AIR MOTORS

FOR

EMERGENCY SPAN OPERATION

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ABSTRACT

AIR MOTORS FOR EMERGENCY SPAN OPERATION

Emergency drive systems are often required for main drives on movable bridges.

Many types of systems are available and in use on existing bridges. Systems as simple as hand cranks or capstans exist (but are seldom, if ever, used) while systems as complex as completely independent electric drives and controls with an independent power supply are also in use.

A low cost reliable emergency drive can be obtained by using an air motor as the prime mover.

The air motor is permanently installed at the bridge while the air supply commonly is furnished by a truck-mounted maintenance compressor.

The installed cost of the system is small, the required maintenance for the air motor is almost zero, and the reliability is high.

Since most movable bridge contractors rig a temporary air wrench or air drill to operate the span prior to completion of the electrical system, the incremental cost of including a permanent system is very small.

Commercially available air motors with internal gearing can provide torques as high as those produced by 100 HP, 870 RPM electric motors.

The big advantage of the air motor is that it will operate the span completely independent of the electrical system or any failures therein. The limitations are that control is completely manual and the operation is slow.

HISTORY OF THE CONCEPT

The writer has been involved in movable bridge design and construction for over 30 years.

The first job was a double-leaf bascule span of small size, in which the electrical contractor was behind schedule.

The structural/mechanical contractor for the bascule span was run by a clever engineer who installed a temporary air motor drive for each leaf using a pair of large, slow-speed air wrenches. These were used for several months to run the span during the period when the final structural and machinery adjustments were made. Eventually, the electrical system was completed and replaced the air motors.

Almost every other bridge, on which the writer worked, was also air powered with a crude temporary drive during construction.

It became evident that the additional cost for a permanent air motor drive would not be great since a similar temporary system was being used on almost every new project.

In 1970, we proposed the air motor concept to a client for a tower drive lift span in a downtown location. The client was not concerned about power company reliability but wanted a low-cost backup for the relatively sophisticated controls for the tower drive lift span.

Permanent air motors were installed, first without silencers. The exhaust air noise in an enclosed house was excessive, and the silencers were added. Air piping was run down to deck level.

Air pressure was set at 55 PSI at the regulator to avoid overloading the machinery components. The main electric motors were 60 HP at 870 RPM, one in each tower.

After some initial problem with incorrectly labeled parts on the four-way air valves, the system worked satisfactorily.

Many of the movable bridges we have designed since that time have had air motor emergency drives.

DESCRIPTION OF SYSTEM

The air motor systems designed by Hardesty & Hanover consist of five major elements:

1. A vane type reversible air motor with integral reduction gearing.
2. A four-way air valve to control forward-reverse as well as stop and start motor.
3. A disconnect coupling to connect the air motor to the bridge drive system.

4. Air line hardware to furnish filtered air at the desired pressure and with lubricating oil added.

5. A silencer for the exhaust air.

CONDITIONS UNDER WHICH AN AIR MOTOR EMERGENCY DRIVE IS ADVANTAGEOUS

Air motor emergency drives are, perhaps, most advantageous for bridges in builtup areas where the utility company power supply is very reliable and the malfunctions most likely to prevent bridge operation are control circuit malfunctions.

Air motor operation completely bypasses the electrical power and control systems.

The fewer auxiliary drives, the better since they must be hand-operated prior to main drive operation by air motor.

For example, a vertical-lift span without span locks is relatively easy to operate by air motor. A swing span with all its auxiliary drives would be quite difficult.

Tower drive lift spans require two air motor systems and some means for manual synchronization. Double-leaf bascule spans require two air motor systems without the need for synchronization.

Smaller air motors are available for possible use on auxiliary drives, but we have not yet used them.

CHARACTERISTICS OF THE AIR MOTOR

The air motor is a low-horsepower unit with large ratio internal gearing to produce a low-speed high-torque output.

High starting torque and high stall torque values are essential for a movable bridge drive.

To obtain these characteristics, we have generally specified a 7 HP vane type air motor with a maximum power output speed of either 52 RPM or 99 RPM.

For the 52 RPM version, the rated maximum power torque is 710 foot-pounds, the approximate stall torque is 1,200 foot-pounds, and the approximate starting torque is 960 foot-pounds.

Equating the maximum power torque of the air motor to the full-load torque of electric motors shows that the 52 RPM air motor is equivalent in torque to a 117 HP, 870 RPM motor or a 78 HP, 580 RPM motor.

The overload capability of the air motor is of the same order of magnitude as the electric motor so that equating the full-load torque of the air motor to the full-load torque of the electric motor it is to replace is satisfactory for normal operating conditions.

When the full-load torque of the selected air motor substantially exceeds the full-load torque of the electric motor it is to replace, the air motor torque can be reduced by running at reduced air pressure. This is controllable by the pressure regulator in the air line.

AIR SUPPLY

The maximum rated air consumption for the 7 HP air motor is 210 CFM at 90 PSI. This is easily provided by a truck-mounted maintenance department compressor, which is usually a 250 CFM unit.

We normally run rigid steel piping from the air motor to some convenient point at deck level of the structure, preferably on the off-going traffic side of the road for a highway bridge. The line terminates in a coupling compatible with air hoses normally used for construction tools. Lines are pitched to drain condensation. Locked covers can be provided to restrict foreign matter from entering the air line.

SPEED CONTROL

Speed control is a function of the air pressure and volume.

The pressure should be preset using the regulator in the air line. The volume is controlled by the four-way valve.

By manipulating these items in conjunction with a mechanical position indicator, reasonable control of the span can be maintained.

A tower drive vertical-lift span can be raised with twin, unsynchronized drives with only two or three corrections during the lift.

Should undesirable overhauling conditions develop, they can be controlled with a slight amount of air supplied in the reverse direction.

During air motor operation, all normal motor and machinery brakes must be in the released position, generally by the use of hand-release mechanisms.

DISCONNECT COUPLINGS

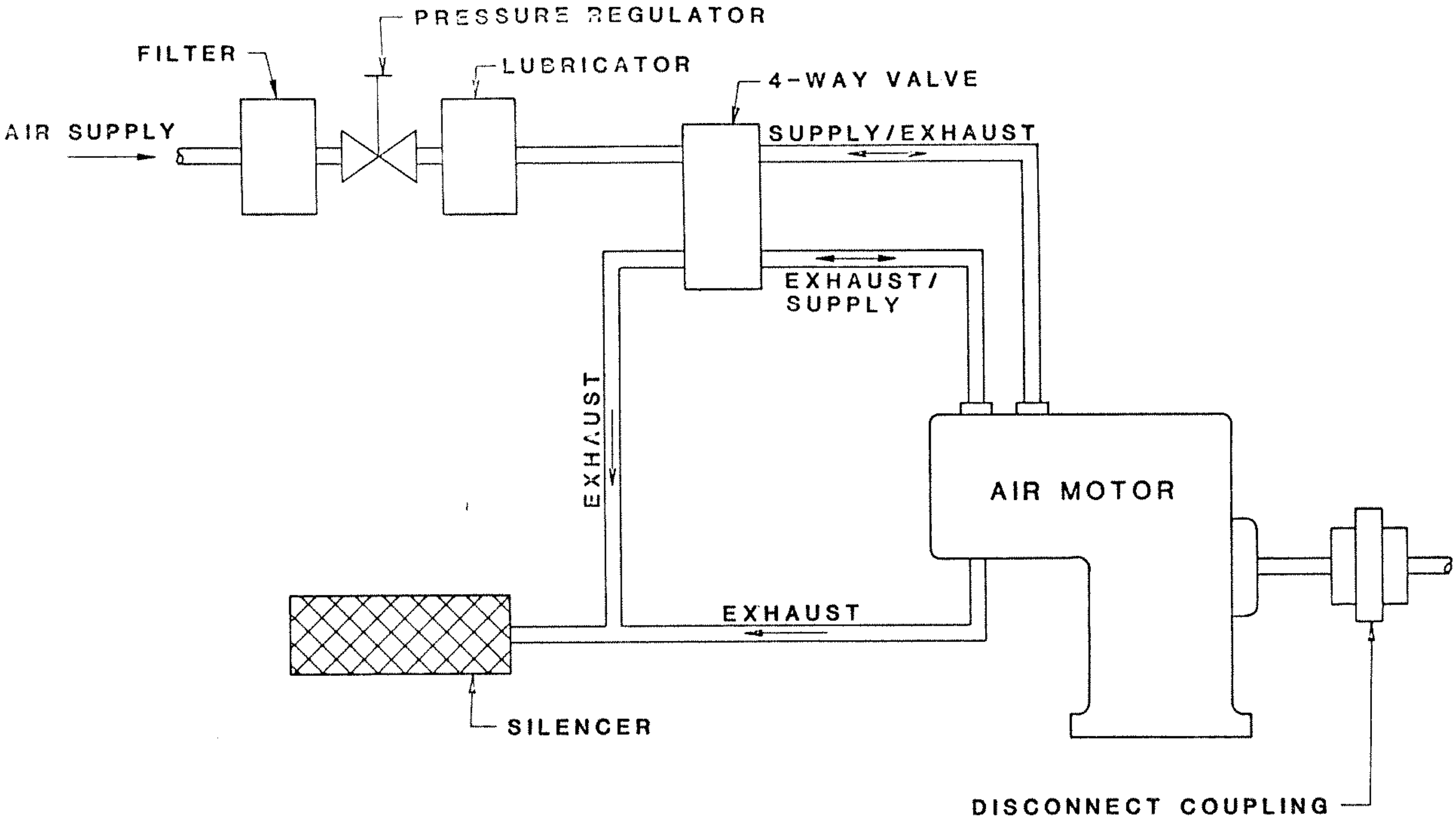
Disconnect coupling between the air motor and drive train may be of any type suitable for extended service in the disconnected position.

We have generally specified a gear type cut-out coupling with shifting lever and detent pins for positive positioning in the engaged and disengaged position. Interlock limit switches monitor the position of the shifting lever to prevent electrical operation when the coupling is engaged.

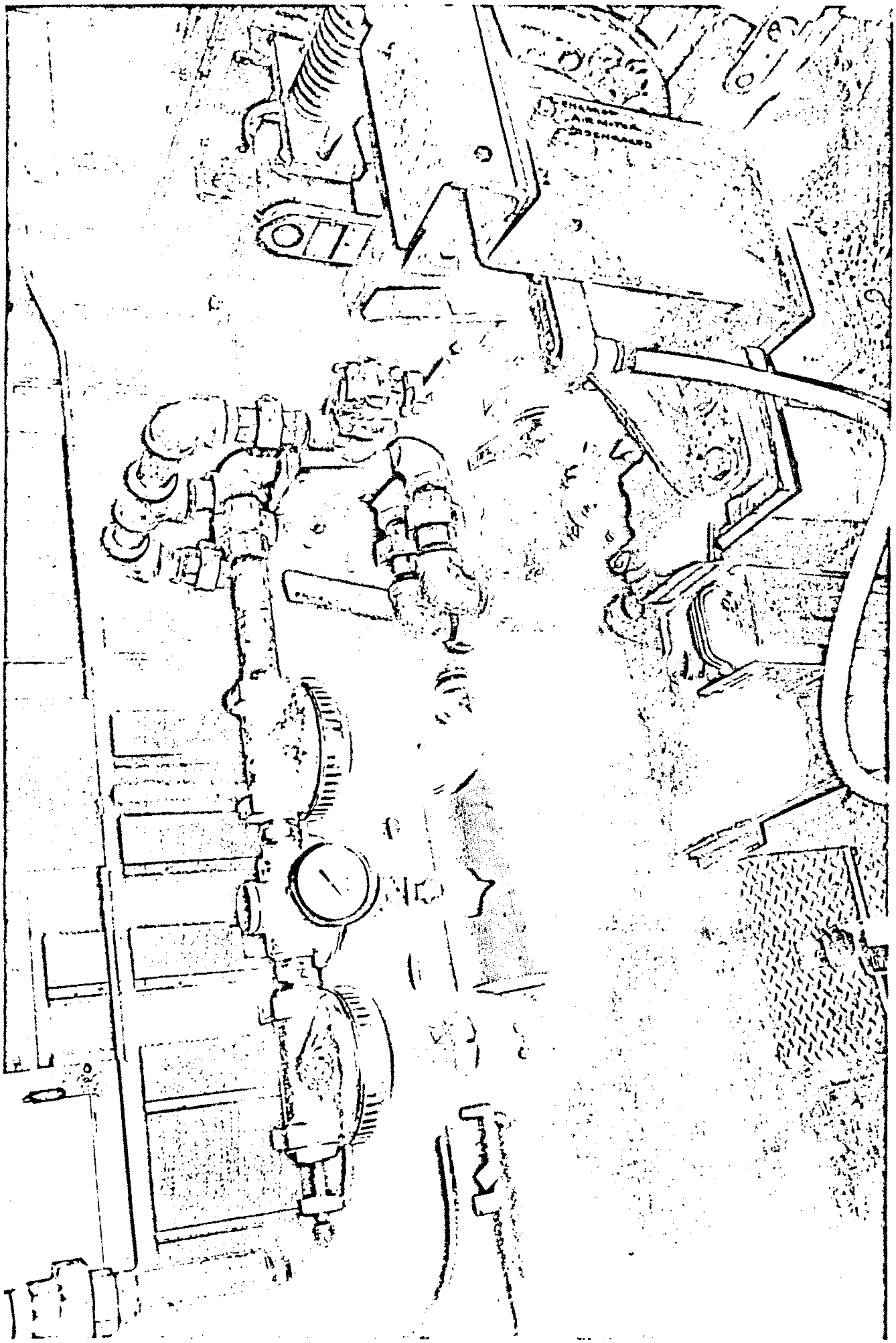
HARDWARE COST

The following costs are the approximate costs, as obtained from the manufacturer, for major items and local distributors for small items. These are purchase prices without piping, tax, shipping, or installation.

1.	7 HP, 52 RPM air motor	$2,990
2.	1-inch four-way valve	200
3.	Disconnect coupling:	
	Roller chain type	100 to
	Gear type with shifter	2,000
4.	Air line hardware	200
5.	Silencer	50
	TOTAL MINIMUM	$3,540
	TOTAL MAXIMUM	$5,440



SCHEMATIC LAYOUT
AIR MOTOR DRIVE


AIR MOTOR