May 26, 1964 R. M. PARKE ETAL 3,134,150

SUSPENSION SYSTEM

Filed May 16, 1962

2 Sheets-Sheet 1

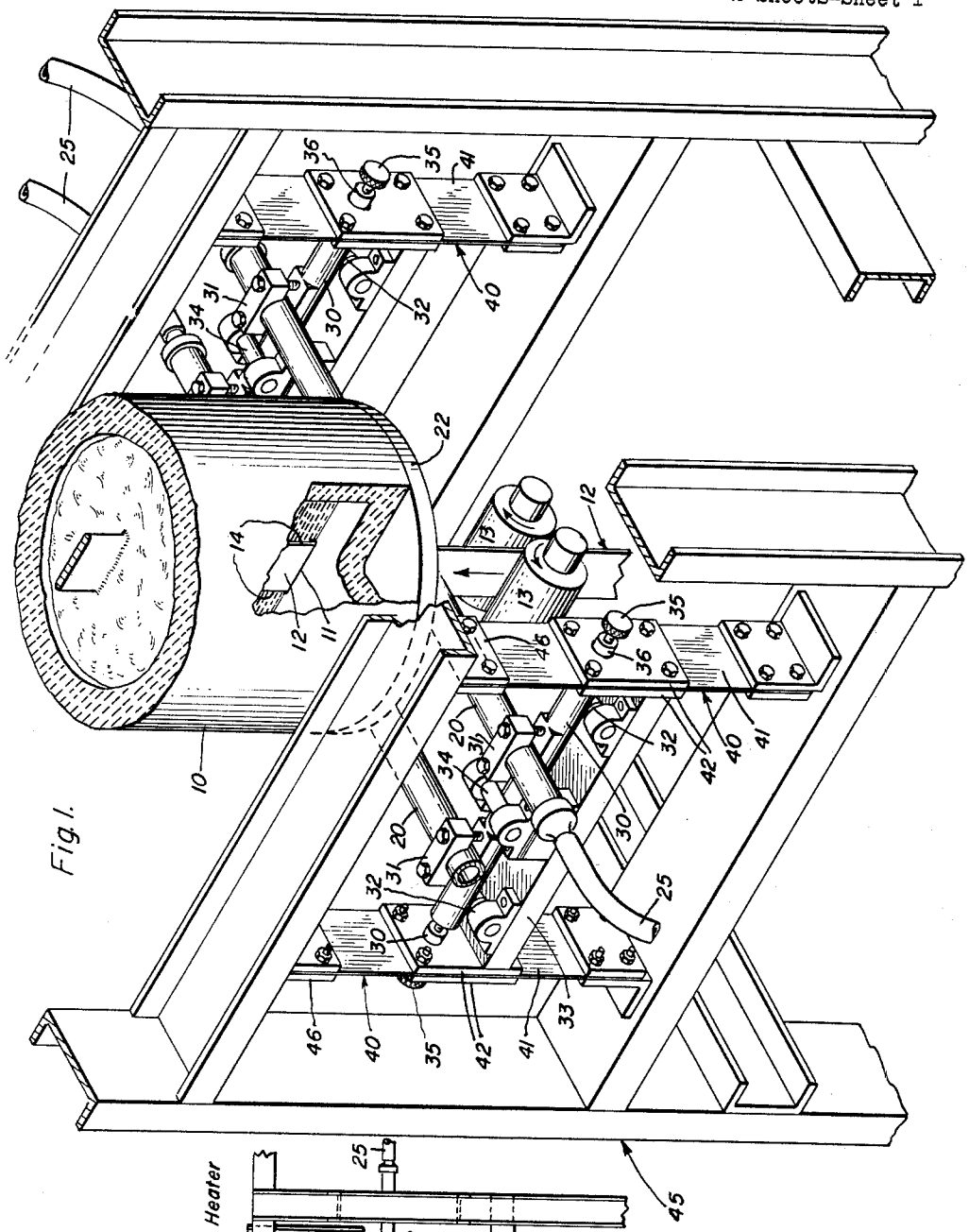

Fig. 1.

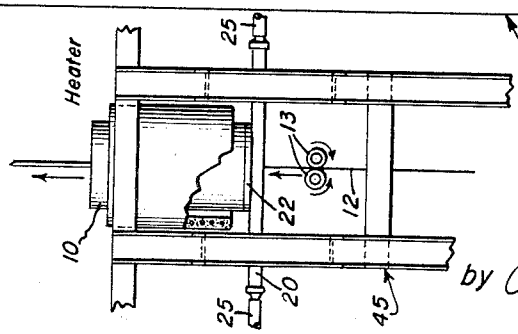

Fig. 2.

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Fig. 3.

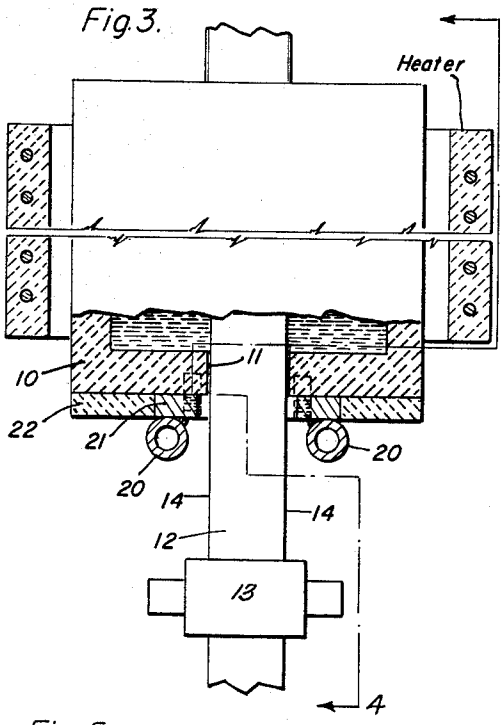


Fig. 4.

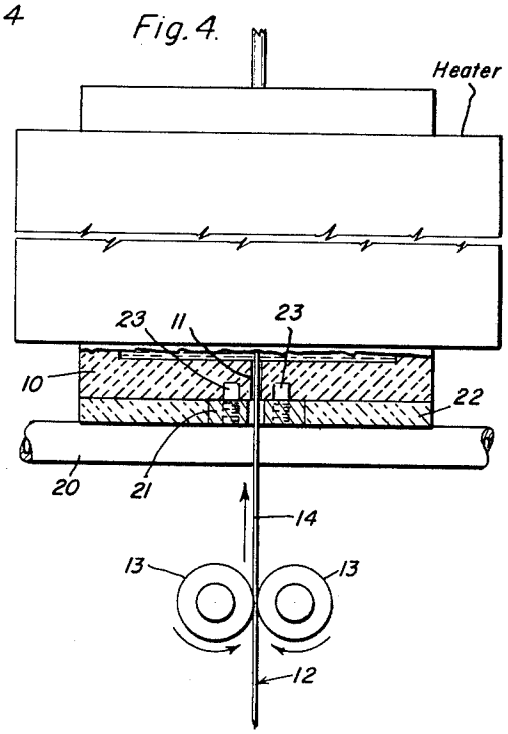


Fig. 5.

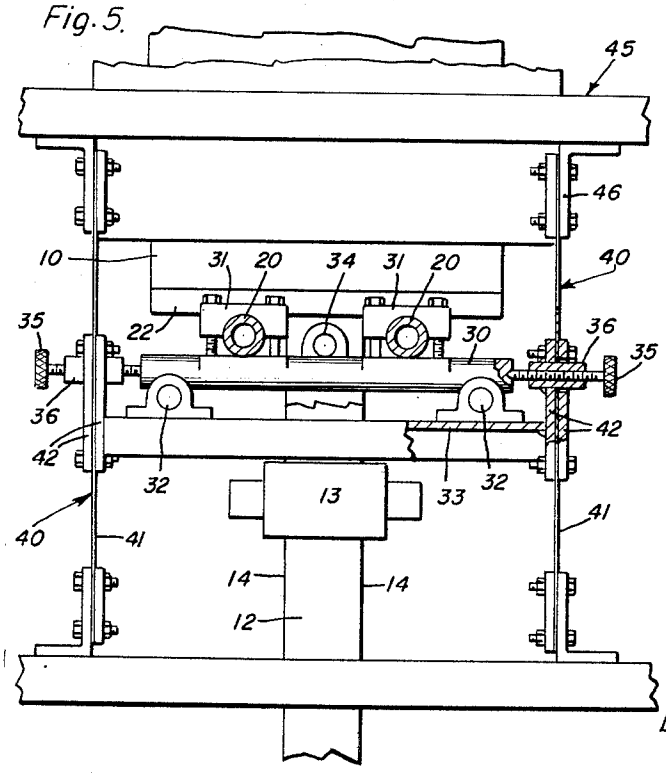
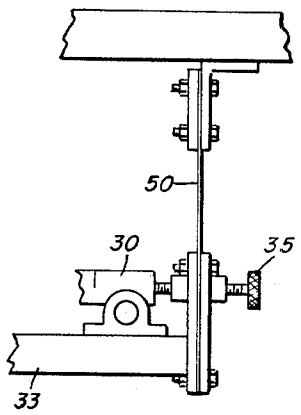


Fig. 6.



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SUSPENSION SYSTEM

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6 Claims. (Cl. 22—57.2)

This invention relates to suspension systems and more particularly to suspension systems for supporting a crucible having a bottom inlet orifice of greater lateral than transverse dimension through which an elongated strip may be passed into the interior of the crucible, whereby the crucible is moveable directionally parallel to the lateral dimension of the crucible orifice.

Strip processing utilizing a vessel or crucible having a bottom inlet orifice located below the surface of fluid contained in the crucible requires minimal clearances between the surfaces of the strip and the surfaces of the orifice to prevent fluid from escaping through the space between them. The required minimal clearances in turn necessitate comparatively accurate control of strip feeding to preclude, as much as possible, contact of the strip with the walls of the inlet orifice. However, edge contact cannot always be prevented totally since most strip contains some curvature parallel to its longitudinal direction which necessarily results in occasional contact regardless of the care taken with respect to strip feed control. Longitudinal curvature, or camber, is present to some degree in all rolled strips.

It is a principal object of this invention to provide a crucible suspension system in which the crucible is free to move in predetermined directions parallel to one dimension of a crucible inlet orifice.

Other objects and advantages of this invention will be in part obvious and in part explained by reference to the accompanying specification and drawings.

In the drawings, FIG. 1 is a partially fragmentary isometric view showing the suspension system of this invention supporting a crucible;

FIG. 2 is a partially schematic side elevation illustrating the manner in which strip is fed upwardly through a crucible;

FIG. 3 is a view showing the manner in which the crucible is mounted on the suspension system and the relationship between the strip and the crucible inlet orifice;

FIG. 4 is a view taken along the line 4—4 of FIG. 3;

FIG. 5 is a partial side elevation of the suspension system showing adjusting means whereby the crucible position can be laterally adjusted; and

FIG. 6 is a fragmentary side elevation showing a modified type of flexible suspension system.

In general, the suspension system of this invention is designed and constructed to flexibly support a crucible or similar container for liquid material in a manner such that it is free for minor movement in preselected directions. The purpose in having the crucible mounted for movement is, as previously stated, to enable compensatory movement of the crucible parallel to the transverse dimension of an elongated inlet orifice contained in the bottom thereof. Broadly, the suspension system comprises flexible support means which are mounted on

rigid structure for flexure in a direction generally parallel to the lateral dimension of the inlet orifice and crucible bearing means which are in contact with the crucible itself and are operatively joined to the flexible support means.

The general construction of the present suspension system can best be seen in FIG. 1 of the drawings, where numeral **10** indicates a crucible which has an inlet orifice **11** having a larger lateral than transverse dimension. It is apparent that the generally rectangular cross-sectional dimensions of the inlet orifice are only slightly greater than those of the strip **12** which is driven by rolls **13** upwardly therethrough. The minimal clearances existing between the walls of orifice **11** and the surfaces of strip **12** are best seen in FIGS. 3 and 4. As an example, the degree of clearance contemplated in the continous casting of steel, a steel strip .065 inch x 5 inches in cross-sectional dimensions would be separated from the orifice walls by spaces of .005 and .010 inch respectively.

Since contact between the edges **14** of strip **12** and the walls of orifice **11** constitutes a major difficulty, it is essential that some way be provided to prevent the strip either from becoming stuck in the orifice or contacting the orifice with force great enough to effect permanent damage thereof. If either of these two things occurs, then the process for coating a strip by passing it up through a suitably constructed crucible is unworkable. To surmount this problem the present invention renders it possible for crucible **10** to shift, one way or the other, parallel to the lateral dimension of orifice **11** whenever one of the strip edges **14** comes into contact with the orifice. Thus, crucible **10** is directly supported by crucible bearing means which are in turn operatively joined to support means mounted on rigid structure for flexure in a direction parallel to the lateral dimension of orifice **11**.

The crucible bearing means comprises a pair of tube-like hollow support members **20** which extend generally parallel to the transverse dimension of orifice **11**. Members **20** are joined to a metal plate **21**, which joining can be by brazing, welding or any other suitable means, and the metal plate is carried within an insulating sheet **22**, all as shown in FIG. 3. Crucible **10** sets on sheet **22** and is fixed in position by pins **23** extending up from metal plate **21**, in which they are threadably secured. It was mentioned earlier that support members **20** are hollow. This configuration is not required in all situations but is preferred when the crucible is to hold material at a high temperature, for example molten steel. Due to the great amount of heat that may be lost through the crucible walls it is necessary that some means be provided for protecting the support members from the heat. Therefore, members **20** are hollow and are connected at each end to suitable cooling fluid supply pipes **25** so that a continuous flow of coolant can be passed therethrough during operation of the apparatus. Obviously in situations where no heat is involved the tube-like construction has no particular advantage and other configurations can be substituted efficaciously. Similarly, the crucible need not necessarily rest directly on its bearing means, since the important feature is merely that it be adequately supported.

As was indicated earlier, a major difficulty confronting

processors desiring to treat strip material by passing it up through a crucible inlet orifice of greater lateral than transverse dimensions to contact it with fluid material contained in the crucible, is that of preventing contact between the edges of the strip and the orifice walls. Contact can result either from improper alignment of the strip with respect to the orifice or from strip camber. Both of these problems are met and overcome by the adjustable and flexible support means to which the crucible bearing means is operatively joined. These support means include adjusting rods **30** which extend generally parallel to the lateral dimension of the crucible inlet orifice and to which the support members **20** are secured by bolted clamping blocks **31**. This clamping arrangement prevents any movement of members **20**, other than in concert with adjusting rods **30**.

Adjusting rods **30** rest on spaced pillow blocks **32**, which are secured to an inverted length of channel iron **33**, and are held against any upward movement by roller block **34**. However, it will be seen readily that the rods **30** are free for movement in a direction parallel to the lateral dimension of the orifice **11**. The means for preliminarily adjusting each rod **30** to some preselected position, to locate crucible **10** with respect to strip **12**, comprises a pair of adjusting screws **35**. Screws **35** are threadably engaged in eyes **36** and contact the ends of rod **30**. Thus by advancing and retracting screws **35**, the rod **30** can be moved small distances in directions parallel to the lateral dimension of inlet orifice **11**. Movement of rods **30** of course effects commensurate movement of crucible **10**.

The preceding discussion concerned itself primarily with the adjustable support means which while important to correct functioning may be of less value than the flexible support means **40** which enable movement of the crucible **10**, by means of the connections previously outlined, in a direction parallel to the lateral dimension of its inlet orifice. Movement in this instance results solely from the edges **14** of strip **12** contacting the walls of the crucible orifice and may therefore be considered as compensatory. That is, whenever an edge of the strip touches a wall of the crucible orifice, either because of strip camber or otherwise, the force which the strip exerts will result in crucible movement.

FIGS. 1 and 5 of the drawings show that the flexible support means comprises generally vertically disposed comparatively thin pieces of sheet material **41**, which are, in most instances, constructed of metal (i.e. medium carbon steel) due to the weight they must support. Additionally, a pair of reinforcing plates **42** are bolted to each of the sheets near the middle thereof and it is to these sheets that channel iron **33** is attached and in which eyes **36** are mounted. The sheets **41** are mounted at each end on rigid structure **45** by means of angle pieces **46** so that the only movement which the strips can undergo is flexure, such that the midpoint of each strip **41** thus traveling in a straight line parallel to the lateral dimension of the inlet orifice.

It is apparent that if flexure of support means **40** is to occur in response to very light contacting pressures between the strip and the crucible they must be of reasonably thin cross-section. For example, for a crucible and its contents together weighing 400–600 pounds, the flexible support means would have cross-sectional dimensions of .065 inch and 5 inches and flex over a vertical distance of 10 inches.

FIG. 6 shows a modified type of flexible support in which there is no lower connection between the flexible sheet **50** and the rigid mounting structure. This construction is as effective as that just outlined with the exception that should the strip entering the crucible jam for any reason the upward pull on the crucible might bend the sheet **50**. Otherwise, the function and operation of the flexible support of FIG. 6 is the same as that discussed previously.

Although the present invention has been described in connection with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and the appended claims.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In a metal casting apparatus including a crucible having a bottom inlet orifice of larger lateral than transverse dimension, and including feed rolls located beneath said crucible for feeding elongated strip upwardly through said inlet opening, the combination of a suspension system comprising flexible support means mounted on rigid structure for flexure in a direction generally parallel to the lateral dimension of the inlet orifice, and crucible bearing means supporting the crucible and operatively joined to said flexible support means for movement directionally parallel to the lateral dimension of the crucible inlet orifice.

2. In a metal casting apparatus including a crucible having a bottom inlet orifice of larger lateral than transverse dimension, and including feed rolls located beneath said crucible for feeding elongated strip upwardly through said inlet opening, the combination of a suspension system comprising vertically disposed flexible support means mounted on rigid structure for flexure in a direction generally parallel to the lateral dimension of the inlet orifice, and crucible bearing means supporting the crucible and operatively joined to said flexible support means for movement directionally parallel to the lateral dimension of the crucible inlet orifice.

3. In a metal casting apparatus including a crucible having a bottom inlet orifice of larger lateral than transverse dimension, and including feed rolls located beneath said crucible for feeding elongated strip upwardly through said inlet opening, the combination of a suspension system comprising vertically disposed flexible support means mounted on rigid structure for flexure in a direction generally parallel to the lateral dimension of the inlet orifice, crucible bearing means supporting the crucible, and adjusting means operatively joining said crucible bearing means to said flexible support means to provide for initial positioning of said crucible bearing means and the crucible at a location on a line parallel to the lateral dimension of the crucible inlet orifice.

4. In a metal casting apparatus including a crucible having a bottom inlet orifice of larger lateral than transverse dimension, and including feed rolls located beneath said crucible for feeding elongated strip upwardly through said inlet opening, the combination of a suspension system comprising vertically disposed flexible support means mounted on rigid structure for flexure in a direction generally parallel to the lateral dimension of the inlet orifice, and crucible bearing means having a fluid conducting passage extending therethrough supporting the crucible and operatively joined to said flexible support means for movement directionally parallel to the lateral dimension of the crucible inlet orifice.

5. In a metal casting apparatus including a crucible having a bottom inlet orifice of larger lateral than transverse dimension, and including feed rolls located beneath said crucible for feeding elongated strip upwardly through said inlet opening, the combination of a suspension system comprising sheet-like flexible support means secured at opposite ends to rigid structure for flexure in a direction generally parallel to the lateral dimension of the inlet orifice, crucible bearing means supporting the crucible, and means operatively connecting said crucible bearing means to said sheet-like flexible supporting means for movement directionally parallel to the lateral dimension of the inlet orifice.

6. In a metal casting apparatus including a crucible having a bottom inlet orifice of larger lateral than transverse

dimension, and including feed rolls located beneath said crucible for feeding elongated strip upwardly through said inlet opening, the combination of a suspension system comprising a pair of parallel sheet-like vertically disposed flexible support means mounted on rigid support means on opposite sides of the crucible for flexure in a direction generally parallel to the lateral dimension of the inlet orifice, crucible bearing means supporting the crucible, rigid means connecting the parallel sheet-like flexible support means of each pair of said means, and adjustable connecting means carried by said rigid connecting means providing for initial positioning of said crucible bearing means at a location on a line parallel to the lateral dimension of the crucible inlet orifice.

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