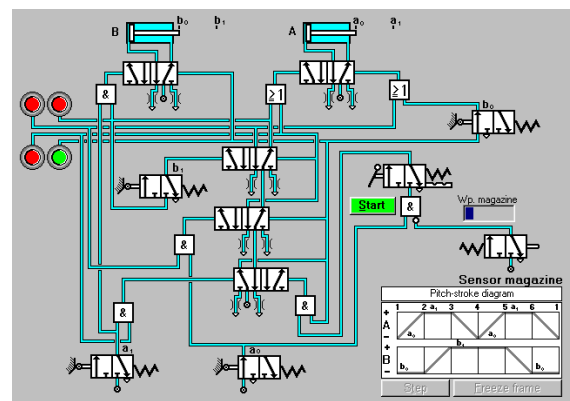## SIMULATION SOFTWARE FOR THERMAL AND FLUIDIC UNITS, PLANTS AND PROCESSES
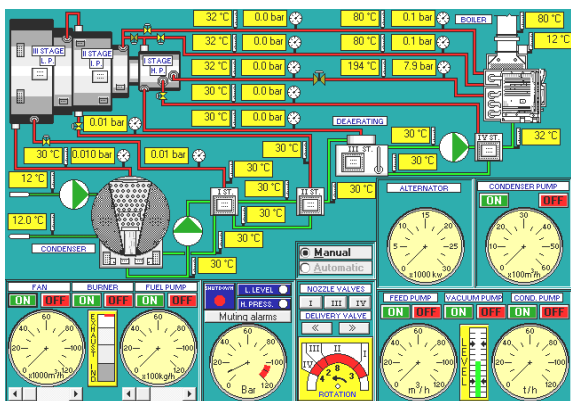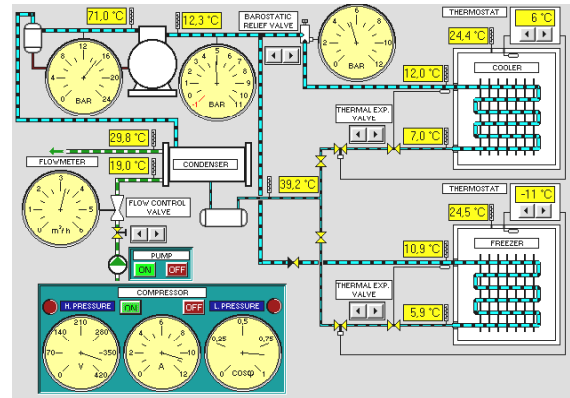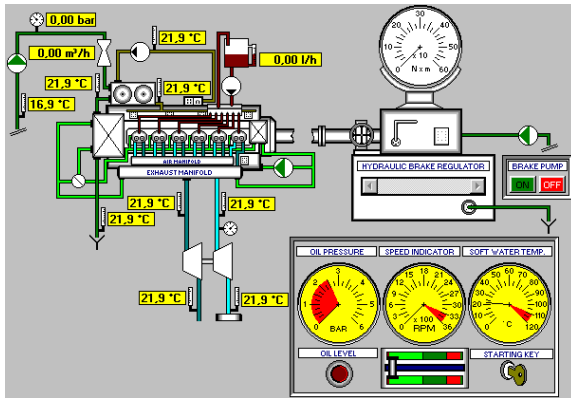

The "**Thermoware**" range of educational software is one of the most updated and effective existing software on the market allowing the theoretical and practical study and PC simulation of many subjects related to the thermotechnics, fluidics and endothermic engines fields. It is so complete and effective that can be considered without fail both a complement and a replacing of the traditional laboratory equipment which are difficult to be installed and more and more expensive in respect of our solution. The programs run on Windows 95/98/ME/2000/NT/XP™ and require an IBM PC or compatible with Pentium processor, a VGA or higher video display, hard disk and mouse. The following is a list of the software presently available:

- **THW-01:** Simulation of a water-tube boiler heating unit with thermal balance calculating
- **THW-02:** Simulation of a steam turbine unit, with thermal balance calculating.
- **THW-03:** Simulation of a refrigeration unit
- **THW-04:** Simulation of a air conditioning plant (summer & winter)
- **THW-05:** Simulation of a water-air with heat pump thermal plant
- **THW-06:** Simulation of 4/2 stroke Otto engine
- **THW-07:** Simulation of 4/2 stroke Diesel engine
- **THW-08:** Simulation of a Diesel engine drive with thermal balance calculating.
- **THW-09:** Simulation of a Diesel engine with hydraulic Brake unit
- **THW-10:** Principles of hydraulics and Centrifuge Pump Program
- **THW-11:** Animated sections of oleodynamic components
- **THW-12:** Simulation of Oleodynamic circuit with 16 components
- **THW-13:** Pneumatics Circuits (Q-L-U cycles and application)
- **THW-14:** Simulation of an electrical ignition car system
- **THW-15:** Simulation of a solar plant
- **THW-16:** Simulation of a civil heating plant – hot water -

All the software is marked by a particular finished graphics with a **dynamic and interactive simulation** allowing a complete and effective training on a very reduced time. Each software title may be delivered in different user's licence installations at the same Customer site: this particular feature makes immediately the laboratories fully autonomous and, at the same time, is a big break down of the budgets needed.

The educational employ and experiments allowed by this range of software are really a lot and the only limit could be the user's fantasy: in fact any software simulates the real working of the plant allowing the settings, operations, experiments and observations exactly like on real plants.

THW-01
SIMULATION OF A WATER-TUBE BOILER HEATING UNIT
WITH THERMAL BALANCE CALCULATING
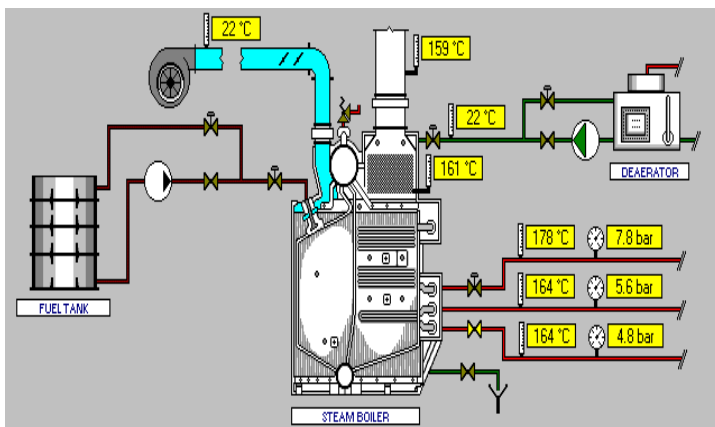
The simulation mode provides a synoptic with plant layout for the management of the boiler (both in manual or in automatic control) and a control board.

Once having set the manually operated valves, start the boiler ventilation and the control level through the control board.

After setting out the air delivery, start the burner and set the fuel delivery. The pressure will raise and the level will change.

This must be compensated by setting the feed water delivery.

When the working pressure is attained, the steam drawing valve must be partially opened and the plant will stabilise.

The selected boiler belongs to the last generation and is equipped with an economiser and a primary and secondary superheated.

All lines, when activated, display the flow and it is so possible to check the operation in progress.

In addition it is available a diagnostic page, including the necessary data for the determination of the heat balance, and a pie chart for its representation.
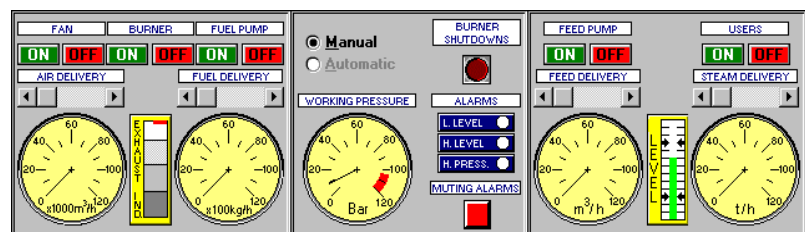

THW-02
SIMULATION OF A STEAM TURBINE UNIT WITH THERMAL BALANCE CALCULATING.

The simulation module includes:
- A synoptic with plant layout, composed of:
  - a water-tube boiler, with separated commands and instrument systems;
  - a multistage turbine, with high - middle - low pressure sections, and the required instrumentation to regulate the lamination and the choke;
  - a surface condenser with correspondent cooling water pump, vacuum pump and condensation pump;
  - three surface exchangers for the regeneration;
  - a de-aerator with regenerating exchanger.

- A diagnostic page including the necessary data to control the plant and to identify the correspondent thermodynamic cycle.
- A heat balance, represented with a pie graphic for the immediate control of the efficiency and of the losses.
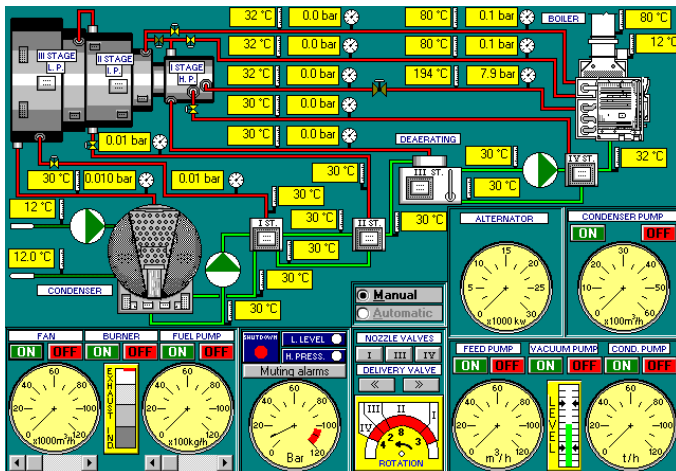

It is, moreover, possible to exclude separately or simultaneously both the resuperheater and the regenerating exchangers to verify the impact on efficiency of the plant.

THW-03
SIMULATION OF A REFRIGERATION UNIT (COOLING SYSTEM)

The simulation module includes, for the working of cooling system with two coolers, one for the refrigerating room and one for the freezer, a synoptic with plant layout, complete of necessary instrumentation, and a control board for the compressor. It is possible, during the operation, to variate the barostatic relief valve or the thermal expansion valves or the cooling water delivery, to verify, checking the instrument systems, how these variations influence the thermodynamic cycle and the plant efficiency.
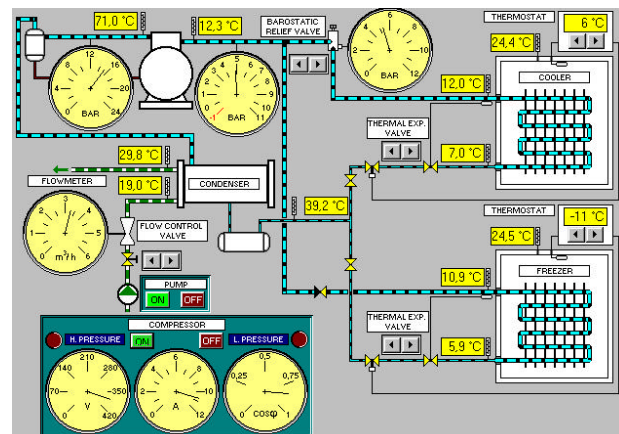
The thermodynamic cycle, covered during the working of cooling system will be, automatically, transferred on Fresno 22 Mollier's printable diagram.

THW-04
SIMULATION OF A AIR CONDITIONING PLANT
(SUMMER & WINTER)

The simulation module includes:
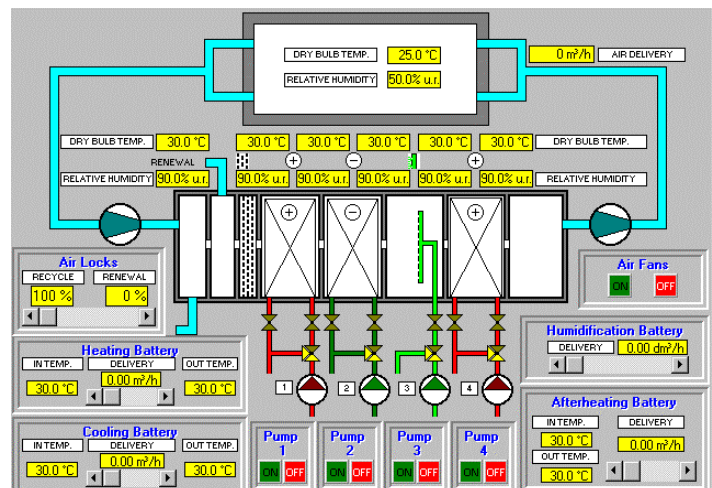- a synoptic;
- a psychrometric diagram.

The synoptic provides: the distribution, made exemplified of air conditioning system lines, complete of valves; centrifugal pumps control board; fans control board and battery control boards.

It has been selected the diagram of A.S.H.R.A.E., metricated at C.A.R.R., for its diffusion among operators.

It is possible, after the insertion of the project data, to perform the following operations:
- air mixing;
- heating;
- adiabatic humidyfication;
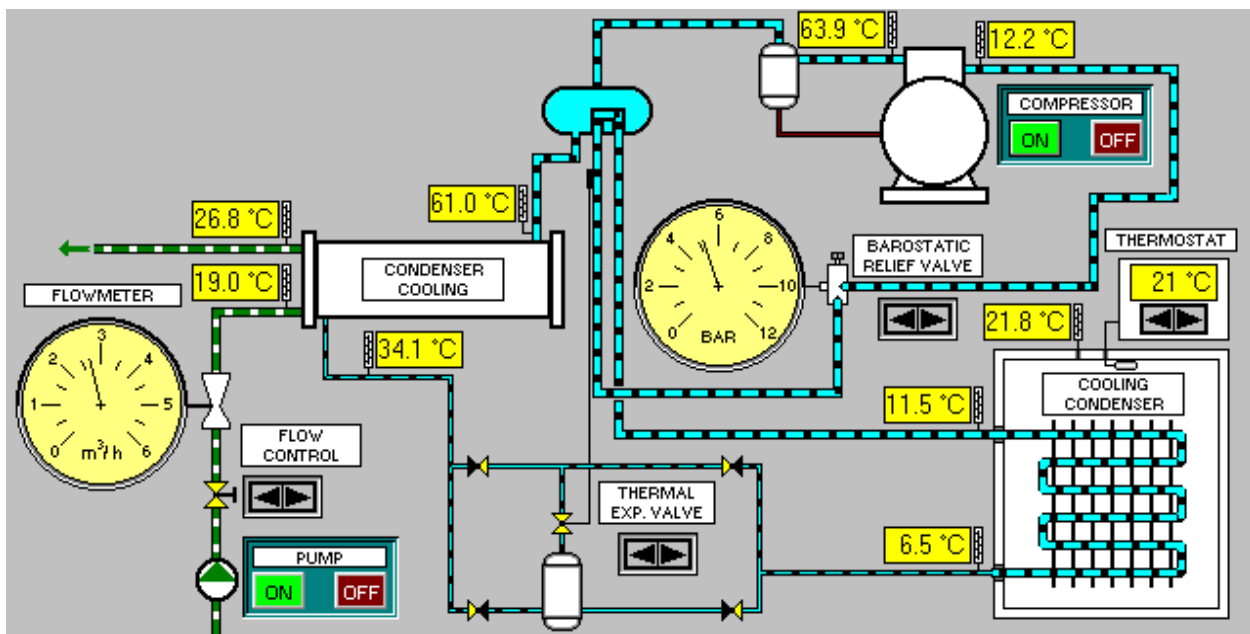- cooling and dehumidyfication;
- afterheating.

All trasformations are inserted on psychrometric diagram, it is thus sufficient to recall it to check the air characteristics after every transformation.

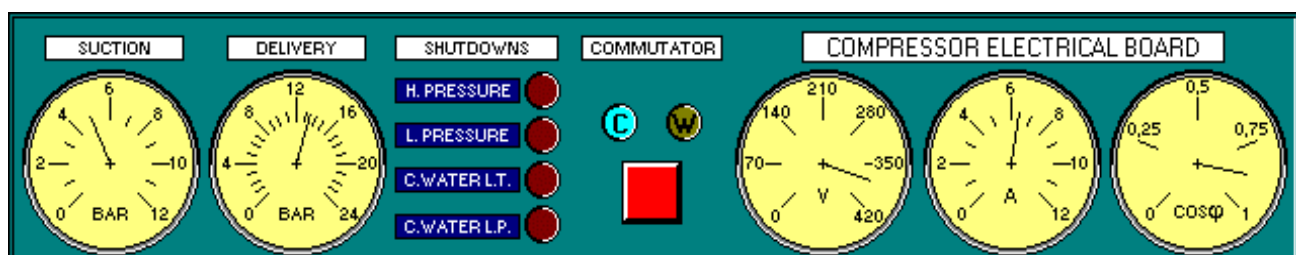# THW-05
SIMULATION OF A WATER-AIR WITH HEAT PUMP THERMAL PLANT

To operate the heat-pump, the simulation module provides a synoptic whit a plant layout

and a control board.

After planning the cooling of the water line, start the compressor.

If no errors have been made, the plant works until the thermostat stops the compressor.

It is possible, during the operation, to set the barostatic relief valve or the thermal expansion valve or the cooling water delivery, in order to verify, by checking the instrument systems, how the variations influence the thermodynamic cycle and the plant efficiency.

In addition it is available the Freon 22 Mollier's printable diagram on which will be automatically transferred the thermodynamic cycle, covered during the working of the heat pump plant.

THW-06 / THW-07
SIMULATION OF 4/2 STROKE OTTO ENGINE
SIMULATION OF 4/2 STROKE DIESEL ENGINE

The program is very useful in explaining a 4-stroke Otto cycle (similar programs are 2-stroke Otto cycle, 2 and 4-stroke Diesel cycle).

In a synoptic there is:

- the animated section of the engine;
- a P. V diagram to show the cycle;
- the timing system.

The program provides, by selection, the performance both of theorethical cycle and of the indicated cycle.

The engine is started with the start button.
Once started it is possible to see the succession of the different strokes, with variable speed, through dynamic slider.The strokes can be followed at the same time in engine section in the cycle and the timing system.

The cycle and timing system, however, are plotted, up to the end, in function of the piston stroke.

To make easier the display of the various strokes, it is also possible, by clicking on proper keys:

- the freeze-frame
- the frame advancing
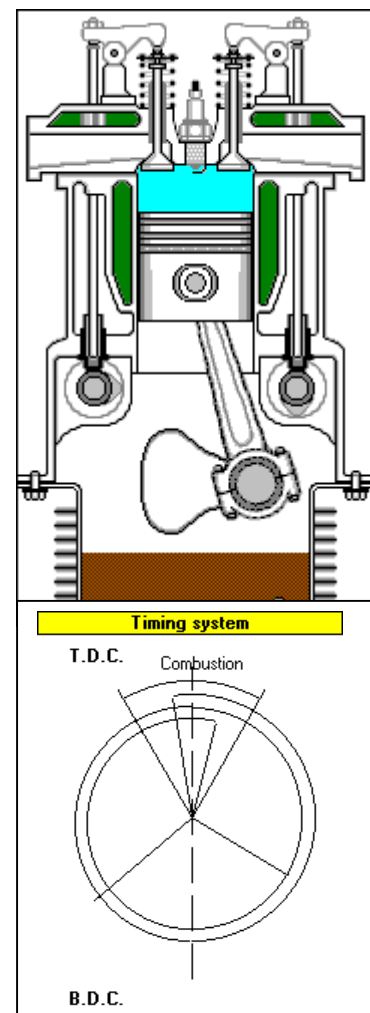
THW-08
SIMULATION OF A DIESEL ENGINE DRIVE WITH
## THERMAL BALANCE CALCULATING.

The synoptic includes: the engine plant; the control instruments; the lines simplified distribution, represented with forecast colour from the regulation in force. The teacher can insert the simulation information for students for a use over normal conditions or, just before the use he can insert some of the faults.

The main features of the plant are:

- One section to run the engine;
- One section with main lines synoptic;
- One section to run the auxiliary machinery.
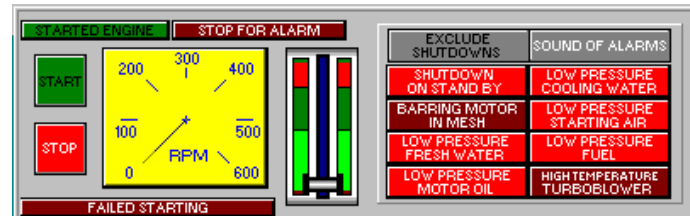
The section to run the engine, as shown in the figure, includes commands and signals to run the engine manual mode. There is a key to start and stop and a lever combined with an analogue revolution indicator to change the speed. A set of lighting signals completes the panel. These signals show the causes of shutdown at the start, with the possibility to exclude them if the problem doesn't make dangerous to start the engine.
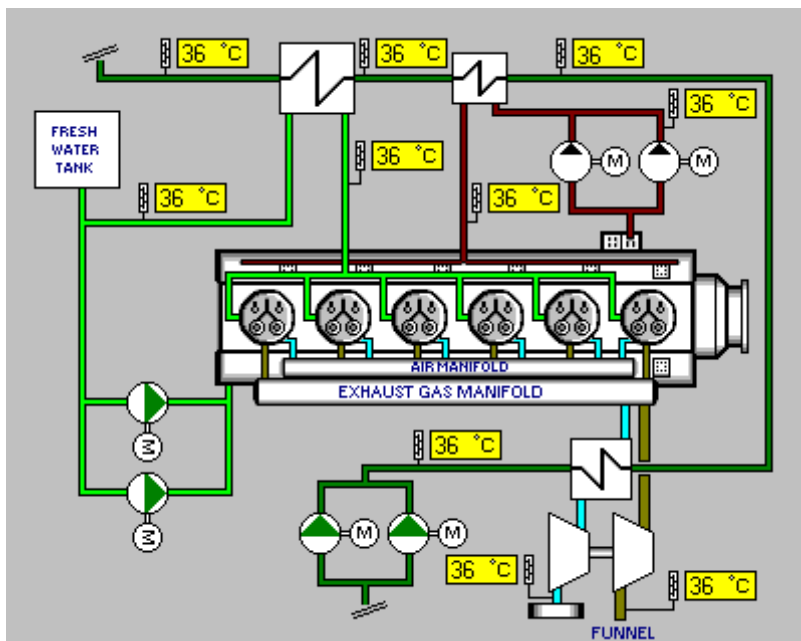
The synoptic in the figure shows the main diagram of the plant part required to do the heat balance of the engine. There are the cooling fresh water, sea water and lubricating oil with digital thermometers to check the temperatures.

The Options menu sends a page of data where all the values are stored (with the respective measurement units). All these data are displayed on the screen and are required to calculate the heat balance. The result will be shown on a pie chart.

The auxiliary machinery section has a set of lighting keys and analogue gauges to check the following propeller services: lube oil; fresh water; sea water; fuel; air.

The auxiliary machinery section has a set of lighting keys and analogue gauges to check the following propeller services: lube oil; fresh water; sea water; fuel; air.
A couple of pumps are provided for each service and compressors for air.
The commands are the following:

- start engine key ;
- stop engine key;
- analogue manometer.

Moreover, there is an analogue thermometer that allows the checking of the exhaust gas temperature value of cylinders and manifolds before turbo blower. The cylinders can be selected from push-button panel.

THW-09
SIMULATION OF A DIESEL ENGINE WITH HYDRAULIC BRAKE UNIT

The synoptic includes again: the engine plant; the control instruments; the lines simplified distribution represented with forecast colour from the regulation in force; the engine panel; the hydraulic brake panel. The Teacher can insert the simulation information for the students for a use in normal conditions, or just before use, he can insert some faults. The started engine simulates the work in different feeding or charging condition.

The main features of the plant are:
- 4 stroke diesel engine;
- hydraulic brake.

Over the engine, 160 kW power, control panel are located:
  - the ignition lock key;
  - the accelerator operating lever;
  - the revolution indicator for driving shaft rpm;
  - the soft water thermometer;
  - the lube oil pressure gauge;
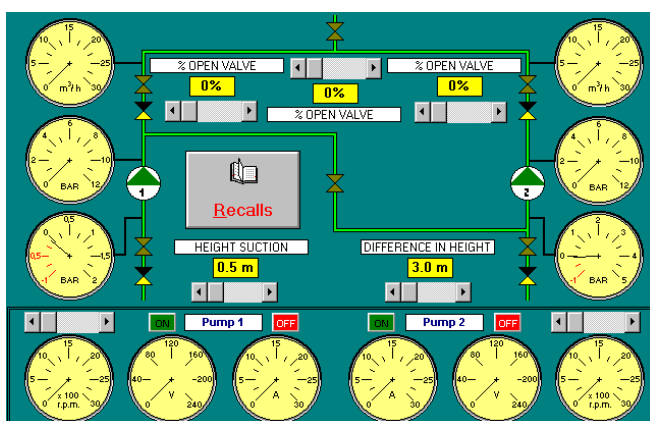 - one pilot lamp for lube oil level;

Over the hydraulic brake control panel are located:
- the pump control panel;
- the hydraulic brake regulator;
- the torque gauge.
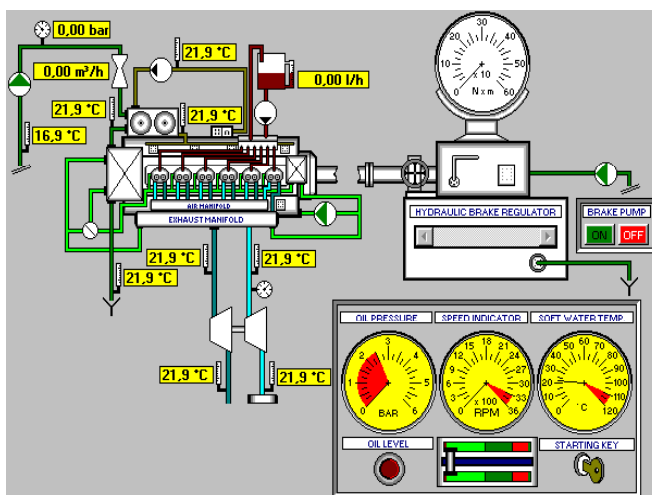
THW-10
PRINCIPLES OF HYDRAULICS AND CENTRIFUGE PUMP PROGRAM

The simulation module includes the plant layout, composed of two pumps with separated control and instrument systems and a further synoptic to perform an exercise over the hydraulics principles.

It is moreover present a hypertext with theory recalls.

The hydraulic circuit includes 4 main configurations:
- running of single pump 1 or 2;
- two running in series pumps
- two running in parallel pumps

It is possible to have the data recording, taken from instrument system, organised in labels, from which, with a special selection, it is possible to visualize the characteristic curves.

| Pump 1	Voltage	Current	Delivery	Delivery Pressure	Suction Pressure	Revolution	
	Volt	Ampere	m³/h	Bar	Bar	r.p.m.	
1	140	11	7.1	3.4	-0.08	2842	
2	140	11	8	3.37	-0.09	2842	
Pump 2	Voltage	Current	Delivery	Delivery Pressure	Suction Pressure	Revolution	
	Volt	Ampere	m³/h	Bar	Bar	r.p.m.	
1	139	10	7.1	3.4	-0.08	2761	
2	139	11	8	3.37	-0.09	2761	

THW-11
ANIMATED SECTIONS OF OLEODYNAMIC COMPONENTS

The program target is to simplify the comprehension of the student and the work of the teacher by visualizing the sections, both static and animated, of various components, drawn following the UNI specifications and accompanied by concise monographic notes.

The program aims to show through the animation of the various sections, what happens inside the moving oil worked components when the fluid goes through.

It allows therefore, the display and the description of 15 oildynamic components and exactly:
1) Check valve
2) Pilot operated check valve
3) Double check valve
4) Flow controller
5) Flow control check valve
6) Safety valve
7) Slide valve 3/2 with button
8) Slide valve 4/2 with electromagnets
9) Pilot operated slide valve 4/2
10) Slide valve 4/3 by-pass position
11) Slide valve 4/3 subcircuit unloading
12) Double acting cylinder
13) Gear pump
14) Semi-rotary engine
15) Accumulator
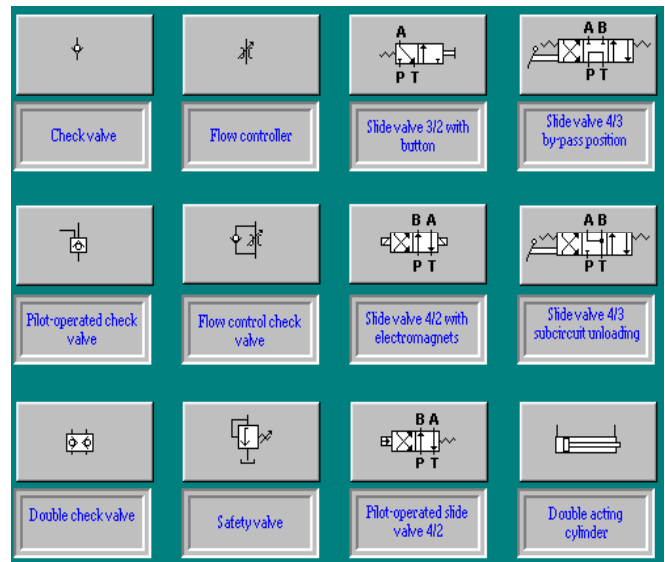
To show the animated components and, successively, the explicative text it is sufficient to click with the mouse on the component symbol.
It is also possible the setting or stopping the movement speed. The teacher can also insert his personal notes on the selected component.
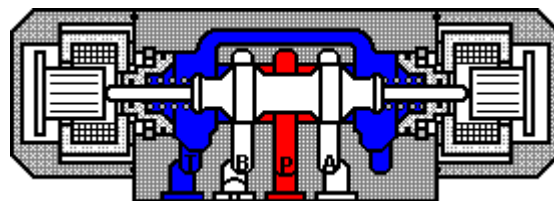
THW-12
SIMULATION OF OLEODYNAMIC CIRCUIT WITH 16 COMPONENTS

The program is articulated to represent a helpful tool for the Teacher in the management of the subject and to be a valid support for the student that can easily follow the evolution of the dynamic situation. The synoptic is divided in three sections:
- oildynamic plant;
- slide valves;
- actuators.

All the oildynamic components are dynamic and at the beginning are in stand-by. After starting the circuit, the program moves the slide valve and show the oil flow in the related circuits.
The program aims to show through the animation of the various sections, what happens inside the moving oil worked components when the fluid goes through.
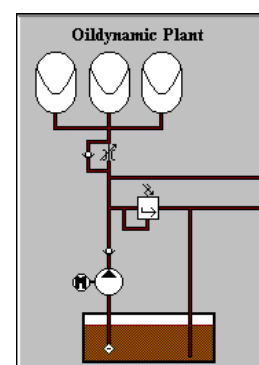
It allows therefore, the display and the description of the animated sections, drawn following the UNI specifications, of 16 oildynamic components and exactly:

1) Check valve
2) Pilot operated check valve
3) Double check valve
4) Flow controller
5) Flow control check valve
6) Safety valve
7) Slide valve 3/2 with button
8) Slide valve 4/2 with electromagnets
9) Pilot operated slide valve 4/2
10) Slide valve 4/3 subcircuit unloading
11) Slide valve 4/3 by-pass position
12) Manual slide valve 4/3 by-pass position
13) Double acting cylinder
14) Gear pump
15) Semi-rotary engine
16) Accumulator

In order to show the animated components it is enough to click with the mouse on the chosen component's symbol. Each component is accompanied by concise monographic notes and it is possible the setting or stopping of the movement speed.
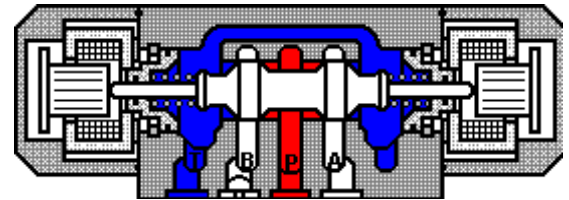
THW-13
PNEUMATICS CIRCUITS: Q-L-U CYCLES AND APPLICATIONS

The program is articulated in a way to represent an helpful tool for the Teacher in the management of the subject and to be a valid support for the student that can easily follow the evolution of the dynamic situation about square cycle, L cycle and three cylinders cycle.

The components animation and, above all, the chance to advance one step at a time, allows overcoming the comprehension of a static circuit working: the student ability to store at subsequent times the distributors and actuators respective positions.
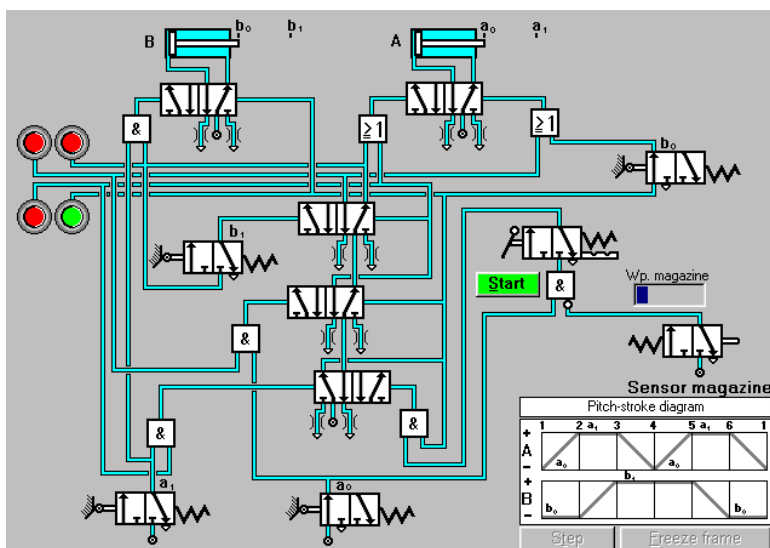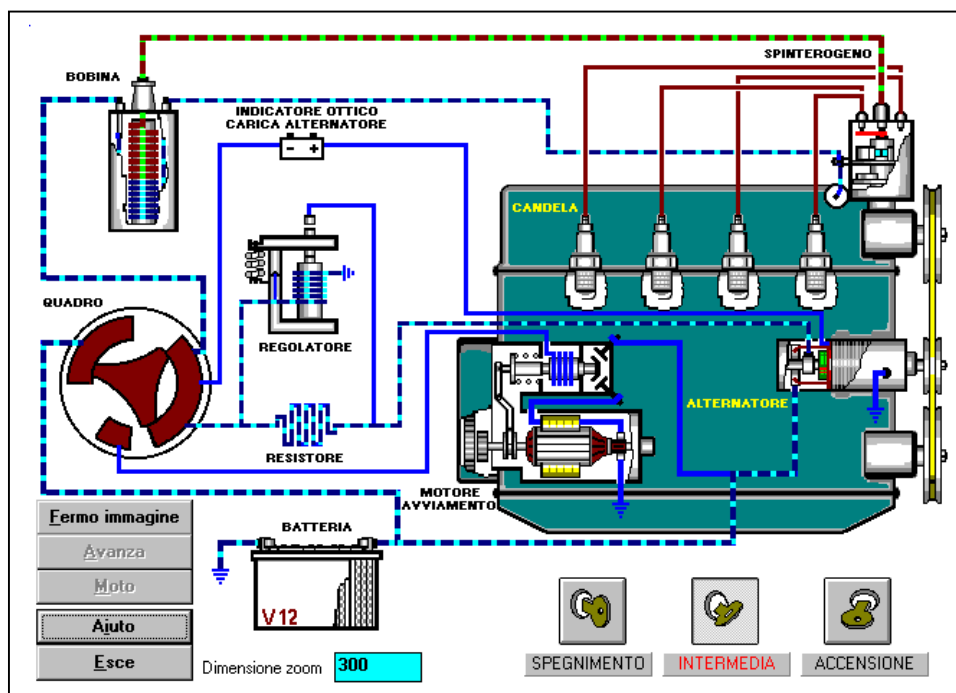

All the pneumatic components are movable and at the program starting they are in stand-by.

When the circuit starts, air flows are visible on the pipes.

To verify the sequential schema of the proposed modules is very easy with the aid of stroke/step diagram and with the aid of the key "Freeze-frame".

THW-14
SIMULATION OF AN ELECTRICAL IGNITION CAR SYSTEM

The software allows to dynamically and interactively simulate the operation of a vehicle on-board ignition circuit. All the electric ignition system components are shown on the synoptic table:

1. Battery
2. Salient-pole alternator
3. Starter
4. Spark plug
5. Voltage regulator and resistors
6. Coil
7. Distributor

By positioning the mouse on the labels and selecting an option, a window will open up with the sectional view of the selected electric component.

The pressing of the keyboard button F1 with the window opened will allow you to display an explanatory text of the selected component.

Every time the mouse pointer changes from ⃠ to ↖, the interface turns active. By pressing the right button it will be actuated the ZOOM function which enlarges the selected area. Zoom extent can be modified by entering the desired value in the box provided.

Other controls available:

The **Help** button opens an explanatory hypertext.
The **Image freeze** button freezes the programme on the selected image.
The **Forward** button makes the programme to go on one step at a time.
The **Motion** button resumes moving conditions.
The **Exit** button terminates the programme.

The engine start procedure is similar to the one actually performed on a vehicle
Just select the icons available on the ignition key; then, after start-up, go to the intermediate position.

The software is therefore highly suitable to efficiently and economically manage both the basics of the electric ignition system provided on the vehicle and the study of the single components that make up the system

THW-14
SIMULATION OF A SOLAR PLANT

The temperatures reached in civil hot-water generating systems are not very high; therefore flat-plate solar collectors can be used. The operating principle takes advantage of the so-called "greenhouse effect" where solar rays penetrate a structure equipped with a transparent plastic or glass cover generating relatively high temperatures inside. Such effect is based on the fact that the glass can be differently permeated by sunlight and infrared rays. Solar rays show their maximum energy in the visible range: they are able to pass through the glass without sensible absorption and heating the "greenhouse" bottom which, in its turn is emitting infrared rays for which the glass is not transparent.
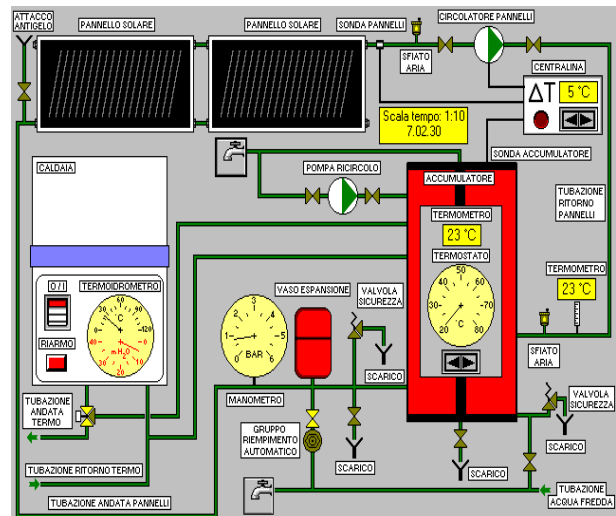
The synoptic table provides all the controls, regulations and the typical control instruments with the possibility of assessing the heat exchanges involved.
A record of the faults and of the activity work session is also available. The solar energy hot-water generating system is essentially composed of four sections:

- receiving surface (one or several solar panels);
- heat exchanger;
- primary circuit (collector-exchanger);
- secondary circuit (hot water delivery to the user).

After the program has been started, the following items can be entered:

- name of the student;
- type of drill (even with fault simulation);
- access to the drill data record set up by the teacher;
- assessment of solar panel inclination;
- month, standard time and exposure time selection.

In particular, the recorded data file can only be accessed by the teacher and are protected by a password. You can select over 15 different solar energy system faults as well as the time, starting from the beginning of the drill, after which the faults will be activated automatically.

Moreover, each drill can be accompanied by a description by entering a short text in the space provided. This allows the teacher to store a great number of drills, each of them different from the others in terms of contents and complexity.

The synoptic table available on the screen shows the following items:
- control equipment;
- typical commands;
- illustrative distribution of the system lines;
- wall-installed gas-fired boiler;
- valves;
- management control unit:
- boiler and boiling unit control board;
- users

THW-16
SIMULATION OF A CIVIL HEATING PLANT – HOT WATER -
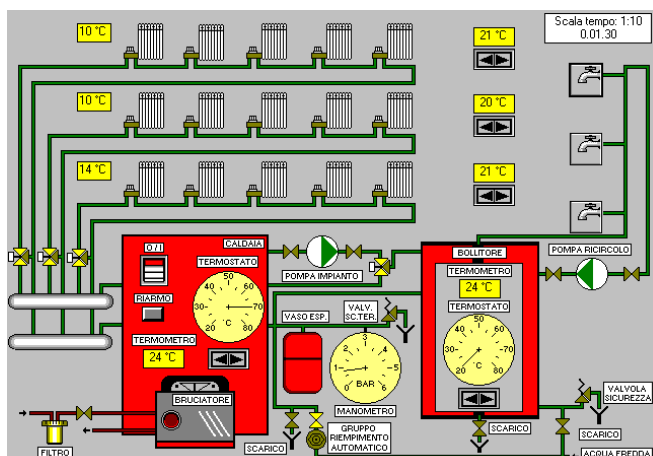
The central heating system simulated by the **THW-16** software supplies heat to a whole building from a dedicated room (central heating unit). The means of heat transmission is the water which is heated below the boiling temperature in the boiler and made circulating through the pipes into the radiators placed in the different rooms. The radiators have been particularly shape designed so that to provide the maximum outer surface with the best efficiency.

Water circulates by means of a pump that provides the necessary delivery capacity to ensure adequate temperature difference between the delivery line and the return line.

The piping network must also allow the water expansion due to heat: in systems equipped with close expansion vessels the water expansion is counterbalanced by the compression of the air enclosed in the vessel. The radiators, which are equipped with a hot-water flow control valve as well as valves to purge the air trapped inside, give off heat by radiation and, partly, by conduction of the air lapping against the radiators. The heat is then delivered to the surrounding environment by the convective motion of air. Besides flowing into radiators, hot water also flows into a heat exchanger (boiling unit) connected to the household system: thus, the hot water for the waterworks is so kept separated from the water flowing through radiators.

After the program has been started, the name of the student can be entered. Moreover, the various characteristic parameters of the system to be simulated can be set or the access can be made available to a drill previously set by the teacher and stored in the data record.

Within this section (accessible only by the teacher and protected by a password), you can select a great number of systems faults as well as the time, starting from the beginning of the drill, after which the faults will be activated automatically.

The synoptic table available on the screen shows the following items:

- control equipment;
- illustrative distribution of the system lines;
- wall-installed gas-fired boiler
- system valves;
- management control unit:
- boiler and storage boiling unit control board;
- users.

Immediately after being switched on, the system simulates the operation of a real system. The timer available allows you to assess the heat exchanges involved.

A record section is also provided, which stores all the system activities as well as the faults made by the students when practising.

(For all the above mentioned software titles a demo disk is available on request)