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M. R. HUTCHISON.

MECHANICALLY ACTUATED ACOUSTIC DIAPHRAGM.

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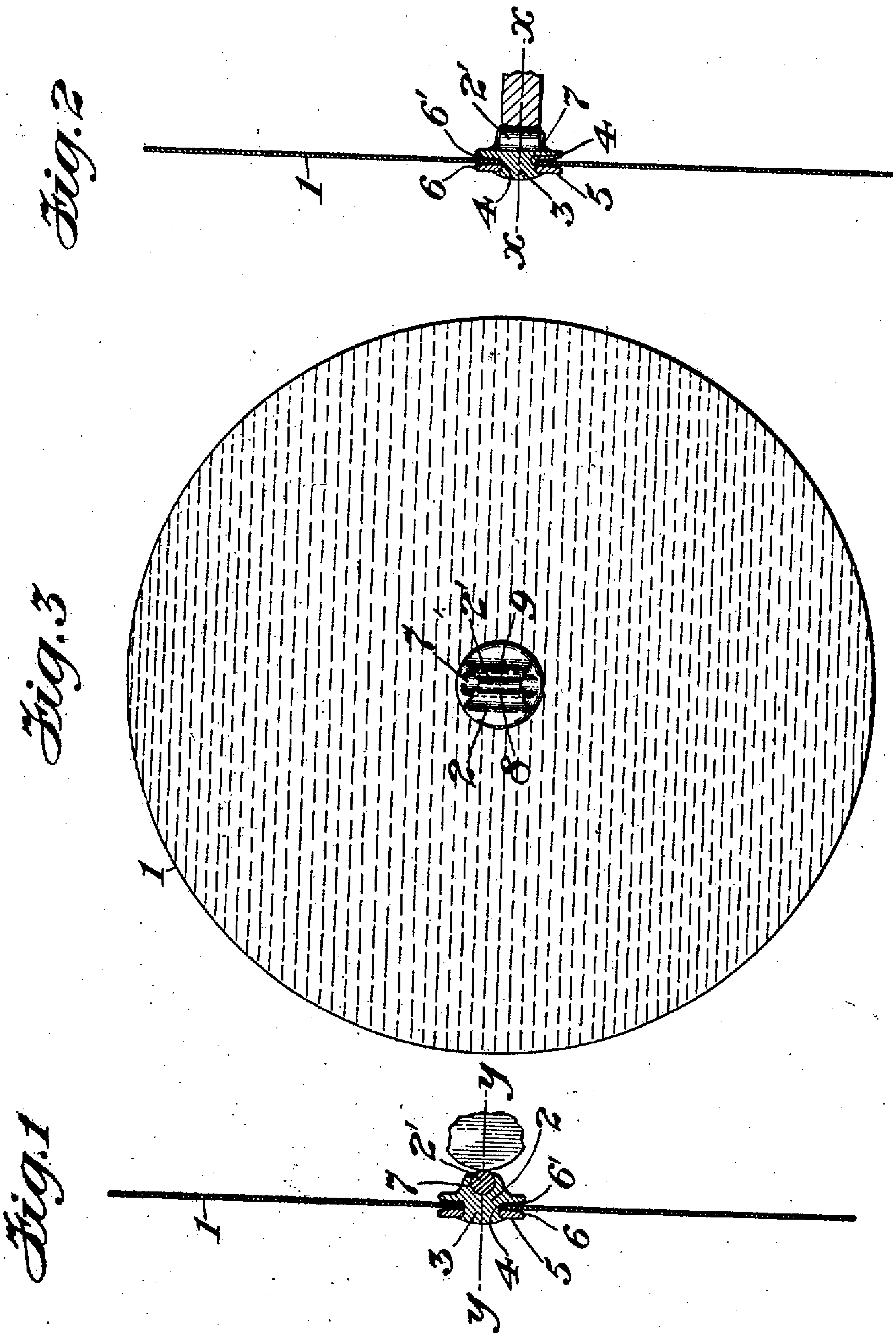

WITNESSES

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MECHANICALLY-ACTUATED ACOUSTIC DIAPHRAGM.

No. 883,643. Specification of Letters Patent. Patented March 31, 1908.

Original application filed May 16, 1907, Serial No. 373,946. Divided and this application filed November 26, 1907. Serial No. 403,932.

To all whom it may concern:

Be it known that I, MILLER REESE HUTCHISON, a citizen of the United States, and a resident of Summit, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Mechanically-Actuated Acoustic Diaphragms, of which the following is a specification.

This invention relates to signals or alarms, particularly such as are intended to perform functions similar to those of fog signals, boat whistles, automobile horns, etc.

It relates particularly to that class of such signals or alarms in which the sound wave is generated by a diaphragm adapted for forcible bodily displacement by mechanical means.

In one of my prior applications, Ser. No. 305,933, filed March 14, 1906, I have disclosed and have made broad claims to the basic features of the mechanically displaced diaphragm alarm or signal, and also claims for the broad combinations in such devices of a cam as the actuating member for effecting the forcible bodily displacement of the diaphragm. In said prior applications, I have disclosed and claimed various forms of connection whereby relatively great power may be applied through the cam or other driving member to the diaphragm so as to produce a signal of great volume without causing excessive wear and tear. Furthermore, in my more recent application, Serial No. 373,946, filed May 16th, 1907, I have shown and described the specific details of construction herein shown, and it is to be understood that my present application is a division of said application Serial No. 373,946, and is intentionally limited to certain specific features. The various broad combinations and the broad inventions are claimed in the several prior applications referred to.

In devices of the above type, it is desirable to mechanically apply the power in such manner as to insure high velocity and great amplitude of bodily displacement in a direction perpendicular to the diaphragm and at the same time to minimize the production and destructive effects of vibratory stresses in other directions. When such devices are made of ample proportions and capable of utilizing considerable amounts of power, as is necessary for the above described purposes the forcible bodily displacement of the diaphragm may be simply and economically effected by means of a driving member which may or may not move in a direction exactly normal to the surface of the diaphragm. If the power of the driving member is applied to the diaphragm through the medium of a cam projection having a movement across the face of the diaphragm at the point of contact therewith, as in the case of a rotary cam, the direct frictional wear and concussion of the cam may be resisted by forming or providing the diaphragm with a wear piece which may be an anvil with a face of hardened steel. I have discovered, however, that there may be a further destructive effect of concussion or vibration as well as of localized bending due to the velocity and amplitude of the forcible bodily displacement, by which effects the metal of the diaphragm may be quickly fatigued and ruptured. This seems to be due to the fact that notwithstanding all refinements of adaptation of shape and construction of driving member to driven member, the high velocity of the movements and considerable amounts of power transmitted, give rise to various localized bending and vibratory stresses, some of which are not developed at lower speeds, and which at the higher speeds may be of pronounced character and destructive effect.

I have discovered that disruptive wear and tear of the diaphragm from various causes, including those above suggested, may be obviated by convexing or rounding off the anvil faces where they contact with the diaphragm so as to prevent fatigue and cutting action, which I have found results from violent localized bending and other effects of the high velocity movement and vibrations of the parts where the contact faces are plane and their peripheral edges sharp. The rounding of the edges or convexing of the surfaces of the contact of the anvil with the diaphragm, is especially important on the sides which lie in the direction of transverse movement of a driving member, and the convexing may be decreased or even omitted in directions at right angles thereto; but it is usually preferable to extend the rounding or beveling more or less uniformly around a complete annulus extending a greater or less distance toward the center of each clamping face.

A second feature of my invention consists in a special arrangement of a diaphragm formed with a tough grain or fibrous structure, the fibers being approximately parallel with each other and with the surface of the diaphragm. A suitable material for such a diaphragm is steel of fine quality formed by the rolling process. Such material is very much tougher in any other direction than it is in a direction at right angles to the fiber, and one feature of my invention consists in so arranging matters as to make certain that where the direction of movement of the driving member has any lateral component not normal to the diaphragm, such component or components will take effect in the general direction of the fiber, rather than transversely thereto.

While I fully show, describe, and point out in the appended claims certain novel features of construction, arrangement, and operation which characterize my invention, it will be understood by those skilled in the art that various omissions, substitutions, and changes in the forms, proportions, sizes, and details of the device and of its operation, may be made without departing from the terms of my claims.

My invention will be more fully understood in connection with the accompanying drawings, in which

Figure 1 is a section taken on the line $x—x$ Fig. 2; Fig. 2 is a section on the line $y—y$, Fig. 1, and Fig. 3 is a face view of the diaphragm showing the anvil in plan.

The diaphragm 1 may be of any suitable material, but is preferably of tough metal, and if of corrodible material, may be formed or provided with a protective covering. The diaphragm need not be of pure iron, because it is not intended for purposes involving electric or magnetic action. I find that fine quality sheet steel is a good material. The rolling process gives a hard surface finish tending to resist corrosion. I have discovered that rolled steels having a fibrous structure such as vanadium, nickel, or nickel-chrome steel, particularly those varieties having great elasticity and freedom from crystallizing tendency are very satisfactory materials, when arranged and used in accordance with my invention.

Since the diaphragm is intended for high velocity operation giving rise to relatively great instantaneous stresses, it is preferably made of ample diameter and thickness. It is provided with special means for protecting it against damage by action of the driving member which applies the power thereto.

As shown in the drawing, the power is applied through contact with or impact upon a wear piece 2′ of anvil 2. This is preferably a separate piece of self-hardening steel, suitably secured to the diaphragm and not integral therewith. One feature of my invention consists in special construction of means for attaching the anvil to its diaphragm. The connection consists of a projection or shank 3, extending through a perforation 4, in the diaphragm, and secured on the backside thereof and preferably by permanently upsetting or deforming one of the engaging members, as by riveting the material of the shank over a washer or nut 5 surrounding the shank. The shank serves to center the parts in operative relation to the diaphragm and functionally it constitutes a tension-member to withstand the lateral displacing effort of the cam or other striking member and of the inertial stresses which result from the vibration of the parts. As shown in the drawing, the shank 3 is itself malleable and is riveted over the washer 5 so as to hold the wear piece tightly clamped to the diaphragm. Whatever may be the specific means employed for holding the wear piece or anvil secured to the diaphragm, it is extremely important that the edges of the faces of the two coöperating members adjacent the diaphragm, be rounded as at 6 and preferably convexed or beveled off, as at 6′, in order to prevent the above described destructive action on the diaphragm, which would result from sharp edges and in less degree from plane faces. By convexing or beveling the faces as well as rounding off the edges of the anvil securing members, the bending effects and vibratory stresses are less localized and are caused to take effect more gradually, being spread out in such manner as to effectually cushion their violence and lessen their destructive effects without decreasing the amplitude or velocity of the bodily displacement of the diaphragm. This feature is of great advantage even where the driving member delivers its power in a direction exactly perpendicular to the diaphragm. The convexing or beveling off of the edges may be varied both in degree and in its extent about the periphery or toward the shank 3. Preferably, however, the rounding or beveling is carried back on a straight or convex bevel forming a flat truncated cone or segment of a sphere extending nearly or quite to the shank 3. The form and extent of the variation from a true plane by convexing or beveling will vary somewhat with the size, stiffness and amplitude of vibration of the diaphragm; but one skilled in the art will understand that the space for play of the diaphragm at the free edges of the anvil securing surfaces, will preferably be sufficient to avoid too localized or abrupt bending of the diaphragm, even when it is bent by the driving to the extreme limit for which it is designed. In actual practice, the angle of the beveling or curvature of the convexing is usually less than that indicated in the drawings.

A convenient form of anvil 2 consists of a small cylinder 2′ of self-hardening steel fitted into a recess 7, and there secured in any desired manner, as by upsetting or riveting down the lips 8, 9, preferably so securely as to prevent all possibility of rotary or of endwise movement of the cylinder. By making these lips 8, 9 and the shank 3 of one integral piece of malleable metal, many mechanical difficulties and defects are avoided.

The above features of construction are of great advantage in connection with any mechanically driven diaphragm, regardless of whether the diaphragm is formed of a homogeneous structureless material, or one having a distinct grain. Where the metal has a grain, there is another feature of my invention which consists in a special directional relation between the grain of the diaphragm and the direction of presentation of the wear piece to its driving member. Indeed, the direction of the grain is equally important, whether the wear piece or anvil is a separate piece secured to the diaphragm or is formed integrally with the diaphragm. I have discovered that where the diaphragm is of rolled steel or similar grained material and the contact lines of the wear surface or anvil are parallel with the grain or fiber of the steel, the diaphragm is more likely to crack or wear out, and one part of my invention consists in so relating the anvil to the diaphragm that the impact surface is presented to its driving member in the general direction of the grain, so that when the cam or other driving member strikes the anvil, any vibratory stresses in directions other than normal to the plane of the diaphragm, may take effect in directions of greater, rather than less strength of fiber. In Fig. 3 of the drawing, I have indicated by parallel broken lines the general direction of trend of the grain of the fiber of the diaphragm. It will be noted that the wear or anvil surfaces are presented for impact in the direction of the grain of the metal, the long straight-line elements of the wear surfaces of the cylinder being directed transversely of the fiber. If the wear surface is integral with the diaphragm, the directional relation of impact with respect to the grain of the metal will be the same as above.

The surface of engagement between the diaphragm and the anvil or its securing means may be formed or arranged to tightly clamp the diaphragm at the center and to leave an annular space for play of the diaphragm engaging faces of the securing members at the free edges thereof. I have found, however, that securing members originally formed so as to have a tight clamping engagement at the center sometimes work loose, or may intentionally be arranged loosely, if so desired; but even in the latter case, if the free edges are suitably rounded, or are of sufficiently soft material so as not to have a cutting action, the device will operate satisfactorily, but the annular space for such play of the diaphragm should be predetermined by and made approximately proportional to the maximum proposed amplitude of vibration of the diaphragm when in use.

I claim:

1. An acoustic diaphragm, consisting of a sheet of rolled steel and an attached impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising clamping members on opposite sides of the diaphragm, secured in position by a tension member extending through a perforation in the diaphragm, one or more surfaces of engagement between the diaphragm and clamping members being relieved or cut away toward the periphery so as to have a decreased clamping engagement from the perforation outwardly when the diaphragm is in normal position, and to have an increased engagement with the concave surface of said diaphragm as it is flexed by application of power through said impact or wear piece, substantially as and for the purpose described.

2. An acoustic diaphragm and an attached impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising diaphragm engaging members on opposite sides of the diaphragm, secured in position by a tension member extending through a perforation in the diaphragm, one or more surfaces of engagement between the diaphragm and the engaging members being relieved or cut away toward the periphery so as to have a decreased engagement near the free edges when the diaphragm is in normal position, and to have an increased engagement with the concave surface of said diaphragm as it is flexed by application of power through said impact or wear piece, substantially as and for the purpose described.

3. An acoustic diaphragm and an attached impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising diaphragm engaging members on opposite sides of the diaphragm, secured in position by a tension member extending through a perforation in the diaphragm, the diaphragm engaging the face of the impact or wear piece being relieved or cut away toward the free edges so as to have an increased engagement with the concave surface of said diaphragm when it is flexed by application of power through said impact or wear piece, substantially as and for the purpose described.

4. An acoustic diaphragm, consisting of a sheet of rolled steel and an attached impact or wear piece for securing and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising clamping members on opposite sides of the diaphragm, secured in position by a tension member extending through a perforation in

the diaphragm, the edges of the diaphragm engaging face being rounded so as to prevent abrupt flexing or cutting action when the diaphragm is flexed by application of power through said impact or wear piece, substantially as and for the purpose described.

5. An acoustic diaphragm and an attached impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising diaphragm engaging members on opposite sides of the diaphragm, secured in position by a tension member extending through a perforation in the diaphragm, the edges of the diaphragm engaging face being rounded so as to prevent abrupt flexing or cutting action when the diaphragm is flexed by application of power through said impact or wear piece, substantially as and for the purpose described.

6. An acoustic diaphragm and an attached impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising diaphragm engaging members on opposite sides of the diaphragm, secured in position by a tension member extending through a perforation in the diaphragm, the edges of the diaphragm engaging faces being rounded so as to prevent abrupt flexing or cutting action when the diaphragm is flexed by application of power through said impact or wear piece, said diaphragm being formed of metal having a fibrous or grained structure and said impact or wear piece having its impact or wear surface extending transversely of the general direction of trend of the fiber of the metal, so that said surface is presented for engagement or impact in a direction of greater strength of the metal, substantially as and for the purpose described.

7. An acoustic diaphragm and an attached impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising diaphragm engaging members on opposite sides of the diaphragm and a tension member extending through a perforation in the diaphragm and upset or riveted to hold said parts in position, the edges of the diaphragm engaging face being rounded so as to prevent abrupt flexing or cutting action when the diaphragm is flexed by application of power through said impact or wear piece, said diaphragm being formed of metal having a fibrous or grained structure and said impact or wear piece having its impact or wear surface extending transversely of the general direction of trend of the fiber of the metal, so that said surface is presented for engagement or impact in a direction of greater strength of the metal, substantially as and for the purpose described.

8. An acoustic diaphragm, consisting of a sheet of rolled steel and an attached impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising clamping surfaces on opposite sides of the diaphragm, and a tension member extending through a perforation in the diaphragm and upset or riveted to hold said parts in position, the edges of an element at the diaphragm engaging face being rounded so as to prevent abrupt flexing or cutting action when the diaphragm is flexed by application of power through said impact or wear piece, substantially as and for the purpose described.

9. An acoustic diaphragm, consisting of a sheet of rolled steel and an attached impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising clamping members on opposite sides of the diaphragm, secured in position by a tension member riveted through a perforation in the diaphragm, one or more surfaces of engagement between the diaphragm and the clamping members being relieved or cut away toward the free edge of the clamp so as to have a decreased clamping action toward the free edges when the diaphragm is in normal position, and to have an increased engagement with the concave surface of said diaphragm as it is flexed by application of power through said impact or wear piece, substantially as and for the purpose described.

10. An acoustic diaphragm consisting of a sheet of elastic metal and an impact or wear piece fixed in position for receiving and transmitting mechanically applied power to forcibly flex said diaphragm, the diaphragm engaging surface of said impact or wear piece being slightly beveled or convexed away from the normal face of the diaphragm so as to engage the diaphragm over a given area when in its normal position, and then over a larger area as it is concaved by forcible application of the power through said impact or wear piece, substantially as and for the purpose described.

11. An acoustic diaphragm, consisting of a sheet of elastic metal and an attached impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising clamping members on opposite sides of the diaphragm, secured in position by a tension member extending through a perforation in the diaphragm, the surfaces of engagement of diaphragm and clamp being formed and arranged so as to clamp the diaphragm adjacent the perforation therethrough, and to present an outer annular space slightly convexed so that the surfaces of contact will come into contact over a gradually increasing area and thereby produce a cushioning effect when said diaphragm is forcibly flexed

by application of power through said impact or wear piece, substantially as and for the purpose described.

12. An acoustic diaphragm, consisting of a sheet of rolled steel, an impact or wear piece for securing and transmitting mechanically applied power to forcibly flex the diaphragm and means for securing the impact or wear piece in operative relation to the diaphragm, said impact or wear piece having a diaphragm engaging face normally in contact with the surface of the diaphragm adjacent the point of attachment, and having an annular outer portion radially convexed or beveled away from the surface of the diaphragm, substantially as and for the purpose described.

13. An acoustic diaphragm formed of metal having a fibrous or grained structure, and provided with a wear or impact element having a surface extending transversely of the general trend of the grain of the metal, substantially as and for the purpose described.

14. An acoustic diaphragm formed of rolled steel, and provided with a wear or impact element having a surface extending transversely of the general trend of the fiber of the steel, substantially as and for the purpose described.

15. An acoustic diaphragm formed of rolled steel, and provided with an anvil riveted thereto with its wear surface presented for engagement or impact in the direction of trend of the grain of the diaphragm, substantially as and for the purpose described.

16. An acoustic diaphragm, consisting of a sheet of elastic metal provided with an impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, said impact or wear piece being formed with hard surface for impact or wear, and a malleable metal surface engaging the diaphragm, the center of the diaphragm engaging face of said impact or wear piece being attached to said diaphragm and the free edges thereof being rounded so as to prevent abrupt flexing or cutting action when the diaphragm is flexed by application of power through said impact or wear piece, substantially as and for the purpose described.

17. An acoustic diaphragm, consisting of a sheet of rolled steel and an attached impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising malleable metal clamping surfaces on opposite sides of the diaphragm, and a tension member extending through a perforation in the diaphragm and upset or riveted to hold said parts in position, the edges of the diaphragm engaging face being rounded so as to prevent abrupt flexing or cutting action when the diaphragm is flexed by application of power through said impact or wear piece, substantially as and for the purpose described.

18. An acoustic diaphragm consisting of a sheet of elastic metal and an impact or wear piece fixed in position for receiving and transmitting mechanically applied power to forcibly flex said diaphragm, the diaphragm engaging surface of said impact or wear piece being of malleable metal and slightly beveled or convexed away from the normal face of the diaphragm so as to engage the diaphragm over a given area when in its normal position, and then over a larger area as it is concaved by forcible application of the power through said impact or wear piece, substantially as and for the purpose described.

19. An acoustic diaphragm consisting of a sheet of hard elastic metal provided with an anvil of malleable metal and a hard metal element having a wear surface, said anvil being formed with a recess containing such hard metal element held therein by upsetting and having a shank riveted through a perforation in the diaphragm, substantially as and for the purpose described.

20. An acoustic diaphragm consisting of a sheet of hard elastic metal provided with an anvil of malleable metal and a hard metal element having a wear surface, said anvil being formed with a recess containing such hard metal element held therein by upsetting and having a shank riveted through a perforation in the diaphragm, the diaphragm engaging face or faces being tightly clamped to the diaphragm adjacent the perforation, but out of contact therewith at the free edges, substantially as and for the purpose described.

21. An acoustic diaphragm consisting of a sheet of hard elastic metal, provided with an anvil of malleable metal and a hard metal cylinder, said anvil being formed with a cylindrical recess containing such hard metal cylinder held therein by upsetting of the metal of said anvil one side of such cylinder being exposed, substantially as and for the purpose described.

22. An acoustic diaphragm consisting of a sheet of hard elastic metal, provided with an anvil of malleable metal and a hard metal cylinder, said anvil being formed with a cylindrical recess containing such hard metal cylinder held therein by upsetting of the metal of said anvil one side of such cylinder being exposed, an integral shank projecting from said anvil being riveted against a washer on the rear side of said diaphragm, substantially as and for the purpose described.

23. An acoustic diaphragm, consisting of a sheet of hard elastic metal, provided with an attached impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising clamping members on opposite sides of the diaphragm, secured in

position by a tension member extending through a perforation in the diaphragm, the surface of engagement between the diaphragm and clamping members being formed and arranged so as to tightly clamp the diaphragm at the center and to leave an annular space for play of the diaphragm between the clamping surfaces at the free edges of the latter, the space for such play being predetermined by and approximately proportional to the maximum proposed amplitude of vibration of the diaphragm when in use, substantially as and for the purpose described.

24. In an acoustic diaphragm formed of metal having a fibrous or grained structure, provided with an anvil secured thereto by riveting and having its impact or wear surface presented for engagement or impact in the direction of trend of the grain of the diaphragm, said anvil having a diaphragm engaging face formed and arranged to clamp the diaphragm adjacent the point of attachment, but beveled or rounded off toward the edge which lies in the direction of the trend of the grain of the diaphragm, substantially as and for the purpose described.

25. An acoustic diaphragm and an attached impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising diaphragm engaging members on opposite sides of the diaphragm, secured in position by a tension member extending through a perforation in the diaphragm, the diaphragm engaging faces of said members being formed or arranged so as to leave a space for play of the diaphragm between the diaphragm engaging surfaces at the free edge of the diaphragm engaging members, the space for such play being predetermined by and approximately proportional to the maximum proposed amplitude of vibration of the diaphragm when in use, substantially as and for the purpose described.

26. An acoustic diaphragm and an attached impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising diaphragm engaging members on opposite sides of the diaphragm, secured in position by a tension member extending through a perforation in the diaphragm, the diaphragm engaging faces of said members being rounded at the edge and formed or arranged so as to leave a space for play of the diaphragm between the diaphragm engaging surfaces at the free edges of the diaphragm engaging members, the space for such play being predetermined by and approximately proportional to the maximum proposed amplitude of vibration of the diaphragm when in use, substantially as and for the purpose described.

27. An acoustic diaphragm, formed of relatively thick rolled sheet vanadium steel, provided with an attached impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising a diaphragm engaging member having a diaphragm engaging face made of malleable metal, substantially as and for the purpose described.

28. An acoustic diaphragm, formed of relatively thick rolled sheet vanadium steel, provided with an attached impact or wear piece for receiving and transmitting mechanically applied power to forcibly flex the diaphragm, such wear piece comprising a diaphragm engaging member having a diaphragm engaging face made of malleable metal and rounded at the edges, substantially as and for the purpose described.

29. An acoustic diaphragm, formed of relatively thick rolled sheet vanadium steel, and means for applying power to said diaphragm to forcibly flex the same, said means comprising a diaphragm engaging member made of malleable iron, substantially as and for the purpose described.

Signed at New York city in the county of New York and State of New York this 16th day of November A. D. 1907.

MILLER REESE HUTCHISON.

Witnesses:
C. O. SNYDER,
IRVING M. OBRIEGHT.