July 12, 1966 S. J. RUDY ETAL 3,260,509

JET VIBRATOR

Filed May 14, 1964 2 Sheets-Sheet 1

FIG. 1

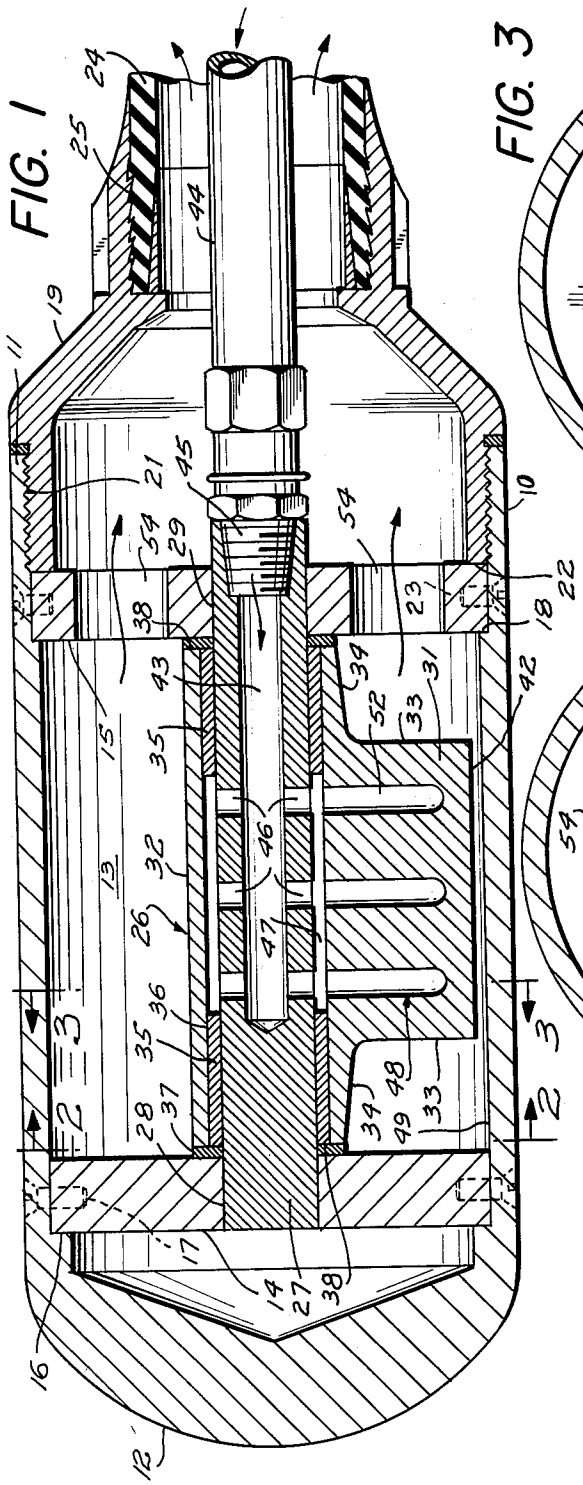
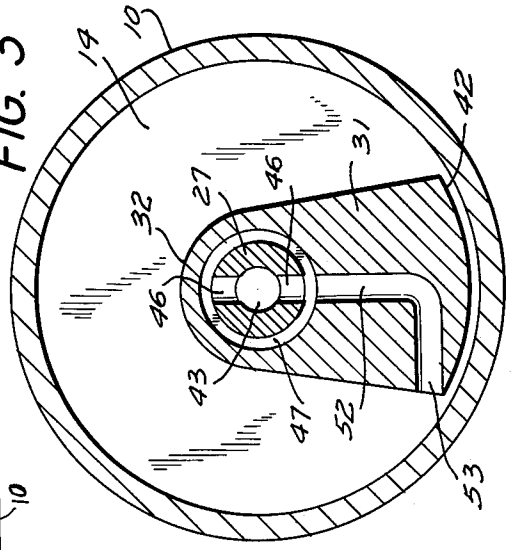


FIG. 3



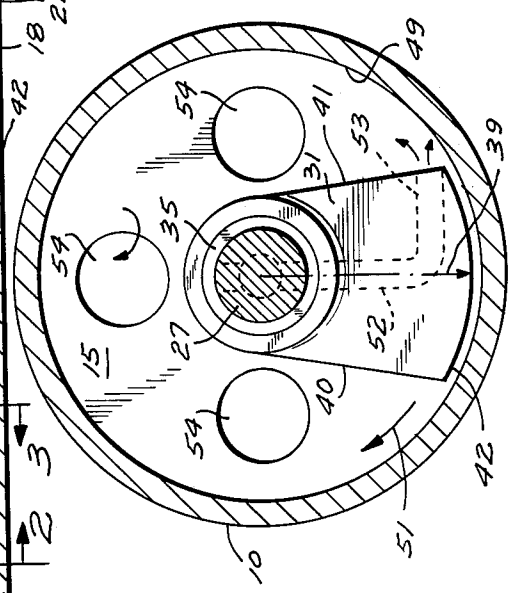


FIG. 2

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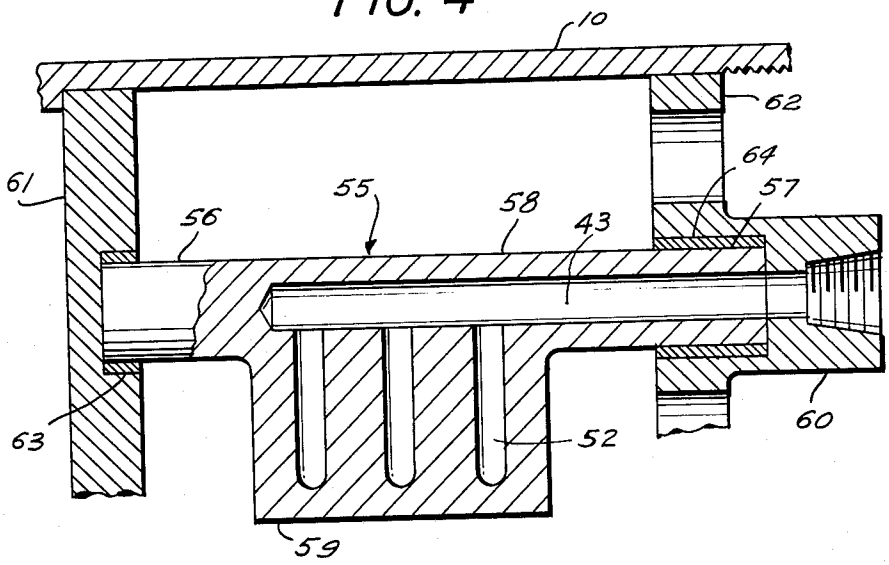
FIG. 4



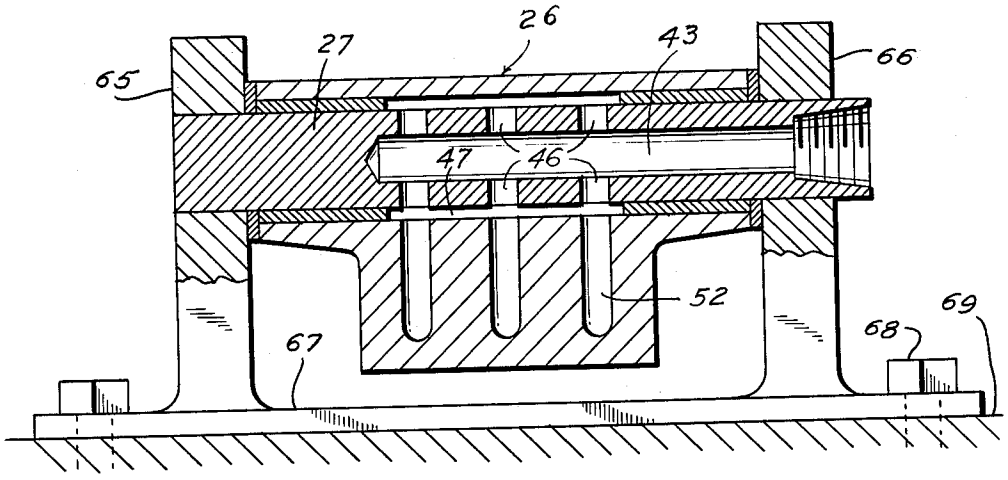


FIG. 5

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JET VIBRATOR

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4 Claims. (Cl. 259—1)

This invention is concerned with a pressurized fluid operated vibrator utilizing a jet reaction principle of operation.

Pneumatic vibrators are known wherein pressurized air is fed into a chamber tangently relative to the surface of a hollow open ended cylinder therein so as to cause the latter to roll eccentrically about a stationary core of relatively reduced diameter. In such vibrators, much of the driving energy of the operating air is wasted when the roller obtains a position on the core below and out of tangent relation to the entering air stream. Other pneumatic vibrators are known wherein a fixed core is provided in a rotor chamber and has a radially slidable blade, over which blade and core a hollow open ended cylinder is caused to eccentrically roll as pressure air is fed radially through the core to one side of the blade into a space between the cylinder and the surface of the core. In this type of vibrator the blade is subjected to undesirable frictional wear and jarring by the gyrating cylinder. Close bearing tolerances at the open ends of the rotating cylinder relative to the end walls of the rotor chamber are also required to avoid undesirable air leakage to exhaust ports formed in an end wall of the device.

The general object of the present invention is to provide a jet powered vibrator which fully utilizes the energy of a pressurized medium in driving a vibration producing eccentric rotor; which substantially eliminates close tolerance fits in its construction; which will operate satisfactory in any position of repose; and which has no dead-center or stall position.

A particular feature of the vibrator of the present invention is a rotor weight eccentrically supported for rotation upon a stationary shaft, about which shaft it is adapted to be propelled by the reaction forces produced by air jet discharged through orifices in the rotor.

A feature of the rotor lies in the particular arrangement of the jet orifices whereby the thrust reaction produced by the discharging jets is substantially expended in driving the rotor about its axis.

Another and more particular object of this invention is to provide a vibrator having a jet propelled out-of-balance rotor.

And a further object is to arrange in the rotor jet orifices in such manner that the thrust produced by the discharging jets is largely utilized in propelling the rotor about its axis.

A further feature of the rotor is that it has a full annular bearing support upon the surface of the shaft about which it turns, so that there cannot be any undesirable sudden dropping or pounding of the rotor in a radial direction relative to the shaft at the termination or start of the rotor action, as may occur in those vibrators wherein a hollow cylinder of large diameter rotates eccentrically about a shaft of substantially lesser diameter.

Further, the particular construction of the rotor of the present invention and its relation to its supporting shaft enable it to rapidly develop high speed and to impart vibrations of high frequency and strong amplitude to its casing. This advantage makes the vibrator of the present invention desirable for use in settling fresh concrete, particularly concrete having a heavy mix wherein vibrations of strong amplitude are desired to overcome the resistance offered by the heavy mix.

Accordingly, a further object of this invention is to provide a fresh concrete mix pneumatic vibrator incorporating the various features and advantages above mentioned.

Another object of the invention is to provide a pressurized fluid operated vibrator which is of extremely simple construction, of low cost manufacture and maintenance, and which is of rugged construction.

The invention further lies in the particular construction and arrangement of its component parts, as well as in their cooperative association with one another to effect the objects intended herein.

The foregoing, as well as other features, objects and advantages of this invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings wherein an embodiment of the invention is illustrated. It is to be expressly understood, however, that the drawings are for purposes of illustration and description, and they are not to be construed as defining the limits of the invention.

In the accompanying drawings:

FIG. 1 is a longitudinal section through a jet propelled vibrator embodying the invention;

FIG. 2 is a section taken on line 2—2 of FIG. 1;

FIG. 3 is a section taken on line 3—3 of FIG. 1;

FIG. 4 is a modification of the invention; and

FIG. 5 represents a further modification of the invention.

In the accompanying drawings illustrating the invention there is disclosed (FIGS. 1–3) a vibrator having a cylindrical casing or shell **10** which is open at its rear end **11**, and is closed at its front or bottom end by means of a nosed wall **12**. A cylindrical rotor chamber **13** is defined in the casing between a pair of parallel cylindrical end walls **14** and **15**. These walls are stationary with the casing being restrained in suitable manner against relative axial and rotational movement. The end wall **14** is shown here as seated upon an annular internal shoulder **16**. Restraining means, such as screws **17**, hold the end wall **14** to the casing against relative axial and rotational movement. The opposite end wall **15** is seated upon an annular internal shoulder **18** of the casing. An exhaust hose fitting **19** screwed into the open end **11** of the casing, as at **21**, is drawn tight so that an end wall **22** of the hose fitting abuts the end wall **15** and holds the latter tightly seated upon the shoulder **18**. Further restraining means, such as screws **23**, may be used to insure the end wall **15** against axial and rotational movement relative to the casing. A flexible air exhaust hose **24** is clamped fast, as at **25**, to the fitting **19**.

An out-of-balance or eccentric rotor **26** is rotatably supported within the rotor chamber upon a stationary shaft **27**. The shaft extends axially through the rotor chamber, and is rigid at its ends **28** and **29** with the end walls **14** and **15**. The rotor **26** is a one-piece structure having a central body portion **31** of generally triangular configuration, as best seen in FIGS. 2 and 3. The apex part **32** of this body portion is elongated at opposite ends beyond its end faces **33**, as indicated by the generally cylindrical portions **34**. The rotor is supported upon the shaft for rotation by means of bushings or sleeve bearings **35** which are fitted in opposite ends of a bore **36** of uniform diameter extending through the cylindrical portions **34** and apex **32** of the rotor. Suitable washer bearings **37** may be disposed between the end walls **14**, **15** and the corresponding ends of the rotor to avoid end play of the rotor relative to the end walls. The bearings **35** and **37** may be of the lubricant impregnated type. The sleeve bearings **35** are elongated and thus provide a broad area of support for the rotor upon the shaft.

The structure and relation of the rotor to the shaft is such that it swings very easily thereon. It is supported

in stable equilibrium upon the shaft. The shaft is preferably highly polished so as to reduce to a minimum friction between it and the rotor bearings. The end walls **38** of the rotor are also highly polished and flat so as to bear with a minimum of friction upon the washer bearings **37**. The opposite sides **40** and **41** (FIG. 2) of the triangular body **31** of the rotor are equal, both being tangent at opposite points to the cylindrical surface of the apex portion **32**. The bottom surface **42** of the triangular body is arcuate, having a radius concentric with that of the shaft. The altitude of the triangular body intersects the axis of rotation of the rotor and coincides with the vertical center line as well as with the line direction of the center of gravity of the rotor, all as indicated by the arrow **39** in FIG. 2. These several characteristics of the rotor facilitate swinging of the rotor relative to the shaft with a minimum of friction and retarding forces.

The rotor is caused to swing or rotate about the shaft by means of the thrusts or reaction forces produced by pressurized medium, here, pneumatic fluid, which is fed through the shaft to the rotor and discharged as jets into the rotor chamber from the triangular body of the rotor. To this end, the shaft is provided with an axial passage **43** having an inlet at one end of the shaft. A pressure air supply flexible hose line **44**, extending coaxially of the exhaust hose line **24**, has a threaded connection **45** with the inlet end of the passage **43**. Pressure air fed to the passage **43** passes through a plurality of radial ports **46** in the shaft to an annular channel **47** defined by the rotor bore **36** about the shaft between the inner ends of the bushings **35**. The bushings **35** also serve to prevent leakage from this channel around the shaft to the rotor chamber.

Pressure air passes from the channel **47** into a plurality of jet orifices **48** in the triangular body of the rotor, from which orifices it forcefully issues in jet streams to the rotor chamber to one side of the rotor and impinges against the closely located opposing wall **49** of the rotor chamber. Thrusts or reaction forces produced by the discharging jet streams act to propel the rotor about the shaft in the direction indicated by the arrow **51** (FIG. 2). The jet orifices **48** are of a particular construction whereby the reaction forces produced by the discharging jets are exerted in a direction substantially at right angles to the line direction of the center of gravity, which line direction in this case is also coincident, as earlier mentioned, with the vertical center or altitude of the rotor as well as the radius thereof. Here, three jet orifices are disclosed. Each comprises a first vertical passage **52** which communicates at its upper end with the annular channel **47**, and the axis of which passage coincides with the vertical line direction of the center of gravity. At its lower end, the vertical passage communicates with a second, or discharge passage **53** extending substantially at right angles therefrom and opening out of the side **41** of the rotor body. The discharge end of the jet orifice is preferably located at the lower extremity of the side **41** of the body of the rotor so as to obtain a greater mechanical advantage than would be provided by the reaction forces if the discharge opening were closer to the center of rotation of the rotor. Provision is afforded by means of a plurality of ports **54** in the end wall **15** to allow rapid exhaust of the discharging jet streams from the rotor chamber to the exhaust hose **24**. As a consequence of its construction, the rotor rapidly develops a high speed of rotation and imparts vibrations of strong amplitude to the casing.

In FIG. 4 is illustrated a modified form of the invention wherein the out-of-balance rotor **55** has a pair of trunnions **56, 57** extending integrally from opposite ends of the apex portion **58** of a central triangular body portion **59**. The trunnions support the rotor for rotation in the rigid end walls **61, 62**. The trunnion **56** at the left is supported for rotation in a bearing **63** fitted in the end wall **61**; and the trunnion **57** at the right is supported for rotation in a bearing **64** fitted in the end wall **62**. The end wall **62** is provided with an axial bossed extension **60** to accommodate a pressure air hose connection such as that shown at **45** in FIG. 1.

While the invention is illustrated in FIGS. 1–4 as housed in a casing suitable for use for immersion in and for vibrating flowable material, such as fresh concrete, the invention is, however, subject to wide commercial application. It may be used for vibrating core boxes to obtain separation of a mold; or for vibrating hoppers to facilitate the flow of small particles therethrough; or for vibrating machines or other devices as might be needed.

In FIG. 5, representing a further illustration of the invention, the rotor **26** shown in FIG. 1 is disclosed as mounted for rotation on the shaft **27** which is here supported between two end walls **65** and **66** defining upright members of a mounting plate **67**. This mounting plate may be anchored by suitable fastening means, such as bolts **68**, to a wall **69** which may be the wall of a core box, hopper, machine or other device to be vibrated.

It is understood that the end walls **65, 66** shown in FIG. 5 may be modified as taught by the showing in FIG. 4 to accommodate the form of the rotor **55** shown in FIG. 4.

It is also understood that hydraulic pressure fluid may also be utilized as the operating medium for driving the rotor.

Actual proportions of the rotor will depend upon the size of the vibrator and/or the vibratory effect desired under certain operating conditions. However, the various parameters may be easily established by use of well known engineering techniques.

While embodiments of the invention have been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes can be made in the design and arrangement of the parts without departing from the spirit and scope of the invention; it is our intent, therefore, to claim the invention not only as shown and described herein but also in all such forms and modifications as may reasonably be construed to fall within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A vibrator comprising in combination, an eccentric solid weight, restraining means to support said weight for rotation whereby a revolving radial force is produced upon the restraining means, said eccentric weight being formed to provide passageways for the conduction of a pressurized fluid therethrough and to eject said fluid so that the reactive force of the ejected fluid will cause rotation of the eccentric weight, and an elongated housing providing a chamber in which the eccentric weight is contained, the chamber being closed at one end and having an opening, said opening being arranged for connection with a hose line for conducting pressurized fluid to the eccentric weight, and conducting exhaust fluid from the chamber.

2. A vibrator propelled by pressure fluid jet reaction forces, comprising a casing having a rotor chamber open at one end, an out-of-balance rotor formed with a longitudinally extending shaft portion having a full bearing support about it for rotation in the chamber and formed with a solid body portion depending centrally from the shaft portion, the body portion being of triangular form having opposed triangular end faces and longitudinally extending side faces, inlet passage means for feeding pressure fluid through the shaft portion into the body portion, and relatively restricted passage means for causing discharge of the pressure fluid in jets from a side face of the body portion so as to propel the rotor about its bearing support by means of the reaction forces produced by the discharging jets.

3. A vibrator according to claim **2**, wherein a pressure fluid supply hose line is connected with the inlet passage, and an exhaust hose line is connected over the open end of the chamber in coaxial surrounding spaced relation to the supply line.

4. A pneumatically powered vibrator immersible for operation in fresh concrete mix, comprising a casing having a longitudinally extending chamber sealed at its bottom end and open at its top end, an eccentric rotor weight having a hub portion journaled axially in the chamber and having a solid body portion depending integrally from the hub portion, the body portion being provided with similar end faces and a pair of longitudinally extending opposed side faces, inlet passage means extending axially into the hub portion, a pressure air supply hose line extending through the open end of the chamber and connected with the inlet passage, a plurality of jet port means opening out of one side face of the body portion having communication through the body portion with the inlet passage means for causing issuance of pressure air from the said one side face of the body portion in jet streams into the chamber so as to propel the rotor about the shaft by reaction forces of the discharging jets, and an exhaust hose line connected over the open end of the casing in coaxial relation to the supply line for exhausting spent air from the chamber.

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