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# DESIGN AND CONSTRUCTION OF A DIE CASTING MOULD SUITABLE FOR PRODUCTION OF VARIOUS SIZES OF KEY BLANKS

Adejuyigbe, S. B. and A. O. Oyedele
Mechanical/Production Engineering Department,
Federal University of Technology,
P.M.B. 704, Akure, Nigeria.

**Abstract.** Efforts have been made to group the various types of key that are most commonly used by the public at large. A suitable die casting method is used taking into account such limitations as the sizes of the keys, their serviceability, rate of production, as they affect the method of producing the unit price of the key blanks and the selection of materials. The new design and construction is an improvement over the existing one in use, which utilizes only one space in the mould for the production of the blank key. If the technique is put into practice, it will save the country's foreign exchange earnings and could also discourage the importation of blank keys from abroad.

**Keywords:** Die-Casting, Mould, Design, Production, Key Blanks

## 1. INTRODUCTION

Presently in Nigeria, the only means of getting most of the key blanks available in the market is through overseas placement orders. Some of the important reasons why production of the key blanks are necessary range from providing a new one for damaged keys, replacement for lost ones, total omissions of keys from the shipped package from manufacturer, to providing spare keys in case of any future eventualities.

Gordon [1] reported that the process of die-casting refers to castings made by forcing metal under pressure into a metallic cavity or die. There are two methods of die-casting;

- Gravity die casting or permanent mould casting: It is similar to sand casting except that the mould is made of metal, and is called a die.
- Pressure - die-casting: It is suitable for low and medium melting point metals and alloys.

Several aspects of die-casting methods and processes have received attention of researchers [1-3]. Some of their works include:

Material selection, which involves the use of three principal modes of die failure, related to die materials, which are heat checking, mechanical erosion and chemical attack. How the mould works, that is the melting, pouring of molten metal, casting properties of non-ferrous metals. The area of automation in die-casting, most especially the melting of solid particles in an agitated molten metal bath and automatic metal pouring.

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However, all the above-enumerated research failed to look at the adaptation of die casting into the local needs in developing countries like Nigeria. It is on this note therefore, that a research was embarked upon on such process like die-casting mould, which can conveniently produce such blanks for the keys that are abundantly available in the market at their barest minimum prices.

Hence this research aims at solving the problem of producing abundant blank keys for our local consumption in developing countries like Nigeria.

## 2. MATERIALS AND METHODS

This work was carried out at the Federal University of Technology, Akure, using the facilities and the machine tools available in the Mechanical Engineering Workshop, for the construction of the die casting mould. Heating of the metal and the pouring was done using the facilities and equipment of Metallurgical and Materials Engineering laboratory. Some of the facilities and equipment used are: Centre Lathe machine, band saw machine, vertical milling machine, different sizes of shell end mills, electric arc welding machine, electric furnace, and so on and so forth.

Some of the materials used for the keyblanks vary. The most suitable choice of them all is sorted out amongst the non-metallic alloys. The materials used for this research is aluminium alloys. Other materials that can also be used are: Zinc base alloy, magnesium base alloys, copper base alloy, lead base alloy, and tin base alloy.

### 2.1 *Die Casting Mould Design*

The gravity die-castings are made by paving way for the molten metal under the pressure provided by the gravity head into a static mould consisting of two-hinged clamp together (Fig.1). The mould has the following dimensions: 25mm thick X 163 mm long by 78mm wide mild steel plate. The mild steel is used because it has

extremely good surface finish, thus reducing the need for machining. On the mould are such features as the parting surface, gates, vent holes, locating pins for alignment, to ensure progressive solidification of the molten metal from the farthest end of the casting to the point of entry by conduction principle.

The key blank cavities are laid out, such that the longer and thicker upper parts of the keys are surrounded from this part, which can be greater than that of lower thinning section base/handle. As metal shrinks on cooling, allowances are provided in the mould cavities accordingly. The mould designs followed the patterns reported by Musuku and Mileham [4-9].

Other allowances are provided on the cavities for machining and draft allowances. As the die-cast key blanks partially stick to the die, some form of taper or draft angle ($3^0 - 5^0$) are usually allowed to ease removal.

*2.2 Die Casting Mould Construction*

The moulds constructed are shown in Plates 1 and 2. Some of the processes are described below:

*2.2.1 The Engravements in the Mould*

The creation of the mould cavity started by first cutting the block used into the two halves using power hacksaw machine. Then a vertical milling machine was then used to produce a rough surfacing on the mould. After that, the key blank cavities are engraved or milled using 6mm. 9mm, 8mm, and 5mm shell end mills. The depth of engravement was made mid-way into each of the moulds thereby leaving a parting line at the middle (Fig. 1 and Fig. 2). Then a grinding machine was used to polish the surfaces of the mould to a mirror finish.

*2.2.2 Assembly of the Mould*

The top and bottom halves of the mould are joined together with two hinges on the rear of the dies to ease the opening and closing of the mould. These types of moulds are easy to manipulate by an operator.

*2.3 Collection of Various Key Samples*

At first, various types of key were collected. in order to take their dimensions as produced by their different original manufacturer. After all the dimensional analysis it was possible to group together most of the keys as shown in Table 1 below.

This classification or grouping in Table 1 was done putting into consideration the most commonly available Keys in nearly all house doors, gates and different families of automobile.

Table 1: Classification of Various Keys

| ITEM | TYPE | MODEL USED FOR |
|---|---|---|
| A | Volkswagen family keys | Bettle, Igala, Kombi Bus, Passat, Aud |
| B | Mercedes Family Keys | 200, 220, 230, 300 |
| C | Datsun Family Keys | 120y, 180k, 180B, 140y, 200 |
| D | Glass Door | Common doors |
| E | Suzuki Family Motor Circle | 80, 100, 120, 125 etc |
| F | Union Keys | Residential/Office/Sales/Lockers/Hos Doors |

Source: Market Survey by the Author

*2.4 Selection Of The Production Method*

There are various possible methods by which an engineer or designer can manufacture the key blanks in the workshop.

However, practical experience has shown that the most economically viable option of them all is the casting method. Some of other ways of blank key production are; machining method, welding method and forging method. Looking at the most economically viable method, casting method was adopted in the research.

*2.5 The Pouring of Molten Metal*

With the two halves of the mould in horizontal position, securely clamped and slightly pre-heated, the die casting mould is now ready for filling. A steady, constant and consistent stream of the molten metal should be poured from a pre-heated ladle by gravity. After the pouring operation, the die casting mould is left for some time to allow the molten metal to solidify. The casting is now removed and smooth file is used to produce the different types of teeth on the blanked head.

The following foundry equipment and tools were used during the pouring into the mould:

(i) The blast furnace;
(ii) A pouring ladle;
(iii) Aluminium alloy ingots;
(iv) Diesel fuel and matcher;
(v) A suitable clamp (for the mould); and
(vi) A gripping pliers (for holding the mould)

## 3.0 RESULTS AND DISCUSSION

*3.1 The Results Of The Mould And The Key Blanks Produced*

The die casting mould was securely clamped and pre-heated slightly with its two halves in the horizontal position and an aluminum alloy molten metal was then poured into the mould

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cavity under the action of gravity by the use of a pre-heated ladle. The molten metal was poured

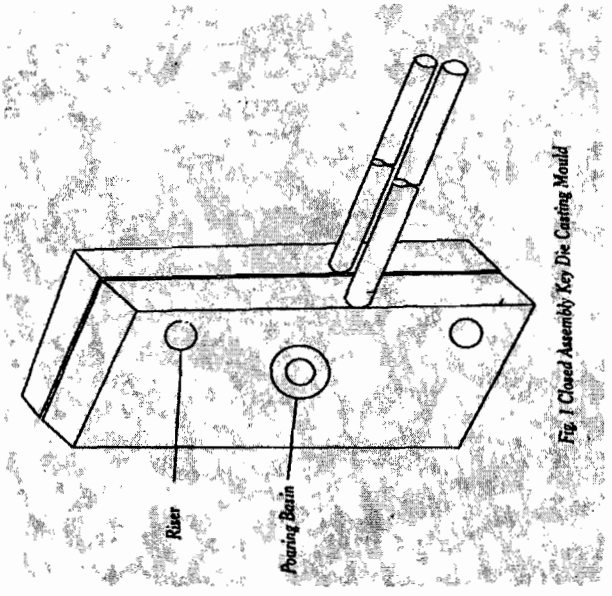


Fig. 1. Closed Assembly Key Die Casting Mould

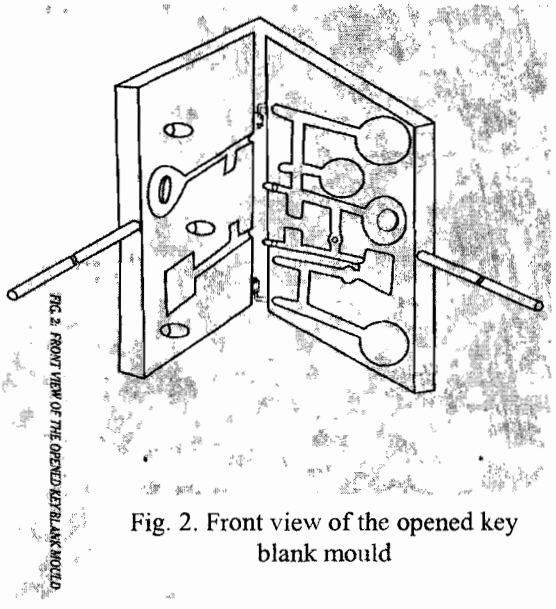


Fig. 2. Front view of the opened key blank mould

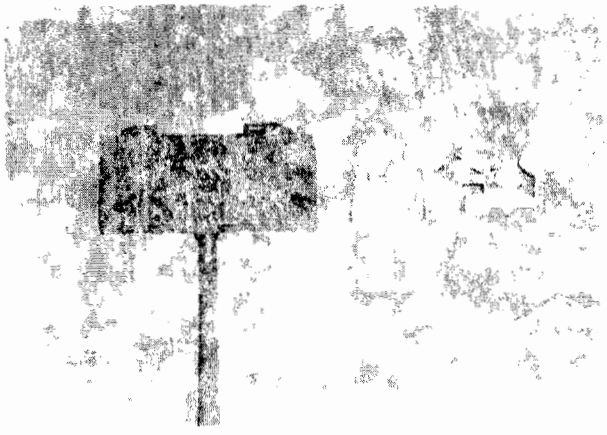

Plate 1. Mould and the blank keys

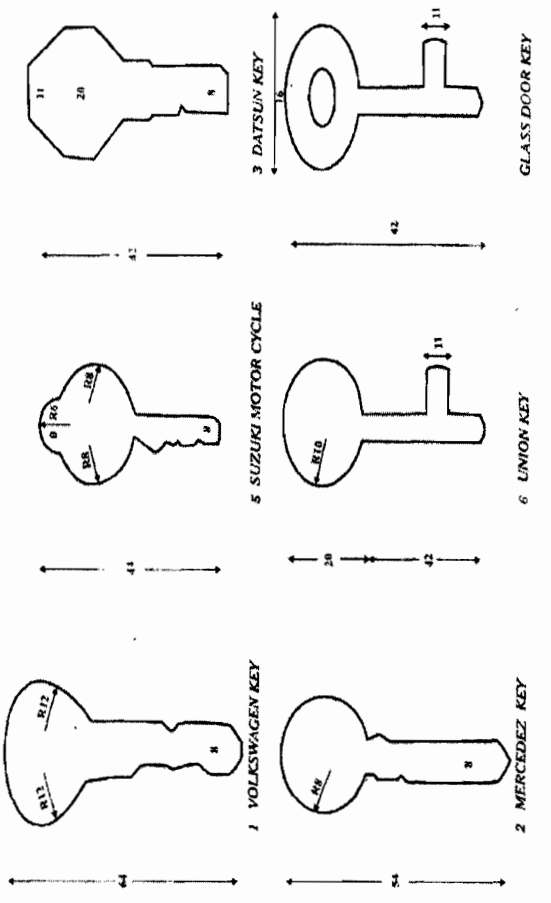


Fig. 3. Sizes of key blank are shown in

Plate 2. Interior of the mould showing different blank sizes

into the mould cavity and allowed to solidify to the required shapes of the key blanks.

After solidification, the split die was opened and the casting ejected. The different types of key blanks being cast were then separated into different shapes by the use of hacksaw ready for machining or for the use of a smooth file to produce the different types of teeth on the blanked head.

The result of the mould and the blank keys produced are shown in Plate 1. The interior of the mould showing different blank sizes is shown in Plate 2. Different sizes of key blank are shown in Fig. 3.

All the above sizes of key blank were produced using the mould shown in Figs. 1 and 2. The blank keys produced are similar to those imported from overseas.

*3.2 The Cost Implications*

The breakdowns of the overall cost of the mould are as stated below:

Variable cost or direct costs are:

| | | |
|---|---|---|
| a. | Metal used for die-casting Mould | ₦ 750.00 |
| b. | Hinges | ₦ 50.00 |
| c. | Rods | ₦ 120.00 |
| d. | Miscellaneous | ₦ 500.00 |
| e. | Drawings | ₦2,500.00 |
| | Total Direct Cost | ₦2,500.00 |

Indirect Costs are:

| | | |
|---|---|---|
| a. | Labour Cost | ₦1,500.00 |
| b. | Overhead Cost | ₦ 500.00 |
| | Total Indirect Cost | ₦2,000.00 |

Overall Cost of the Mould ₦5, 920.00

The overall cost enumerated above will be added to the cost of the molten metal used to produce the blank. The price of the keys is at ₦70.00 for door key and ₦100.00 for vehicle key. At a time the mould would produce six keys at a time.

4 Vehicle keys ⟹ 4 x 100
⟹ ₦400.00

2 Union or Glass door keys ⟹ 2 x 70
⟹ ₦140.00

Total ₦540.00

If the following operations can be performed once a day for five days in a week:

⟹ 5 x 540 = ₦2, 700.00

In a month → ₦2, 700.00 x 4 = ₦10,800.00

From the foregoing analysis, it is possible to recover the money used in building the mould and the cost of molten metal within a month. This actually indicated that one can easily break-even if one can invest in this project of casting blanks for the use of various categories already listed in work.

## 4. CONCLUSION

With the successful construction of the die casting mould, batch or mass production of various sizes of key blanks can now be made possible with a lot of ease and within a reasonable short time. The key blanks are easily marketable as they can be made for individuals who accidentally lost their original keys or anyone who just wants theirs as spares. It is also possible to supply the blanks to some manufacturing firms producing keys. This will eliminate completely the usual hardship in obtaining the "tin-god" form called "M" for overseas placement of such blanks.

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