ergy to the industrial installation, and cause a complete shut-down. In this connection it is noteworthy to mention that experiments are now under way to determine whether or not motors can be built to withstand full starting voltage, thus eliminating controlling devices and practically making the motors entirely independent and operative under low temporary voltage conditions. Time limt low voltage releases are now used reducing to some extent the confusion which now takes place on the occurrence of a fault affecting the consumer through temporary practically instantaneous low voltage conditions.

In the time setting of a relay scheme it has been found necessary to allow at least 1/4 of a second for the operation of the oil circuit breaker which it controls. Thus it may be seen that with a 2 second setting at the generating bus on a radial feeder which passes through sub-stations through consecutive switches, and where the relays are set to operate in sequence, not many sections of line can be controlled without introducing a higher setting at the generating bus which would be inadvisable. In situations of this kind, balanced relay schemes are used either through parallel line operation or by pilot wires where relays are located some distance apart. A very important point to consider in applying the time delay setting to a relay sequence is the characteristic curve of various types of relays individually and collectively as each curve must conform exactly with the rest in order that conjunctive and selectivity of operation may be obtained inasmuch as precision values are necessary both as to time and current settings.

A problem properly solved along the same lines as that of the calculating board in reference to the various constants and variables encountered in relay connections, covering current transformer ratio errors due to burdens carried by relays, their change in ratio caused by abnormal short circuit currents in conjunction with relay and oil switch operating variables and constants and general system factors, would more or less establish a millenium in relay engineering. But as this proposition has not yet been developed, the various problems must be studied and solved selectively, allowances made for known errors and proper general applications. Numerous relay schemes have been placed in operation each of them more or less distinctive of the systems applied to and to promote the general objective, a great number of different types and classes of relays have been designed. The relay engineer who feels confident that the scheme which he has used and the relays which he has applied to attain this objective is the one who has passed through years of operating experience and has corrected a certain amount of misdirected energy after a concentrated study of constantly changing prerequisites to a properly designed project.

A FUSIBLE ALLOY WHICH SOLDERS GLASS TO GLASS OR GLASS TO METAL

By J. W. Beams, Jr.

In many instances it is necessary to join glass to glass or glass to metal where it is not possible to heat the parts to be joined to high temperatures; and where sealing wax or other cements, which usually contain organic compounds, would either dissolve or give off vapors that would contaminate the materials under investigation. It is essential in most cases that a thin layer of the solder should be sufficiently strong to give rigidity to the joint. Another property that is of importance, if readjustment of the apparatus is likely to be made, is the ease with which the seal can be made or removed. An urgent need arose in connection with research being carried on in the Rouss Physical Laboratory for a cement which would meet the above requirements. A search among existing cements and solders did not reveal one that would serve the purpose, so it became necessary to develop a new one.

Welo[1] found that ordinary Wood's metal could be used in some cases as a seal in vacuum apparatus. This metal was tried for the present purpose but did not prove satisfactory as a small twist loosened the whole joint. Also the surface must be very thorougly cleaned before the metal will stick. However, by experimenting with various fusible alloys the writer finds that one composed of two parts by weight each of tin and cadmium and four parts each of lead and bismuth meets all the requirements. The metals are melted together in a crucible and poured, while still in the molten state, into a jar of water. The alloy solidifies in little pellets. This procedure is necessary because the alloy if allowed to cool while in the crucible sticks to its sides and cannot be removed without reheating. The surface of the glass is cleaned, although this is not absolutely essential, and the solder applied to the glass surface with a small soldering iron, which is heated just a few degrees above the melting point of the alloy. Thin coatings of the solder are applied to the two surfaces to be joined and then the final seal is made between the two coatings with more of the alloy. A good seal can always be distinguished by the excellent mirror made by the surface of the alloy in contact with the glass. The melting point of the solder is a few degrees below the boiling point of water so that if it is desired to remove the seal, it is placed in boiling water and the alloy drops off the glass leaving a clean smooth surface, or if this is not possible, the seal may be removed by moving a hot soldering iron around the joint.

1. Journal of Optical Society of America, Vol. 8, No. 3, p. 453.

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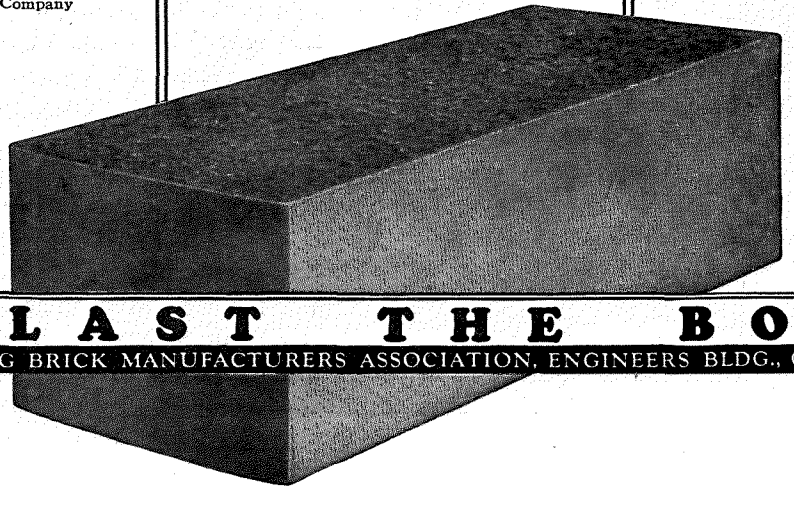


OUTLAST THE BONDS

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION, ENGINEERS BLDG., CLEVELAND, OHIO

The alloy sticks not only to glass surfaces but to metals and wood as well and therefore gives an easy means of fastening glass to metals. The joint if properly soldered is very strong. In several tests with a piece of plane glass two centimeters in diameter soldered across the end of a glass tube of the same diameter, an outward pressure of several atmospheres was applied without breaking the seal.

Steps have been taken in New Haven, Conn., to ban the use of one-man cars on the railway operating within the city limits. The reasons for such a course is an endeavor "to prevent accidents—facilitate traffic—and preserve good order and secure the safety of persons using the city streets."—*Electric Railway Journal.*

Electrification of the branch line of the Mexican Railway between Esperanza, Puebla and Orizaba, Vera Cruz, a distance of 29 miles, is now in progress. The contract was secured by an American company, but the actual work is being done by the Mexican Railway under the supervision of American electrical engineers. The work is up-grade from 4.7 to 5.25 per cent.

The overhead construction will cost approximately $250,000; the substation $250,000; and 10 electric locomotives $1,250,000. The substation will be equipped to convert 42,000-volt, 60-cycle, three-phase, high tension alternating current into a 3,000-volt direct current. Power will be furnished by the Puebla Electric & Power Company, Tuxpan.—*Electric Railway Journal.*

The ring gear was practically the first part of an automobile to receive "individual heat treatment," by means of the Gleason quenching machine. The problem of the prevention of warping during the process has been, and still is, a baffling one.—*Automotive Industries.*

The Kansas Power & Light Co., is constructing a modern power plant at Tecumseh, Kan. The initial capacity will be 15,000 kw. and a sixty-mile transmission line to Topeka and Atchison will be built to serve a population of more than 150,000. The power plant and transmission line are expected to cost in the neighborhood of $3,600,000. Both the power plant and the transmission line have been leased for fifty years.—*Power.*

An experimental engine has been built and operated in Germany that developed over three thousand horsepower per cylinder.—*Southern Engineer.*

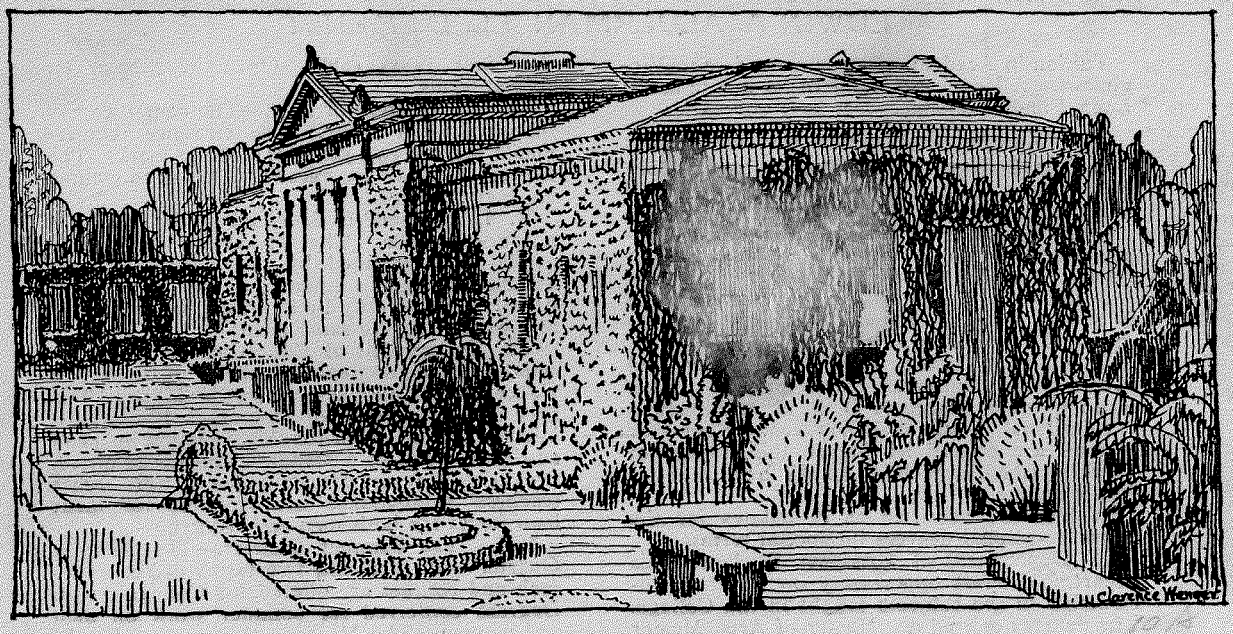
LIGHTER-THAN-AIR CRAFT

[Continued from page 149.]

the valuable water to the storage tanks. It is essential that the ship maintain as nearly constant weight during flight as is possible; so it is necessary to retain all water evaporated in the radiators of the engines. Hence the condensers for each engine. All fuel used during flight is a direct loss in weight, and this loss can only be compensated by the release of helium which is highly undesirable in view of its value. It is estimated that the ship when fully loaded carries about 2,000 pounds of water and 16,000 pounds of fuel and lubricating oil. The weight of the unloaded ship is 82,000 pounds. The crew consists of eleven officers and twenty-seven men, which, allowing about 150 pounds per man, makes up an aggregate weight of 5,400 pounds.

In the preceding paragraph we see that the total overall weight of the ship is approximately 105,400 pounds. By the laws of Physics we can find the buoyant force exerted by the 2,500,000 cubic feet of helium. This is found to be slightly greater than the load at ordinary conditions of temperature and pressure. We say *"ordinary conditions of temperature* and *pressure"* because helium obeys both Boyle's and Charles' Laws, the buoyancy being increased 300 pounds per degree rise in temperature and is inversely proportional to the barometric pressure. In connection with these facts we make reference to the trip over the Rocky Mountains, during which an altitude of 7,500 feet was necessary. To reach this altitude a twofold problem presented itself. When the barometric pressure is low, as it is in high altitudes, the gas expands; but the density of air at the same altitude is proportionally less, and the temperature is lower; so in order to successfully maintain sufficient height the horizontal rudder had to be turned at a downward angle, which is not safe because the fore end of the ship is tilted upward. This brings up the fact that in case of any accident to the engines or flying gear the ship would settle to the earth. In this event the ship would be demolished due to inadequate landing equipment. However, to overcome this difficulty ballast consisting of water, fuel, and oil can be dropped. The loss of any of the above mentioned, will complicate the situation still more; therefore a problem is here presented, that is still to be solved in the field of lighter-than-air machines.

The precision that is reached in handling this machine is evidenced by an account of the operations gone through in casting off from its mooring mast. The machine is first towed out of its hangar by a crew of three hundred men. It is then affixed to a conical receptacle at the top of a mast of approximately 140



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