This invention relates to powered mining and excavating equipment operable to generate and to advance a cylindrical bore through natural earth strata, and more particularly to such equipment characterized by an excavating head rotatable about a central axis to disrupt and dislodge material from a circular area at the inner end of the bore, and has as an object to provide novel and improved means for operatively supporting, translating, and advancing such a head for efficient realization of its purposes.

A further object of the invention is to provide novel and improved mining and excavating equipment operable to generate and advance a cylindrical bore through natural earth strata with coincidental scavenging of excavated material from the area of its dislodgement.

A further object of the invention is to provide novel and improved mining and excavating equipment characterized by an excavating head rotatable about a central axis to generate and advance a cylindrical bore through natural earth strata and to scavange the excavated material as an incident of such head rotation.

A further object of the invention is to provide novel and improved mining and excavating equipment unitarily combining an excavating head and material-conveying means efficiently operable for the generation and advancement of a cylindrical bore through natural earth strata.

A further object of the invention is to provide novel and improved mining and excavating equipment characterized by unique means efficiently operable to collect and rearwardly translate material excavated thereby in the generation and advancement of a cylindrical bore through natural earth strata.

A further object of the invention is to provide novel and improved mining and excavating equipment distinguished by unique means efficiently operable to selectively and variously advance the same along a cylindrical bore through natural earth strata generated thereby.

A further object of the invention is to provide novel and improved mining and excavating equipment adapted for accommodation within a cylindrical bore through natural earth strata generated thereby and provided with unique means variably and selectively operable to adapt the equipment for translation in supported engagement with uneven surfaces and to guide and determine the direction of equipment advance.

A further object of the invention is to provide an operatively combination with a mining and excavating unit of unique means for reactively shifting the equipment with respect to abutments immobilized against walls of a cylindrical bore through natural earth strata generated by the equipment.

A further object of the invention is to provide a novel and improved unit operable to excavate natural earth material from and to translate the excavated material rearwardly along a cylindrical bore that is susceptible of production in a wide range of desired sizes from known and available facilities and materials, that is organized to give practical effect to established operative principles, that is in operation uniquely conservative of power and labor, that is continuously operable for long periods of time without occasion for operative delays incident to positioning of the unit for use, translation of the unit, or removal of excavated material, that is selectively and advantageously manipulable to meet the customary variations of operation, and that is practical in attainment of the ends for which designed.

With the foregoing and other objects in view, my invention consists in the construction, arrangement and operative combination of elements as hereinafter set forth, pointed out in my claims, and illustrated by the accompanying drawings, in which—
in my patent above noted, an assembly rotatable about a central axis with efficient excavating effect is shown in the drawings as comprising a transverse yoke bar 10 provided with a gear box 11 extending centrally from its mid-portion and with spaced-parallel teeth 12 extending perpendicularly therefrom at both sides of the box. The shafts 13, for the first time in the box 11 on an excavating projects with its axis coincident with that of head rotation, and paired crank shafts 14 journals in and through the box 11 and teeth 12 mount gouge bars 15 for reciprocation parallel to said teeth and outwardly beyond the free end of the latter in reaction to rotation of the crank shafts 14. The typical box 11 on an excavating 16 with the yoke bar 10 of the head projecting beyond and at the opposite sides of the said housing. A motor 17 is supported and fixed coaxially of and with the housing 16, as by means of a tubular support 18 fixed interiorly of the housing, and the power output shaft 19 of the motor 17 engages with and through a speed-reducing mechanism 20 to connect interiorly of the box 11 with the crank shafts 14, thereby to apply operation of the motor 17 for actuation of the crank shafts 14 and their associated gouge bars 15. At its side remote from the housing 16, the spiral scoop 22 is fixed to one end of an elongated tubular casing 25 coaxially aligned with the housing. At its junction with the casing 25, the spiral scoop 22 opens thereto in full registration with the interior thereof so that rotation of the excavating head, housing 16, scoop 22, and the common axis of a bore generated by said head applies the intake mouth 24 to any loose material obstructing the path of its rotation in a manner effective to charge any such material within the scoop for delivery thence interiorly of the adjacent end of the casing 25 in a manner long utilized for the charging of material to the interiors of rotating mills, and analogous equipment. The otherwise smooth, cylindrical interior of the casing 25 is equipped with and interrupted by a continuous spiral flight 26 closing against the interior wall of the casing and extending about an open central passage coextensive with said casing, which flight is pitched to apply rotation of the assembly including said casing about the axis of the latter in a direction to penetratively advance the auger 13 and to advance the spiral scoop for intake of material through its mouth 24 for translation of material outwardly by said casing from the end of the latter connected to the scoop through said casing and to discharge at and through the other end thereof. The assembly including the excavating head, housing 16, scoop 22, and casing 25 is mounted for translation and for rotation about its axis in a rigid frame 27, and any expedient particular construction represented by the illustrated tubular organization, which includes annular rings 28 at its opposite ends for convection with annular bearing rings 29 fixed exteriorly about and inwardly adjacent the ends of the casing 25 in any feasible arrangement appropriate to revolveably associate said casing within and through the frame 27 in a manner to retain the casing against a shift longitudinally of the same. A maximum transverse dimension of the frame 27 is considerably less than the diameter of the bore generated by the associated excavating head, whereby to leave an annular clearance between said frame and the adjacent bore walls for the operative accommodation of pneumatic tire wheels 30 thereon carried by the frame 27 for free rotation in planes radial of the casing 25 and are arranged at each end of the frame in a group of four such wheels uniformly spaced angularly about the assembly in alignment longitudinally thereof with the corresponding elements at the other end of the frame, it being practical and expedient, as illustrated, to mount each of the wheels 30 on and for rotation about a spindle 31 fixedly extending perpendicularly from the free end of a bracket 32 fixedly projecting radially from the journal 28 terminating each of the ends of the frame 27. The wheels 30 are preferably fixed and arranged to rotate in two perpendicularly related planes diametrically of the casing 25 and associated assembly and to define in each such plane a pattern such as to engage the outer arc of the constituent wheels with and to roll along walls of the cylindrical bore generated by the diametric planes containing the wheel pattern being preferably vertical and the other such plane horizontal, as is indicated by the views of the drawings. Rotation of the assembly characterized by the excavating head and casing 25 is the function of a motor 33 carried by the frame 27 in driving engagement through a speed reducer 34 with a pinion 35 disposed for rotation about an axis parallel to that of the casing 25 in meshed engagement with a ring gear 36 fixedly and exteriorly embracing said casing between the bearings 29 supporting the same, it being manifest that the drive arrangement shown and described is effective when the motor 33 is actuated to rotate the casing 25 coaxially in and relatively to the frame 27 centered and supported in a cylindrical bore engaged by the wheels 30, and to simultaneously rotate the excavating head, housing 16, and spiral scoop 22 fixedly associated with said casing in an outward extension beyond the associated casing and frame. Energy to power the motor 17 for actuation of the gouge bars 15 characterizing the excavating head is supplied from any suitable source through leads 37 connected with contacts riding upon a conducting ring 38 fixedly and exteriorly to and rotatable with the casing 25 in any appropriate particular arrangement, from which ring contacts suitable leads, not shown, convey the energy supplied by the leads 37 to the motor 17 in a manner and arrangement conventional to and well within the skill of the pertinent art. Thus is provision made for selective rotation of the assembly symbolized by the casing 25 about its axis to apply the associated excavating head for disruptive effect upon a circular area perpendicularly to the axis of the said casing, during which rotation the disintegrating elements of the excavating head are susceptible of simultaneous actuation under selective control applicable through the motor 17.

The provision and arrangement of the wheels 30 equipped with pneumatic tires facilitates translatory progress of the unit along the necessarily uneven walls of the bore under development and the penetration of such translatory path and of the bore defining the same in a unique manner. As is fully understood, the inflation pressure of a pneumatic tire establishes the effective radius of such tire under load throughout a variable range less than the maximum radius obtaining at the ultimate inflation. The wheels are thus designed, and such characteristic of pneumatic tires is availed of in the manner represented by Figure 7 to adjust
and to regulate the distance between the outer arcs of the coplanar wheels transversely paired at each end of the frame 27, it being manifest that with maximum inflation pressure obtaining in the tires of the so-paired wheels there is a maximum separation between the outer arcs of the tires, which distance may be diminished through variation in the pressure obtaining in either or both of the tires. This unique feature of the invention is realized through an arrangement which permits an operator to selectively adjust the inflation pressure acting within the pneumatic tire of each of the wheels 30 and may be exemplified in various ways. Essential to selective adjustment of inflation pressure characterizing the tires of the wheels 30 is an element of the invention typified by Fig. 9, effective to establish and maintain pressure flow communication between the interior of the tire and a pressure flow line 39 through the spindle 31 and wheel bearing rotatable thereon, it being immaterial to the practice of the invention how such flow pressure communication is established and maintained. Given a pressure flow line freely communicating with the interior of the pneumatic tire characterizing each of the wheels 30, each of said lines leads through a three-way valve 40 to connect with a pressure supply line 41 serviced by a compressor, not shown, or other supply of fluid under pressure, in such manner as to apply manipulation, fluid under pressure, in each instance, for pressure flow connection between the supply line 41 and the flow line 39 controlled thereby, for alternative interruption of flow from the supply line 41 and simultaneous venting of the associated flow line to atmosphere, and finally for interruption of flow of the line 41 and from the line 39 in either direction through the valve. With the tire of each wheel 30 connected for regulation and adjustment of its inflation pressure by means of a valve 40 in the manner shown and described, provision is made for selectively and individually varying the effective diameters of the wheel tires in a manner to permit any and all of said wheels to roll over and access inward projections of the bore walls and to shift either end of the frame 27 diametrically of the bore, both vertically and horizontally, a moderate distance ultimately determining the direction of bore advance.

Efficient operation of the excavating head for its intended purposes when rotating with and as the leading end of the assembly symbolized by the casing 25 is a function of the force and continuity of the pressure urging the same axially against the material to be dislodged, and a further unique feature of the invention is the provision of novel means for selectively establishing and regularly maintaining a force continuously acting to translate the frame 27 and associated rotatable assembly longitudinally of the bore against the area under excavation. Shiftable and selectively operable as abutments frictionally engageable against the walls of the bore through which the assembly characterized by the frame 27 is to be advanced, split rings 42 of stiffly-resilient material, such as steel, are provided in a diameter approximating that of the bore and with a gap, or circumferential interruption, in each ring which permits contraction thereof to a size which will shift readily along the bore when the ring is transverse thereof. Each ring 42 is equipped with a hydraulic ram unit 43, of conventional construction, hingedly mounted on and chordally of the ring to bridge the circumferential interruption thereof interiorly of the ring, whereby, when the ram 43 is operatively placed in an appropriate hydraulic system, as by means of flow lines 44 extending from the ram 43 operatively to expand the associated ring 42 and retraction of said ram 43 is to contract the ring. To best realize the advantages of the invention, two of the rings 42 are utilized in spaced parallell relation about and in planes perpendicular to the axis of the frame 27, preferably between the assemblies of the wheels 30 at the opposite ends of said frame. As so disposed and positioned, each of the rings 42 is independently led to and for translation at times with the frame 27 by means of hydraulic ram units 45 pivotally engaging between lugs 46 fixedly in standing radially of the ring and brackets 47, or the equivalent, extending radially from the frame 27, or from a band 47' fixedly embracing the frame. The linkage provided by the rams 45 is such as to dispose each ring 42 in trailing relation with the points of ram attachment to the frame, thus to dispose the rams 45 at a slight inclination to the longitudinal axis of the frame assembly and concurrent toward said axis forwardly thereof toward the excavating head, and the rams 45 connecting with each ring 42 are preferably paired to lie in a vertical plane diametrically of the associated frame and ring organization. The rams 45 are operatively included, as by means of flow lines 48, in an appropriate hydraulic system as a conventional manner operable to effect selective extension and retraction of the rams; it being manifest that retraction of the rams operates to shift the associated rings toward the excavating head of the assembly and that extension of said rams operates to shift said rings away from said excavating head.

As typified by the diagrammatic showing of Fig. 8, the flow lines 44 serving the rams 43 independently carried by the rings 42 lead through correspondingly separate reversing valves 49 to operative connection with a pressure line 50 and a return line 51 of a fluid pressure system of any appropriate particularity in a generally conventional manner effective through selective manipulation of the valves 49 to independently extend, retract, or immobilize the separate rams 43 for consequent selective expansion, contraction, or maintenance of expanded or contracted condition of the ring 42 associated therewith. The paired rams 45 linking each of the rings 42 to the frame 27 are symbolized by but a single representation in Fig. 8 from each of which the lines 48 lead independently through a reversing valve 52 to operative connection with the pressure and return lines 50 and 51 to indicate a generally conventional fluid hydraulic arrangement where-through selective manipulation of the valves 52 may be applied to synchronously and correspondingly extend, retract, or immobilize the paired rams 45 associated with each ring 42 for consequent selective adjustment of the associated ring longitudinally of the frame 27, or, when the ring is immobilized in clamped engagement with the bore wall, for shift of the frame relative to such ring longitudinally of the bore. Thus provision is made for selectively and independently expanding the separate rings 42 into clamped engagement with the bore wall through the rams 45 as they serve as abutments against which extension of the associated rams 45 may act to rigidize the frame and excavating assembly in the direction of desired operation, and, conversely, for selectively and independently contracting the separate rings away from the bore walls to a condition in which retraction of the rams 45 operates to advance the associated ring along the frame 27 and bore to a new position with respect to the latter; it being fully apparent that the said rings may be shifted, expanded, and contracted in an alternative sequence effective to permit maintenance of continuous pressure through one or the other of the ram 45 pairs urging the excavating head in the direction of desired penetration, or conversely effective, when desired, to apply retraction of the ram pairs for reverse travel of the frame and head assembly.

Efficient transfer of excavated material from the floor of the bore and to the interior of the casing 25 through the agency of the scoop 22 is enhanced and facilitated thereby the provision of an arc fixedly transversely of the end of the frame 27 to substantially fit and conformably close against the lower portion of the bore spacedly adjacent the wall of the scoop 22 remote from the excavating head, whereby advance of the assembly in an excavating direction acts through said shield to push loose material into the path of the rotating scoop and its mouth 24, and by the provision of spiral
blades 54 fixed exteriorly of the housing 16 and rotatable therewith in a maximum diameter approximating that of the bore to urge loose material thereby encountered into the path of the scoop intake.

Material translated interiorly of the casing 25 in reaction to the influence of the flight 26 may discharge from the housing and rotate with the end of said casing to a conveyor 55, or analogous means, effective to continue translation thereof outwardly of the bore under development, or, as represented by Figure 6, tubular extensions 56, equipped with spiral flights 26' arranged to supplement the action of the flight 26, may be co-axially aligned with and clamped to the trailing end of the casing 25 to rotate therewith on roller mounts 57 shiftable along the floor of the bore for consequent delivery of excavated material through successive such extensions at any desired point remote from the excavating head.

Constructed and organized as shown and hereinafore described, the assembly is operable as set forth to traverse and to advance a cylindrical earth bore regularly determinable as to direction, to excavate efficiently in reaction to regularly continuous pressure applied to promote penetrative effect of the excavating elements, to scavenge digested earth material from the excavating area, end to translate such material to ultimate desired delivery, all with practicality, advantage, and economy deriving from the novelties of concept and operative structural combination featuring the invention.

Since changes, variations, and modifications in the forms, construction, and arrangement of the elements shown and described may be had without departing from the spirit of my invention, I wish to be understood as being limited solely by the scope of the appended claims, rather than by any details of the illustrative showing and foregoing description.

I claim as my invention:

1. An excavating and mining machine comprising a tubular casing formed with one closed end and a housing extending coaxially therefrom mounted for translation parallel to and for rotation about its horizontally-disposed axis, an independently power-actuable excavating head generative of a bore accommodating said casing and its mounting fixed diametrically across, extending coaxially from and rotatable with the outer end of said casing housing, power means in rotational driving relation with said casing, separate power means within the housing of said casing in driving relation with said casing, separate power means in said housing in power translation of said casing along a bore generated by said head.

2. An excavating and mining machine comprising a tubular casing formed with one closed end and a housing extending coaxially therefrom mounted for translation parallel to and for rotation about its horizontally-disposed axis, an independently power-actuable excavating head generative of a bore accommodating said casing and its mounting fixed diametrically across, extending coaxially from and rotatable with the outer end of said casing housing, power means in rotational driving relation with said casing, separate power means within the housing of said casing in driving relation with said casing, separate power means in rotational driving relation with said casing, separate power means in said housing in power translation of said casing along a bore generated by said head.

3. An excavating and mining machine comprising a tubular casing formed with one closed end and a housing extending coaxially therefrom mounted for translation parallel to and for rotation about its horizontally-disposed axis, an independently power-actuable excavating head generative of a bore accommodating said casing and its mounting fixed diametrically across, extending coaxially from and rotatable with the outer end of said casing housing, power means in rotational driving relation with said casing, separate power means in said housing in power translation of said casing along a bore generated by said head.

4. An excavating and mining machine comprising a tubular casing formed with one coaxial housing closing one end thereof mounted for translation parallel to and for rotation about its horizontally-disposed axis, an independently power-actuable excavating head generative of a bore accommodating said casing and its mounting fixed diametrically across, extending coaxially from and rotatable with the outer end of said casing housing, power means in rotational driving relation with said casing, separate power means in said housing in power translation of said casing along a bore generated by said head.

5. An excavating and mining machine comprising a tubular casing formed with a coaxial housing closing one end thereof mounted for translation parallel to and for rotation about its horizontally-disposed axis, an independently power-actuable excavating head generative of a bore accommodating said casing and its mounting fixed diametrically across, extending coaxially from and rotatable with the end of said housing remote from said casing, power means in rotational driving relation with said casing, separate power means in said housing in power translation of said casing along a bore generated by said head.

6. An excavating and mining machine comprising a tubular casing formed with a coaxial housing closing one end thereof mounted for translation parallel to and for rotation about its horizontally-disposed axis, an independently power-actuable excavating head generative of a bore accommodating said casing and its mounting fixed diametrically across, extending coaxially from and rotatable with the end of said housing remote from said casing, power means in rotational driving relation with said casing, separate power means in said housing in power translation of said casing along a bore generated by said head.
driving relation with actuable elements of said head, a spiral scoop between and rotatable with said casing and housing adapted to infeed excavated material to the casing interior as an incident of its rotation, a spiral flight fixed interiorly of and rotatable with said casing adapted to translate material infed by said scoop longitudinally of the casing to delivery through the end of the inner housing and head, said casing and housing as an incident of casing rotation, abutments selectively clampable to the walls of a bore generated by said head spacedly embracing the translatable assembly, and power means pivotally connecting between and operatively intercoupling each of said abutments with the translatable assembly selectively actuable to shift the latter axially relative to the associated abutment.

7. An excavating and mining machine comprising a tubular casing mounted for translation parallel to and for rotation about its horizontally-disposed axis, an excavating head extending coaxially from and rotatable with one end of said casing, power means in rotational driving relation with said casing, a spiral scoop between and rotatable with said casing and head adapted to infeed excavated material to the casing interior as an incident of its rotation, a spiral flight fixed interiorly of and rotatable with said casing adapted to translate material infed by said scoop longitudinally of the casing as an incident of casing rotation, abutments selectively clampable to the walls of a bore generated by said head spacedly embracing the translatable assembly, power means pivotally connecting between and operatively intercoupling each of said abutments with the translatable assembly selectively actuable to shift the latter axially relative to the associated abutment, and separate power means spaced radially about each end of said casing rollably engageable with the bore walls as the sole support thereof selectively adjustable to regularly vary and determine the effective radial correlation of each end of said casing with the bore generated by the head.

8. An excavating and mining machine comprising a rigid frame, a tubular casing mounted for rotation about its horizontally-disposed axis and in extending entirely through said frame, an excavating head extending coaxially from and rotatable with one end of said casing for the generation of a bore accommodative of said frame, power means on said frame in rotational driving relation with said casing, pneumatic-tire wheels angularly spaced about each end of said frame for rotation in planes radial of said casing adapted to peripherally engage walls of the bore generated by said head and thereby rollably support and position the frame and casing assembly for translatation interiorly of the bore, means at and rotatable with the end of said casing adjacent said head for the infeed of excavated material to the interior of the casing as an incident of casing rotation in the frame, means interiorly of and rotatable with said casing for the translational of material longitudinally therein and to delivery through the end thereof remote from said head as an incident of casing rotation, means selectively actuable for power translation of said frame and casing assembly along the bore generated by said head, and means for selectively adjusting the tire inflation pressure of each of said wheels for consequent regulation of the radial correlation of the casing ends with the associated bore.

9. The organization according to claim 8, wherein said excavating head includes power-actuable elements, said head is fixed diametrically of a tubular housing coaxial and rotatable with said casing and head terminating in an open mouth radial of the casing disposed for advance in the direction of casing rotation.

10. The organization according to claim 8, wherein the means for infeed of excavated material to the interior of the casing comprise a spiral scoop between and rotatable with said casing and head terminating in an open mouth radial of the casing disposed for advance in the direction of casing rotation.

11. The organization according to claim 8, wherein the means for infeed of excavated material to the interior of the casing comprises a spiral scoop between and rotatable with said casing and head terminating in an open mouth radial of the casing disposed for advance in the direction of casing rotation and a shield fixed to said frame spacedly adjacent said scoop transversely of and in substantial marginal conformity with the lower arc of the bore generated by said head.

12. The organization according to claim 8, wherein said head is fixed diametrically of a tubular housing coaxial with said casing and the means for infeed of excavated material to the interior of the casing comprise a spiral scoop between and rotatable with said casing and housing terminating in an open mouth radial of the casing disposed for advance in the direction of casing rotation, a shield fixed to said frame spacedly adjacent said scoop transversely of and in substantial marginal conformity with the lower arc of the bore generated by said head, and spiral blades exteriorly of said housing disposed and adapted to generate material excavated by said head in the orbital path of the scoop mouth as an incident of casing rotation.

13. The organization according to claim 8, wherein said wheels are paired longitudinally and radially of the casing in perpendicularly-related planes through the casing axis, and the means for selectively adjusting the tire inflation pressure of said wheels comprises a supply of fluid under pressure, a flow line operatingly connecting between said supply and the inflatable element of each wheel tire, and a flow control valve in each said line manipulable to selectively direct and to obstruct fluid flow through the associated line.

14. The organization according to claim 8, wherein the means for translation of material longitudinally through the casing as an incident of casing rotation comprises a spiral flight fixed interiorly of and rotatable with said casing pitched to retract material away from the infeed end of the casing as the latter is caused to rotate.

15. The organization according to claim 8, wherein the means for power translation of the frame and casing assembly along the bore generated by the head comprises expansible and contractible split rings spacedly embracing the frame between the wheel supports at the ends thereof for separate clamped engagement at times with walls of the bore generated by said head, selectively-actuable hydraulic rams operatively bridging the interruptions of said rings for power expansion and contraction thereof, and selectively-actuable hydraulic rams pivotally connecting between and operatively intercoupling each of said rings separately to the frame.

16. The organization according to claim 8, wherein the means for power translation of the frame and casing assembly along the bore generated by the head comprises expansible and contractible split rings spacedly embracing the frame between the wheel supports at the ends thereof for separate clamped engagement at times with walls of the bore generated by the head, an hydraulic ram operatively bridging the interruption of each said ring for power expansion and contraction thereof, fluid pressure flow lines connecting each said ram in and with a fluid pressure system, a flow control valve selectively actuable to separately regulate and direct fluid pressure flow through said lines to each of said rams, hydraulic rams pivotally connecting between and operatively intercoupling each of said rings separately to the frame, fluid pressure flow lines connecting the rams engaged with each ring in and with a fluid pressure system, and a flow control valve in the lines serving the rams of each ring selectively actuable to regulate and direct fluid pressure flow through the associated lines for synchronous and corresponding actuation of the rams served thereby.

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