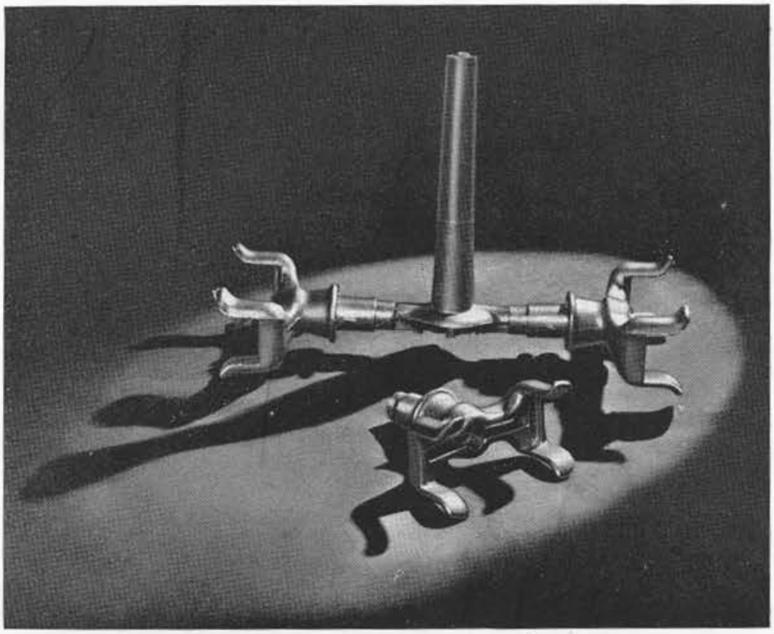

Die Castings

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Telephone Apparatus Development

THE term "die castings" as used throughout the engineering world is applied to both pressure and gravity mold castings. Pressure die castings, which are more adaptable to quantity production necessary for telephone equipment, are cast by forcing the molten metal from the melting pot into the die by air or hydraulic pressure. The alloy, obtained in ingot form, is melted in a melting pot or iron pressure retort, and is then forced through a goose neck into the die, filling the gate, vents, overflow cavities and various runners which lead the metal to the various impressions in the die which are to be fabricated.

After a short period of time during which the die is continuously cooled by water, the molten metal solidifies and the cast part is ejected from the die. The machines used in this process are called automatic or semi-automatic, depending on the manner in which the die is opened and closed during the charging operation as well as the method employed for ejecting the casting. After ejecting, the casting is then ready to have the gates, vents, overflow cavities and fins removed, after which the necessary finishing operations, such as machining and plating, are carried out. The alloys most generally used for die castings are of lead, zinc, tin or aluminum base.

The choice of a proper steel for a die is very important and is one of the most essential factors in maintaining an efficient plant as well as close control over the quality of output.

Most dies for casting aluminum alloys are manufactured from a chromium-vanadium steel which is usually given a special heat treatment. The American Society for Steel Treating has set up a temporary practice for the heat treatment of this type of die. The dies are given a protective covering of oxide or carbon which is usually applied during the tempering of the die. When the castings begin to show checks or ridges on their surfaces—which indicates a type of fatigue failure due to contraction and expansion of the die surface caused by cycles of thermal expansion as the die surface is heated by the molten metal and contraction when cooled by the water—the life of the die is practically over, for die checks are usually undesirable on the finished castings. These die checks may be observed by referring to the title page which shows receiver cups for the handset as they appear after ejection from the die. In this particular case the die has been used approximately 30,000 times and the appearance of the die checks on the surface of the castings indicate that its life is about over.

In die-casting of aluminum base alloys, a temperature of approximately 450° C. in the die itself is usually maintained. Control of this temperature is obtained by special water cooling features in the design of the die and by the use of thermocouples. If lower melting alloys than the normal aluminum base alloys are to be used, the temperature of the die should be reduced accordingly. Care in controlling the temperature results in increased life of the die.

After being ejected from the die usually little or no machining has to be done on the casting, other than tapping for screws, threading, and removal of fins. The die-casting process itself owing to the extremely high cost of the die is essentially a quantity production method of manufacture, and usually cannot be justified unless the number of parts to be made exceeds 5,000. This number may of course be considerably changed, depending on the size and shape of the desired casting.

Up to a few years ago die-cast parts were rarely used in the Bell System. This was because satisfactory alloys of uniform quality and appearance were not as yet developed. Recently, however, the advisability of die casting apparatus parts has been given greater consideration than in former years. The large multiplicity of apparatus parts in the telephone plant presents certain production problems of which die castings are the obvious solution. Owing to the increased use of die castings throughout the country, the manufacturers have been forced to devise methods of increasing both the quality and production of these parts. It was realized

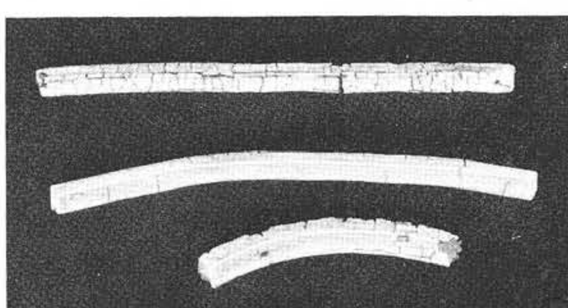

Fig. 2—An exhibit from the investigations now being carried out by the Laboratories on aluminum and zinc-base alloy. Some test specimens showing corrosion and disintegration under exaggerated weathering tests

that numerous parts could be die cast from commercial alloys now in use, but no information was available with respect to the possible variations in the physical properties of these alloys such as strength, impact, corrosion resistance and changes in linear dimensions. Although marked improvement has been made within recent years, the need of specifications for alloys from which apparatus parts are to be manufactured has been felt very seriously.

For quite a few years the Laboratories have been investigating the properties of various die-casting alloys. In addition we have recently participated jointly with the Western Electric Company in an investigation conducted under the supervision of the American Society for Testing Materials.* Studies of the physical properties of aluminum- and zinc-base die-cast test specimens are being made with the expectation of setting up engineering requirements for these alloys. Programs covering an investigation of lead- and tin-base alloys will also be under way within a short time. Studies of shelf-life aging, and variation of the physical properties under outdoor corrosion are being conducted as well as determination of the effect of high temperatures on the physical properties such as may be encountered during a japanning operation.

The use of die castings presents important problems of apparatus design. In choosing an alloy the designer must study the relationship of the number of parts to be made and the cost of the individual part when completed. Tensile and impact strength, resistance of the alloy to warpage and change of linear dimensions, corrosion resistance, ease of machining and subsequent finishing operations such as riveting, polishing and plating, the weight of the finished part must all figure in the selection of the alloy. The plating process is a problem not without its difficulties and extensive studies are now being conducted by our Laboratories in types and methods of plating.

In addition the designer must determine whether or not the part may be produced cheaply and in quantity. Production in the mill may be seriously interfered with if the alloy chosen has a corrosive effect on the die, for the cost per part will be raised considerably if the die is ruined after a comparatively small number of castings are made. Other features such as "hot shortness", — where the alloy lacks high tensile strength at the temperature at which the part is ejected from the die — play

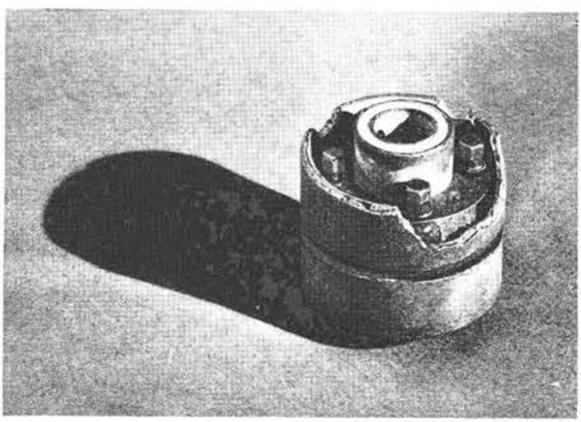

Fig. 3—A coupling for sound-film equipment subjected to accelerated weathering tests. The break in the shell occurred when the coupling was dropped from a 15-inch height

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a very prominent part in the quality of output. The amount of shrinkage, porosity and tendency of the alloy to contain blowholes must also be considered. Porous castings will result from the use of alloys which have a tendency to absorb gases while these gases are being released during solidification. Some alloys cannot be used for the molding of intricate apparatus parts owing to the inability of the molten metal, despite the high pressure applied, to fill out the die completely.

The physical and chemical properties of the alloy also figure prominently in the designer's calculations. Aluminum alloys, which are generally specified when light-weight castings are desired, will disintegrate under outdoor exposure if high percentages of copper are present. The rate of corrosion of these alloys is considerably increased in industrial regions where sulphur dioxide is present in the atmosphere. In such instances, and again where good machining and polishing qualities are desired, the chemical composition must be carefully controlled. The conditions under which a part is to be used such as high temperature or vibration effects, likewise must be taken into consideration before specifying the alloy. Certain alloys cannot stand up under impact during riveting operations. Others are particularly adaptable to this process. In cases where oil or air leakage must be avoided alloys with porous structures should not be used.

Aluminum-base alloys have been introduced to the trade in the past two or three years in which slight additions of copper, nickel or silicon have not only improved to a great extent their physical properties but also have obtained increased resistance to warpage, corrosion and better machining characteristics. Zinc-base alloys are also under investigation by the Laboratories at the present time.

One of the main factors to be taken into account during the consideration of an alloy for an apparatus part is the question of machinability. The cost of the finished part will be considerably increased if the machining quality of the alloy is not satisfactory. In the case of the transmitter and receiver cups used in the molded handset this characteristic is particularly important.

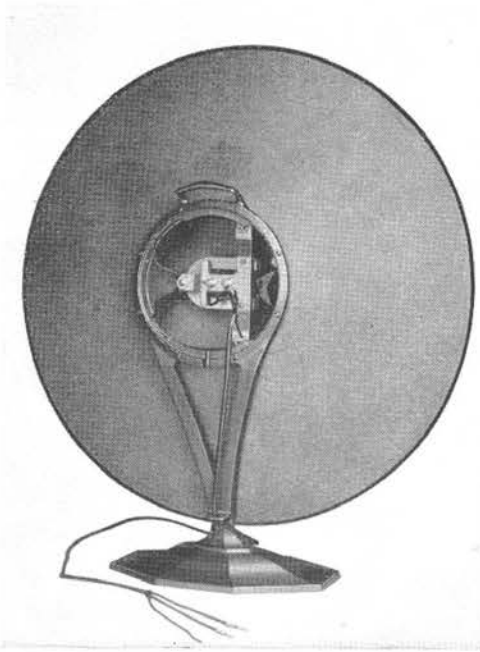

Fig. 4—Another example of die-cast products—the base and frame for the 540-AW and 560-AW loud speaking units

Other die-cast parts used in the Bell System are the base and frame for the 540-AW and 560-AW loud speaking telephones, the cradle for the molded handset, and the handset base. In Figure 3 is shown a coupling which has been subjected to an accelerated test in the laboratory to determine its relative resistance to embrittlement and corrosion. The coupling illustrated was subjected to high temperature for a period of ten days and then dropped from a height of approximately 15 inches. The results show the necessity for careful choice of an alloy. Other uses for die-cast alloys are now projected and it is anticipated that in the next two or three years the use of die-castings in the Bell System will comprise one of the important manufacturing items.

Transatlantic Rates Reduced

Under a revised schedule effective May 11, *the basic rate for telephone calls between New York and London has been reduced from* $45 *to* $30 *for the first three minutes and from* $15 *to* $10 *for each additional minute. Rates between other points will be reduced by an equal amount.*

Chief among factors enabling this reduction was the increased use of the service amounting in 1929 *to about* 60 *per cent as compared with* 1928. *There are now four two-way channels, and service is available twenty-four hours a day.*