to charge the gas side of an accumulator unless you have been trained on the particular type of unit on which you are working.
13. Before disassembling your circuits move the directional control through all positions. This will release the pressure in the components and make hose coupling and uncoupling easier.

Following the above safety precautions should allow you to use the Fluid Power trainer without injury.

ADDITIONAL REFERENCE BOOKS

FLUID POWER BIBLIOGRAPHY

ABC'S OF FLUID POWER

by H.L. Stewart & J.M. Storer, 1966
Howard Sams & Co., Inc.
4300 W. 62nd St.
Indianapolis, IN 46206

ABC'S OF HYDRAULIC CIRCUITS

by Harry L. Stewart
Howard Sams & Co., Inc.
4300 W. 62nd St.
Indianapolis, IN 46206

ABC'S OF PNEUMATIC CIRCUITS

by Harry L. Stewart
Howard Sams & Co., Inc.
4300 W. 62nd St.
Indianapolis, IN 46206

AIR COMPRESSORS, CONDITIONING, COSTS AND THE CRUNCH

by Dr. V.H. Larson, 1976
Hydraulics & Pneumatics
614 Superior Ave. W.
Cleveland, OH 44113

AIR LOGIC DESIGN

by Parker-Hannifin
Parker Hannifin Inc.
Fluid Power Training Dept.
17325 Euclid Avenue
Cleveland, OH 44112

ANALYZING HYDRAULIC SYSTEMS

by Parker-Hannifin
Parker-Hannifin Inc.
Fluid Power Training Dept.
17325 Euclid Avenue
Cleveland, OH 44112

APPLIED PNEUMATICS HANDBOOK

by Fred L. Eargle, 1964
University of North Carolina

BASIC APPLIED FLUID POWER: HYDRAULICS

by Jon Oster, 1968
McGraw-Hill Book Company
330 W. 42nd St.
New York, NY 10036

BASIC FILTRATION

by Parker-Hannifin
Parker-Hannifin Inc.
17325 Euclid Avenue
Cleveland, OH 44112

BASIC FLUID POWER

by Dudley A. Pease, 1970
Prentice Hall, Inc.
Englewood Cliffs, NJ

CLOSING THE LOOP

by Russell W. Henke, 1966
Heubner Publications
Cleveland, OH

COMPRESSED AIR & GAS HANDBOOK, 4th Edition

Compressed Air & Gas Institute
55 Public Square, 12th Floor
Cleveland, OH 44113

CONTROL OF FLUID POWER

by D. McCloy & H.R. Martin, 1973
John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10016

CYLINDERS FOR PROFIT-MAKING DESIGN

by Tobi Goldftas, 1976
Hydraulics & Pneumatics
614 Superior Ave. W.
Cleveland, OH 44113

DICTIONARY OF OIL HYDRAULICS AND SERVO TECHNOLOGY

by W.D. Rahlenbeck, 1967
Krauss-Kopf-Verlag, Mainz, Germany

DRAFTING PRACTICES FOR FLUID POWER DIAGRAMS

National Fluid Power Association
3333 N. Mayfair Road
Milwaukee, WI 53222

ELECTRO-HYDRAULIC SERVOMECHANISMS

by A.C. Morse, 1963
McGraw-Hill Book Company
330 W. 42nd St.
New York, NY 10036

ELECTRO-HYDRAULIC SERVO SYSTEMS

by James Johnson
Hydraulics & Pneumatics
614 Superior Avenue W.
Cleveland, OH 44113

ELEMENTARY GENERAL THERMODYNAMICS

by M.V. Sussman
Addison-Wesley Publishing Co.
Reading, MA 01867

FILTERS & FILTRATION

by R.H. Warring
Trade & Technical Press, Ltd.
Crown House
Morden Surrey, England

FLUID AMPLIFIERS

by J.M. Kirshner, 1966
McGraw-Hill Book Company
330 W. 42nd St.
New York, NY 10036

FLUID DYNAMICS

by James Daily & Donald Harleman
Addison-Wesley Publishing Co.
Reading, MA 01867

FLUIDICS

Society of Manufacturing Engineers
20501 Ford Road
Dearborn, MI 48128

FLUIDICS: COMPONENTS AND CIRCUITS

by K. Foster & G.A. Parker
John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10016

FLUID FLOW AND HEAT TRANSFER

by Aksel Lydersen, 1979
John Wiley & Sons, Inc.
605 Third Ave.
New York, NY 10016

FLUID LOGIC IN SIMPLE TERMS

by M.J. Moylan, 1968
Machinery Publishing
Brighton, England

FLUID MECHANICS

by I.G. Currie, 1974
McGraw-Hill Book Company
330 W. 42nd St.
New York, NY 10036

FLUID MECHANICS FOR ENGINEERS

by M. Albertson, J.R. Barton & D. Dimons, 1960
Prentice Hall, Inc.
Englewood Cliffs, NJ

**FLUID MECHANICS FOR ENGINEERING
TECHNOLOGY**

by Irving Granet, 1971
Prentice Hall, Inc.
Englewood Cliffs, NJ

FLUID MECHANICS FOR TECHNICIANS

by Hardison
Retson Publishing Company, Inc.
Sunset Hills
Retson, VA 22090

FLUID POWER, 2ND EDITION

by H.L. Stewart & J.M. Storer, 1968
Howard Sams & Co., Inc.
4300 W. 62nd St.
Indianapolis, IN 46206

FLUID POWER COMMUNICATION STANDARDS

National Fluid Power Association
3333 N. Mayfair Road
Milwaukee, WI 53222

FLUID POWER CONTROLS

by J.J. Pippenger & R.M. Koff, 1959
McGraw-Hill Book Company
330 W. 42nd St.
New York, NY 10036

**FLUID POWER CONTROLS—ELECTRICAL &
FLUIDIC**

by C.S. Hedges, 1971
Womack Educational Publications
2010 Shea Road
Dallas, TX 75235

FLUID POWER AND CONTROL SYSTEMS

by E.C. Fitch, Jr., 1966
McGraw-Hill Book Company
330 W. 42nd St.
New York, NY 10036

FLUID POWER CURRICULUM GUIDE, 1972

Fluid Power Foundtion
600 Old Country Road
Garden City, NY 11530

FLUID POWER DESIGN ENGINEERS HANDBOOK

by Parker-Hannifin Inc.
Parker-Hannifin Inc.
Fluid Power Training Department
17325 Euclid Avenue
Cleveland, OH 44112

FLUID POWER FOR TECHNICIANS

by Donald G. Newton, 1971
Prentice Hall, Inc.
Englewood Cliffs, NJ

FLUID POWER I. TEXT

Parker-Hannifin Inc.
Fluid Power Training Department
17325 Euclid Avenue
Cleveland, OH 44112

FLUID POWER I. INSTRUCTOR'S GUIDE

Parker-Hannifin Inc.
Fluid Power Training Department
17325 Euclid Avenue
Cleveland, OH 44112

FLUID POWER—PNEUMATICS

by O.A. Johnson
American Technical Society

FUNDAMENTALS OF FLUID MECHANICS

by Sullivan
Retson FPublishing Company, Inc.
Sunset Hills
Retson, VA 22090

GLOSSARY OF FLUID POWER, 1969

Fluid Power Society
909 N. Mayfair Road
Milwaukee, WI 53226

GRAPHIC SYMBOLS FOR FLUID POWER DIAGRAMS

National Fluid Power Association
3333 N. Mayfair Road
Milwaukee, WI 53222

**HEAT EXCHANGERS: DESIGN AND THEORY
SOURCE BOOK**

by N. Afgan & E. Schlunder, 1974
McGraw-Hill Book Company
330 W. 42nd St.
New York, NY 10036

HYDRAULIC AND PNEUMATIC POWER & CONTROL

by F. Yeaple, 1966
McGraw-Hill Book Company
330 W. 42nd St.
New York, NY 10036

HYDRAULIC CONTROLS ON MACHINE TOOLS

by F.L. Mackin
Milwaukee School of Engineering
1025 N. Milwaukee St.
Milwaukee, WI 53201

**HYDRAULICS, HYDRAULIC SYSTEMS FOR
TRACTORS & OTHER MOBILE EQUIPMENT**

by J.H. Turner and J.E. Wren, 1974
American Association for Vocational Instructional
Materials
Engineering Center
Athens, GA 30602

**HYDRAULICS, HYDRAULIC SYSTEMS FOR
TRACTORS & OTHER MOBILE EQUIPMENT,
VOL. II, 1974**

by J.H. Turner and J.E. Wren
American Association for Vocational Instructional
Materials
Engineering Center
Athens, GA 30602

HYDRAULIC MACHINERY

Texaco, Inc.
New York, NY

HYDRAULICS IN MINING EQUIPMENT, PART I

by Myles Altimus, 1955
Pennsylvania State University
College Park, PA

HYDRAULIC & PNEUMATIC CYLINDERS

Trade & Technical Press, Ltd.
Crown House
Morden Surrey, England

HYDRAULICS AND PNEUMATICS

(Monthly magazine of Fluid Power & Control Systems)
Hydraulics & Pneumatics
614 Superior Ave. W.
Cleveland, OH 44113

HYDRAULIC AND PNEUMATIC POWER & CONTROL

by F.D. Yeaple, 1966
McGraw-Hill Book Company
330 W. 42nd St.
New York, NY 10036

**HYDRAULIC & PNEUMATIC POWER FOR
PRODUCTION**

by H.L. Stewart, 1970
Industrial Press Inc.
200 Madison Ave.
New York, NY 10016

**HYDRAULIC SERVO MECHANISMS & THEIR
APPLICATIONS**

Trade & Technical Press Ltd.
Crown House
Morden Surrey, England

HYDRAULICS FOR OFF-THE-ROAD EQUIPMENT

by H.L. Stewart, 1978
Howard Sams & Co., Inc.
4300 W. 62nd St.
Indianapolis, IN 46206

INDUSTRIAL HYDRAULICS, THIRD EDITION

by J.J. Pippenger & T.G. Hicks, 1979
McGraw-Hill Book Company
330 W. 42nd St.
New York, NY 10036

INDUSTRIAL TUBE FITTER'S MANUAL

Parker-Hannifin Inc.
Fluid Power Training Department
17325 Euclid Avenue
Cleveland, OH 44113

INTRODUCTION TO FLUID MECHANICS

by Russell Henke, 1971
Addison-Wesley Publishing Co.
Reading, MA 01867

**INTRODUCTION TO FLUID POWER CIRCUITS &
SYSTEMS**

by Russell Henke, 1969
Addison-Wesley Publishing Co.
Reading, MA 01867

INTRODUCTION TO FLUID POWER

by Russell Henke
Addison-Wesley Publishing Co.
Reading, MA 01867

MOBILE HYDRAULICS MANUAL & 35 MM SLIDES

Sperry-Vickers
World Headquarters
Troy, MI 38084

PNEUMATIC CIRCUITS & LOW COST AUTOMATION

by J.R. Fawcett
Trade & Technical Press, Ltd.
Crown House
Morden Surrey, England

**PNEUMATIC CONTROLS FOR INDUSTRIAL
APPLICATION**

by Frank Wilson, 1965
Society of Manufacturing Engineers
20501 Ford Road
Dearborn, MI 48128

PUMPS, 3RD EDITION

by Harry L. Stewart, 1977
Howard Sams & Co., Inc.
4300 W. 62nd St.
Indianapolis, IN 46206

PUMPS, HYDRAULICS, AIR COMPRESSORS

by F.D. Graham, 1965
Howard Sams & Co., Inc.
4300 W. 62nd St.
Indianapolis, IN 46206

HYDRAULIC SYSTEM ANALYSIS

by George R. Keller
Industrial Publishing Co.
Chicago, Illinois

MOVING PICTURES

AIR BRAKES: PRINCIPLES OF OPERATION

25 Min./16mm sd. Army Area Headquarters. Attn: Signal Officer

AIRPLACE HYDRAULIC BRAKES: PRINCIPLES OF OPERATION

20 Min./16 mm sd. Civil Aeronautics Administration, Aviation Educ. Div., Commerce Bldg., Washington 25, D.C. 20428

AIRPLANE HYDRAULIC BRAKES: TYPES, CONSTRUCTION & ACTION

30 Min./16 mm sd. Civil Aeronautics Administration, Aviation Educ. Div., Commerce Bldg., Washington 25, D.C. 20428

AIRPLANE HYDRAULIC SYSTEMS

15 Min./16 mm sd. Civil Aeronautics Administration, Aviation Educ. Div., Commerce Bldg., Washington 25, D.C. 20428

APPLICATIONS OF PASCALS LAW: PART I

15 Min./Color? 16 mm sd. United World Films, Gov't Films Dept., 1445 Park Ave., New York 29, NY 10029

APPLICATIONS OF PASCALS LAW: PART II

15 Min./Color/16 mm sd. United World Films, Gov't Films Dept., 1445 Park Ave., New York 29, NY 10029

BASIC HYDRAULICS

15 Min./Color/16 mm sd. United World Films, Gov't Films Dept., 1445 Park Ave., New York, NY 10029

BASIC PRINCIPLES OF HYDRAULICS

16 mm sd. Jam Handy Organization, 2821 South Grand Blvd., Detroit, MI 48202

CHARACTERISTICS OF HYDRAULIC FLUIDS

10 Min./16 mm sd. Civil Aeronautics Administration, Aviation Educ. Div., Commerce Bldg., Washington, D.C. 20428

COMPRESSED AIR POWER

16 Min./16 mm sd. Compressed Air and Gas Institute, Educational Committee, 1410 Terminal Tower, Cleveland, OH 44113

CONTROLLED POWER

20 Min./Color/16 mm sd. Sperry Vickers, P.O. Box 302, Troy, MI 48064

DERIVATIONS OF PASCALS LAW: PART I

15 Min./Color/16 mm sd. United World Films, Gov't Films Dept., 1445 Park Ave., New York, NY 10029

DERIVATIONS OF PASCALS LAW: PART II

15 Min./Color/16 mm sd. United World Films, Gov't Films Dept., 1445 Park Ave., New York, NY 10029

FLUID FLOW IN HYDRAULIC SYSTEMS

15 Min./Color/16 mm sd. United World Films, Gov't Films Dept., 1445 Park Ave., New York, NY 10029

FLUID HIGHWAY CONTROL

28 Min./16 mm sd. Jenkins Bros., Inc., 100 Park Ave., New York, NY 10017

FOUR EXPERIMENTS IN HYDRAULICS

17 Min./16 mm sd. National Bureau of Standards, Office of Scientific Publications, Washington, D.C. 20234

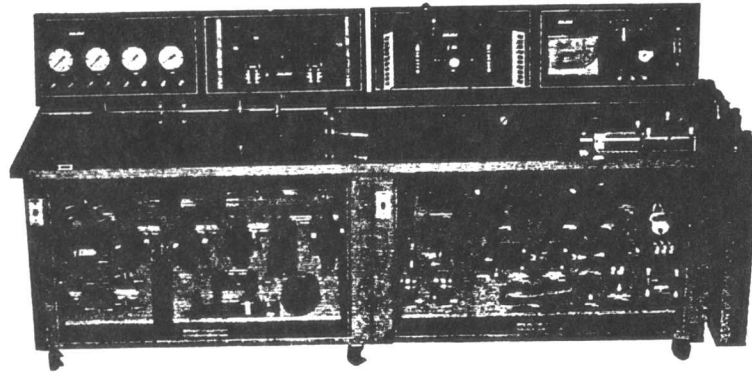
- HARNESSING LIQUIDS**
12 Min./16 mm sd. Shell Oil Co., 1 Shell Plaza, Houston, TX 77001
- HYDRAULICS**
12 Min./16 mm sd. British Information Services, 30 Rockefeller Plaza, New York, NY 10020
- HYDRAULICS**
11 Min./16 mm sd. Ideal Pictures Corp., 58 S.E. Water St., Chicago, IL
- HYDRAULIC BRAKES: PRINCIPLES OF OPERATION**
24 Min./16 mm sd. Army Area Headquarters. Attn: Signal Officer
- HYDRAULIC COMPONENTS**
Color/Slide Films, Denison Engineering Co., Div. of Abex Corp., 1160 Dublin Rd., Columbus, OH 43216
- HYDRAULIC INSURANCE**
12 Min./16 mm sd. Monsanto Chemical Co., 800 N. Lindbergh Blvd., St. Louis, MO 63166
- HYDRAULIC OILS**
Texaco Inc., 135 E. 42nd St., New York, NY 10017
- HYDRAULIC TURRET TRAVERSING MECHANISM**
22 Min./16 mm sd. The Oilgear Co., Attn: Dave Paulson, 2300 S. 51st St., Milwaukee, WI 53219 (no charge)
- HYDRAULIC VALVES—METHODS OF OPERATING VALVES**
Slide Film/50 Frames/sd., Civil Aeronautics Administration, Aviation Educ. Div., Commerce Bldg., Washington, D.C. 20428
- HYDROSTATIC TRANSMISSIONS**
Color/16 mm sd. 10 min. Sunstrand Co., 4751 Harrison Ave., Rockford, IL 61101
- HYDROSTATIC TRANSMISSIONS, POSITIVE DISPLACEMENT PUMP, PLISTON PUMPS**
Falk Corp., 16 mm sound, color film, 17 minutes
- INDUSTRIAL HYDRAULIC TECHNOLOGY**
TEL-A-TRAIN, 309 N. MARKET ST., CHATTANOOGA, TN 37405
- INDUSTRIAL HYDRAULIC SYSTEMS AND FLUIDS**
Sun Oil Company, 160 35 mm color slides with transcript
- LIQUIDS IN MOTION**
13 Min./16 mm sd. Civil Aeronautics Administration, Aviation Educ. Div., Commerce Bldg., Washington, D.C. 20428
- OPERATION PUSHBUTTON**
31 Min./16 mm sd. The Bellows Company, 222 W. Market St., Akron, OH 44303
- OUR INDUSTRIAL AIR POWER**
28 Min./16 mm sd./color. Quincy Compressor Co., Quincy, IL 62301
- POWER UP**
12 Min./color/16 mm sd. Denison Hydraulics Div., Abex Corp., 1160 Dublin Rd., Columbus, OH 43216
- YOURS TO COMMAND**
16 mm sound film, with wall chart. Compressed Air and Gas Institute, 55 Public Square, Cleveland, OH 44113

IDENTIFICATION OF COMPONENTS

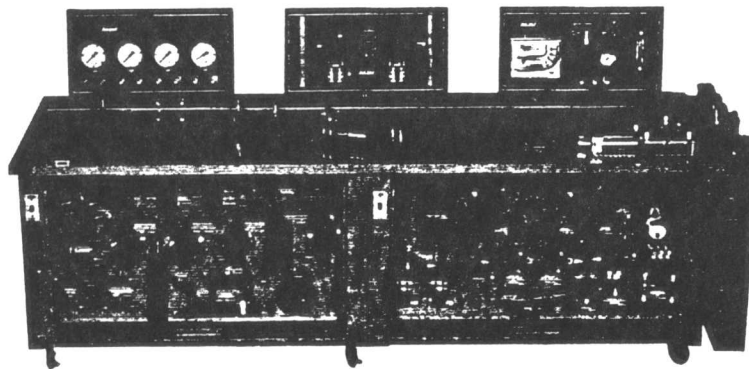
While terminology may vary within the industry, the Fluid Power components found in this training system include:

1. Power units consist of an energy source such as an engine or motor, a fluid reservoir, and a hydraulic pump for converting kinetic energy into a pressurized fluid flow.
2. Actuators are devices for converting the pressurized fluid flow back to kinetic energy. There are two types of actuators; linear actuators include cylinders and reciprocators; rotary actuators include motors and partial rotating devices.
3. There are three kinds of controls: 1) Pressure controls such as relief, sequence, and pressure reducing valves; 2) Flow control for controlling the flow in the entire system or only in part of the system; 3) Directional control for directing the flow to and from components in the system.
4. Hoses, tubing, pipe and manifolds are used to connect the fluid flow between components of the system.
5. Other items used to complete the system may vary from one system to another and are often of special manufacture. These include items such as a filler cap, breather, baffles, reservoir, or accumulator.
6. Filters are used for cleaning the fluid and heat exchangers used for heating or cooling the fluid.
7. Various devices are used to indicate or record what is happening in the system. They include pressure gauges, flow meters, and thermometers.

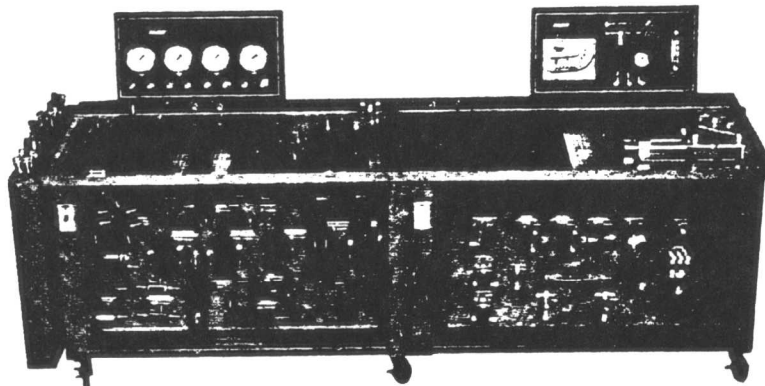
COMBINATION BENCHES



AT-6029 COMBINATION BENCH

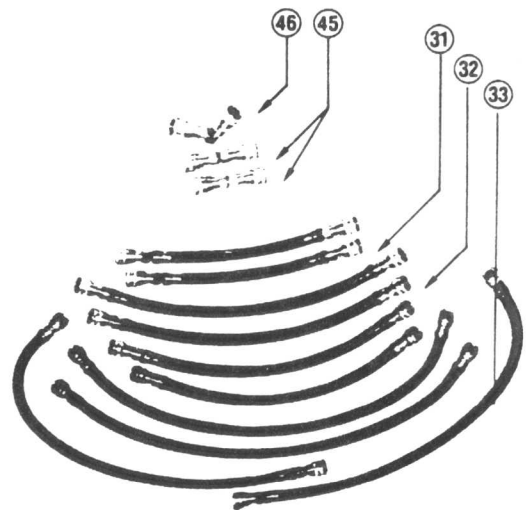
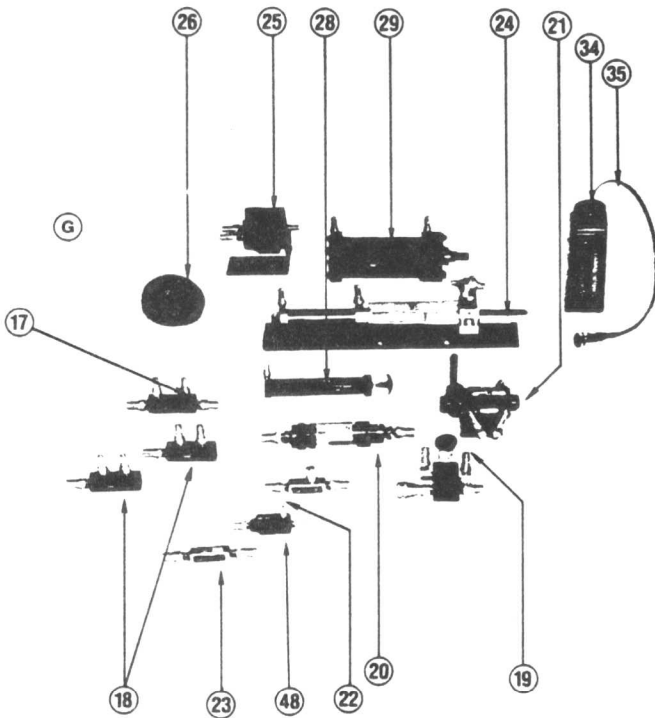
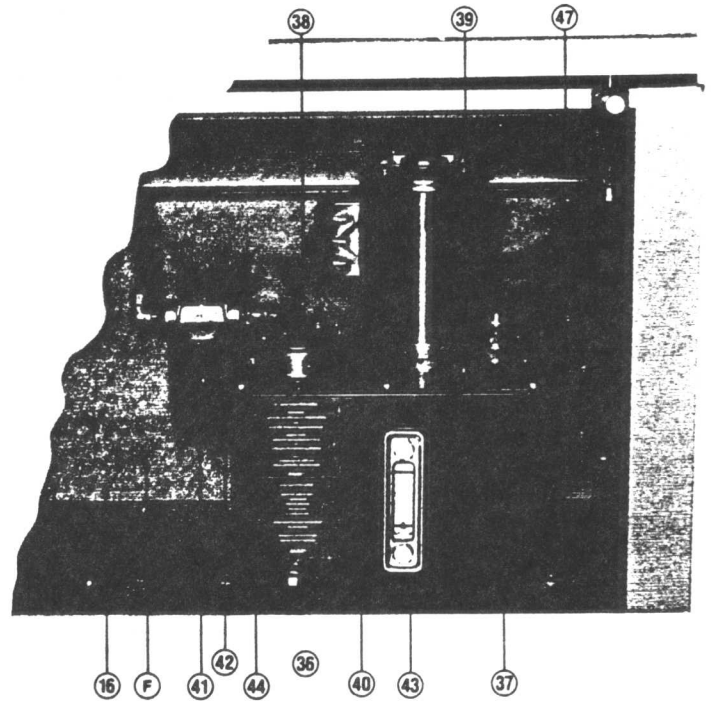
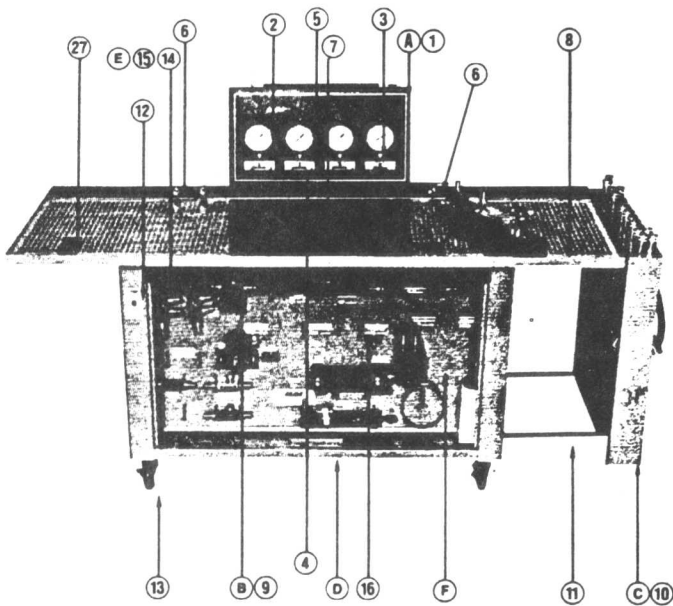


AT-6026 COMBINATION BENCH



AT-6025 COMBINATION BENCH

AT-6022 HYDRAULICS II TRAINER



PARTS IDENTIFICATION

AT 6022

SYM	DESCRIPTION	QTY	PART NUMBER
(A)	HYDRAULIC CONSOLE ASSY	1	10249
(1)	Console	1	1080315
(2)	0-1000 psi Liquid Filled Gauge	3	140087
(3)	30" 0-300 psig Liquid Filled Compound Gauge	1	140095
(4)	Gauge Block	4	600155
(5)	Male Quick Disconnect	8	150052
(B)	BENCH TOP ASSEMBLY	—	—
(6)	Supply/Return Manifold Assy.	2	150052/501015/504001/600288
(7)	Formica Panel	1	180307
(8)	Metal Tray	2	600007
(9)	72" Bench Top	1	810044
(C)	HOSE RACK ASSY.	—	—
(10)	Hose Rack	1	5413
(11)	Hose Rack Stand-off	2	190017
(D)	48" PEDISTAL BASE	—	—
(12)	Switch	1	710012-710020
(13)	Casters	4	480004
(E)	DOOR ASSEMBLY	—	—
(14)	Plexiglas Panel	1	290064
(15)	Lock	1	630095
(F)	COMPONENT MOUNTING BOARD, HYDRAULIC	1	10215
(16)	Mounting Hooks	A/R	Various
(G)	COMPONENT GROUP	—	—
(17)	4-Port Manifold Assembly	1	10462
(18)	3-Port Manifold Assembly	2	10454
(19)	Pilot Operated Relief Valve Assembly	1	10488
(20)	Flow Meter Assembly	1	10496
(21)	4-way Tandem Center Directional Control Valve 1	1	10348
(22)	Non-pressure Compensated Flow Control Valve	1	10397
(23)	Check Valve Assembly	1	10405
(24)	Hydraulic Loading Device	1	10470
(25)	Hydraulic Motor	1	10330
(26)	Motor Flywheel	1	600346
(27)	Hydraulic Motor Clamp	1	190181
(28)	Spring Return Cylinder	1	10322
(29)	Double Acting Cylinder Assy. 2½" bore	1	10595
(30)	Hose Set	1	10272
(31)	12" Hose Assembly	2	120048/150060
(32)	20" Hose Assembly	4	120055/150060
(33)	36" Hose Assembly	4	120063/150060
(34)	Plastic Bottle	1	120113
(35)	Plastic Hose Assy.	1	350033/530048/150060
(36)	Power Unit Assembly	1	11312
(37)	Hydraulic Pump—MTE	1	110007
(38)	1 HP Electric Motor	1	114009
(39)	Relief Valve	1	114017
(40)	5 gallon Reservoir	1	114025
(41)	Filter Assembly	1	114033
(42)	Filter Element	1	180356
(43)	Fluid Level/Temperature Assembly	1	114041
(44)	Filler/Breather Cap	1	900068
(45)	Straight Connector	2	10306
(46)	90° Connector	1	10298
(47)	System Flow Control Valve	1	100156
(48)	Pressure Comp Flow Control	1	10389

FORMULA FOR HYDRAULIC CIRCUITRY

$$\text{Force (pounds)} = \text{cylinder area (sq. inches)} \times \text{line pressure (psi)}$$

$$\text{Displacement (cu. inches/min.)} = \text{cylinder area (sq. inches)} \times \text{piston velocity (inches/min.)}$$

$$\text{Time (seconds)} = \frac{\text{cylinder displacement (cu. inches)} \times 0.2597}{\text{pump delivery (gpm)}}$$

$$\text{Horsepower (hydraulic)} = \frac{\text{gpm} \times \text{pressure}}{1714 \text{ (100\% efficiency)}}$$

$$\text{Oil Velocity (ft./sec.)} = \frac{\text{pump delivery (gpm)} \times 0.3208}{\text{pipe size (sq. inches)}}$$

$$\text{Piston Velocity (in./sec.)} = \frac{\text{stroke (inches)}}{\text{time (seconds)}}$$

$$\text{Pump Delivery (cu. inches/min.)} = \text{cylinder area (sq. inches)} \times \text{piston velocity (inches/min.)}$$

$$\text{Cylinder Velocity (in./sec.)} = \frac{\text{pump delivery (gpm)} \times 231}{\text{cyl. net area (sq. inches)}}$$

THE FOLLOWING CONVERSIONS HAVE BEEN USED THROUGHOUT THIS MANUAL:

Many of the mathematically defined solutions (answers to problems) have been rounded off.

bars	=	psi	=	kPa
3.2	→	50	→	345
7.0	→	100	→	689
14.0	→	200	→	1379
17.2	→	250	→	1724
21.0	→	300	→	2068
24.0	→	350	→	2413
28.0	→	400	→	2758
35.0	→	500	→	3447
70.0	→	1000	→	6894

Inches	Millimeters	gpm	lpm
1-1/8"	= 28.6 mm	1/2	= 1.89
5/8"	= 15.9 mm	1	= 3.78
2-1/2"	= 63.5 mm	2	= 7.56
1"	= 25.4 mm	3	= 11.34