CONJUGACY SEPARABILITY OF SOME ONE-RELATOR GROUPS

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ABSTRACT. Conjugacy separability of any group of the class of one-relator groups given by the presentation \( \langle a, b; [a^m, b^n] = 1 \rangle \) \((m, n > 1)\) is proven.

Introduction

A group \( G \) is conjugacy separable if for any two non-conjugate elements \( f \) and \( g \) of \( G \) there exists a homomorphism \( \varphi \) of group \( G \) onto some finite group \( X \) such that the images \( f\varphi \) and \( g\varphi \) of elements \( f \) and \( g \) are not conjugate in group \( X \). It is clear that any conjugacy separable group \( G \) is residually finite (i.e., recall, for any non-identity element \( g \in G \) there exists a homomorphism \( \varphi \) of group \( G \) onto some finite group \( X \) such that \( g\varphi \neq 1 \)).

Since 1962 when G. Baumslag and D. Solitar [3] discovered the first examples of non-residually finite one-relator groups a lot of results establishing the residual finiteness of various one-relator groups have appeared. It was also shown that some of such groups are conjugacy separable. So, J. Dyer [4] have proved the conjugacy separability of any group being free product of free groups amalgamating cycle. In the same paper she proved an unpublished result of M. Amstrong on conjugacy separability of any one-relator group with nontrivial center. The conjugacy separability of groups defined by relator of form \((a^mb^n)^t\) and \((a^{-1}b'ab^m)^s\), where \( s > 1 \), was proved in [6] and [1] respectively. It should mention that up to now it is not known whether there exists one-relator group that is residually finite but not conjugacy separable.

In this paper we enlarge the class of conjugacy separable one-relator groups. Namely, we prove here the

**Theorem.** Any group \( G_{mn} = \langle a, b; [a^m, b^n] = 1 \rangle \) where integers \( m \) and \( n \) are greater than 1, is conjugacy separable.

We note that the assertion of Theorem is also valid when \( m = 1 \) or \( n = 1 \). Indeed, in this case group \( G_{mn} \) is the generalized free product of two finitely generated abelian groups with cyclic amalgamation and its conjugacy separability follows from the result of [4].

*Key words and phrases.* one-relator groups, conjugacy separability, residual finiteness, free product with amalgamation.

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The residual finiteness of groups \( G_{mn} \) is well known; it follows, for example, from the result of paper [2]. Some properties of these groups were considered in [7] where, in particular, the description of their endomorphisms was given. The proofs in this paper made use of presentation of group \( G_{mn} \) as amalgamated free product. The same presentation will be the crucial tool in the proof of Theorem above and because of this, in section 1, we recall the Solitar theorem on the conjugacy of elements of amalgamated free products and derive, for our special case, the criterion which is somewhat simpler. In section 2 some properties of separability of groups \( G_{mn} \) are established and in section 3 the proof of Theorem will be completed.

1. Preliminary remarks on the conjugacy in amalgamated free products

Let us recall some notions and properties concerned with the construction of free product \( G = (A \ast B; H) \) of groups \( A \) and \( B \) with amalgamated subgroup \( H \).

Every element \( g \in G \) can be written in a form

\[
g = x_1x_2\cdots x_r \quad (r \geq 1)
\]

where for any \( i = 1, 2, \ldots, r \) element \( x_i \) belongs to one of the free factors \( A \) or \( B \) and if \( r > 1 \) any successive \( x_i \) and \( x_{i+1} \) do not belong to the same factor \( A \) or \( B \) (and therefore for any \( i = 1, 2, \ldots, r \) element \( x_i \) does not belong to amalgamated subgroup \( H \)). Such form of element \( g \) is called reduced.

In general, element \( g \in G \) can have different reduced forms, but if \( g = y_1y_2\cdots y_s \) is one more reduced form of \( g \), then \( r = s \) and, for any \( i = 1, 2, \ldots, r \), \( x_i \) and \( y_i \) belong to the same factor \( A \) or \( B \). The length \( l(g) \) of element \( g \) is then defined as the number \( r \) of the components in a reduced form of \( g \). Element \( g \) is called cyclically reduced if either \( l(g) = 1 \) or \( l(g) > 1 \) and the first and the last components of its reduced form do not belong to the same factor \( A \) or \( B \). If \( g = x_1x_2\cdots x_r \) is a reduced form of cyclically reduced element \( g \) then cyclic permutations of element \( g \) are elements of form

\[
x_ix_{i+1}\cdots x_{r}x_1\cdots x_{i-1}, \quad \text{where} \quad i = 1, 2, \ldots, r.
\]

If \( X \) is subgroup of a group \( Y \) we shall say that elements \( a \) and \( b \) of \( Y \) are \( X \)-conjugate if \( a = x^{-1}bx \), for some \( x \in X \).

The Solitar criterion of conjugacy of elements of amalgamated free product of two groups (Theorem 4.6 in [5]) can be formulated as follows.

**Proposition 1.1.** Let \( G = (A \ast B; H) \) be the free product of groups \( A \) and \( B \) with amalgamated subgroup \( H \). Every element of \( G \) is conjugate to a cyclically reduced element. If lengths of two cyclically reduced elements are nonequal then these elements are not conjugate in \( G \). Let \( f \) and \( g \) be cyclically reduced elements of \( G \) such that \( l(f) = l(g) \). Then

(1) If \( f \in A \) and \( f \) is not conjugate in \( A \) to any element of subgroup \( H \) then \( f \) and \( g \) are conjugate in group \( G \) if and only if \( g \in A \) and \( f \) and \( g \) are conjugate in \( A \). Similarly, if \( f \in B \) and \( f \) is not conjugate in \( B \) to any element of subgroup
\[ H \text{ then } f \text{ and } g \text{ are conjugate in group } G \text{ if and only if } g \in B \text{ and } f \text{ and } g \text{ are conjugate in } B. \]

(2) If \( f \in H \) then \( f \) and \( g \) are conjugate in group \( G \) if and only if there exists a sequence of elements

\[ f = h_0, h_1, \ldots h_n, h_{n+1} = g \]

such that for any \( i = 0, 1, \ldots, n \) \( h_i \in H \) and elements \( h_i \) and \( h_{i+1} \) are \( A \)-conjugate or \( B \)-conjugate.

(3) If \( l(f) = l(g) > 1 \) then \( f \) and \( g \) are conjugate in group \( G \) if and only if element \( f \) is \( H \)-conjugate to some cyclic permutation of \( g \).

In the following special case assertion (2) of Proposition 1.1 became unnecessary.

**Proposition 1.2.** Let \( G = (A \ast B; H) \) be the free product of groups \( A \) and \( B \) with amalgamated subgroup \( H \). Suppose that for any element \( f \) of \( A \) or \( B \) and for any element \( h \) of subgroup \( H \), the inclusion \( f^{-1}hfh \in H \) is valid if and only if elements \( f \) and \( h \) commute. If \( f \) and \( g \) are cyclically reduced elements of \( G \) such that \( l(f) = l(g) = 1 \) then \( f \) and \( g \) are conjugate in group \( G \) if and only if \( f \) and \( g \) belong to the same subgroup \( A \) or \( B \) and are conjugate in this subgroup.

In fact, let elements \( f \) and \( g \) be conjugate in group \( G \) and let \( f \) belong to subgroup \( A \), say. If \( f \) is not conjugate in \( A \) to any element of subgroup \( H \) then desired assertion is implied by assertion (1) of Proposition 1.1. Otherwise, we can assume that \( f \in H \) and by assertion (2) of Proposition 1.1 there is a sequence of elements

\[ f = h_0, h_1, \ldots, h_n, h_{n+1} = g, \]

such that for any \( i = 0, 1, \ldots, n \) \( h_i \in H \) and for suitable element \( x_i \) belonging to one of the subgroups \( A \) or \( B \), the equality \( x_i^{-1}h_ix_i = h_{i+1} \) holds. Since for \( i = 0, 1, \ldots, n-1 \) the inclusion \( f^{-1}h_{i+1}f \in H \) is valid, the hypothesis gives \( h_0 = h_n \), i.e. \( x_n^{-1}fx_n = g \).

This means that elements \( f \) and \( g \) belong to that subgroup \( A \) or \( B \) which contains element \( x_n \) and also are conjugate in this subgroup.

Next, we describe more explicit the situation arising in assertion (3) of Proposition 1.1.

**Proposition 1.3.** Let \( f = x_1x_2 \cdots x_r \) and \( g = y_1y_2 \cdots y_r \) be the reduced forms of elements \( f \) and \( g \) of group \( G = (A \ast B; H) \) where \( r > 1 \). Then \( f \) and \( g \) are \( H \)-conjugate if and only if there exist elements \( h_0, h_1, h_2, \ldots, h_r = h_0 \) in subgroup \( H \) such that for any \( i = 1, 2, \ldots, r \), we have

\[ x_i = h_{i-1}^{-1}y_ih_i. \]  \hspace{1cm} (1)

**Proof.** If for some elements \( h_0, h_1, h_2, \ldots, h_r = h_0 \) of subgroup \( H \) the equalities (1) hold then

\[ f = x_1x_2 \cdots x_r = h_0^{-1}y_1h_1^{-1}y_2h_2 \cdots h_{r-1}^{-1}y_2h_r = h_0^{-1}(y_1y_2 \cdots y_r)h_r = h_0^{-1}gh_0. \]
Conversely, by induction on \( r \) we prove that if for some \( h \in H \) the equality \( f = h^{-1}gh \) holds then there exists a sequence of elements \( h_0, h_1, h_2, \ldots, h_r = h_0 \) of subgroup \( H \) satisfying the equalities (1) and such that \( h_0 = h \).

Rewriting the equality \( f = h^{-1}gh \) in the form

\[
x_r^{-1} \cdots x_2^{-1} x_1^{-1} h^{-1} y_1 y_2 \cdots y_r h = 1,
\]

we see that since the expression in the left part of it cannot be reduced, elements \( x_1 \) and \( y_1 \) must be contained in the same subgroup \( A \) or \( B \) and element \( x_1^{-1} h^{-1} y_1 \) must belong to subgroup \( H \). Denoting this element by \( h_1^{-1} \), we have \( x_1 = h^{-1} y_1 h_1 \). If \( r = 2 \) then the equality above takes the form \( x_2^{-1} h_1^{-1} y_2 h = 1 \), whence \( x_2 = h_1^{-1} y_2 h \). Therefore, setting \( h_0 = h_2 = h \), we obtain in that case the desired sequence.

If \( r > 2 \) let’s rewrite the equality \( f = h^{-1}gh \) in the form

\[
h^{-1} y_1 h_1 x_2 \cdots x_r = h^{-1} y_1 y_2 \cdots y_r h.
\]

This implies that if we set \( f' = h^{-1} h_1 x_2 \cdots x_r \) and \( g' = y_2 \cdots y_r \), then \( f' = h^{-1} g'h \). Since the length of elements \( f' \) and \( g' \) is equal to \( r - 1 \), then by induction, there exists a sequence \( h_1' = h, h_2', \ldots, h_r' = h_1' \) of elements of subgroup \( H \), such that \( h_1'^{-1} h_2' = (h_1')^{-1} y_2 h_2' \) and for any \( i = 2, 3, \ldots, r \)

\[
x_i = (h_{i-1}')^{-1} y_i h_i'.
\]

Since \( x_2 = h_1'^{-1} y_2 h_2' \), then setting \( h_i = h_i' \) for \( i = 2, 3, \ldots, r \), we obtain the desired sequence, and induction is complete. Proposition 1.3 is proven.

We conclude this section with one more property of amalgamated free product.

**Proposition 1.4.** Let \( G = (A \ast B; H) \) be the free product of groups \( A \) and \( B \) amalgamating subgroup \( H \) where \( H \) lies in the center of each of groups \( A \) and \( B \). Then for any element \( f \in G \) not belonging to subgroup \( A \) we have \( f^{-1}Af \cap A = H \).

In fact, since subgroup \( H \) coincides with the center of group \( G \) (see [5], page 211), the inclusion \( H \subseteq f^{-1}Af \cap A \) is obvious. Conversely, let element \( f^{-1}af \) belong to subgroup \( A \) where \( a \in A \). Since \( f \notin A \) then either \( f \in B \setminus H \) or \( l(f) > 1 \) and (without loss of generality) the first component of reduced form of \( f \) belongs to \( B \). In any case the assumption \( a \notin H \) would imply that \( l(f^{-1}af) > 1 \). Thus, \( a \in H \) and therefore \( f^{-1}af = a \in H \).

**2. Some properties of groups \( G_{mn} \) and of their certain quotients**

In what follows, our discussion will make use of the presentation of group \( G_{mn} \) as an amalgamated free product of two groups. To describe such presentation, let \( H \) be the subgroup of group \( G_{mn} \), generated by elements \( c = a^m \) and \( d = b^n \). Also, let \( A \) denote the subgroup of group \( G_{mn} \) generated by element \( a \) and subgroup \( H \), and let \( B \) denote
the subgroup of group $G_{mn}$, generated by element $b$ and subgroup $H$. Then it can be immediately verified that $H$ is the free abelian group with base $c, d$, group $A$ is the free product $(\langle a \rangle * H; (a^m = c))$ of infinite cycle $\langle a \rangle$ and group $H$ with amalgamation $\langle a^m \rangle$, group $B$ is the free product $(\langle b \rangle * H; (b^n = d))$ of infinite cycle $\langle b \rangle$ and group $H$ with amalgamation $\langle b^n \rangle$, and group $G_{mn}$ is the free product $(A * B; H)$ of groups $A$ and $B$ with amalgamation $H$.

The same decomposition is satisfactory for certain quotients of groups $G_{mn}$. Namely, for any integer $t > 1$ let $G_{mn}(t)$ be the group with presentation

$$\langle a, b; [a^m, b^n] = 1, a^{mt} = b^{nt} = 1 \rangle$$

and $\rho_t$ be the natural homomorphism of group $G_{mn}$ onto $G_{mn}(t)$. Then it is easy to verify that subgroup $H(t) = H_{\rho_t}$ of group $G_{mn}(t)$ is isomorphic to the quotient $H/H^t$ (where, as usually, $H^t$ consists of all elements $h^t$, $h \in H$), subgroup $A(t) = A_{\rho_t}$ is the amalgamated free product $(\langle a; a^{mt} = 1 \rangle * H(t); a^m = cH^t)$ of cycle $\langle a; a^{mt} = 1 \rangle$ of order $mt$ and group $H(t)$, subgroup $B(t) = B_{\rho_t}$ is the amalgamated free product $(\langle b; b^{nt} = 1 \rangle * H(t); b^n = dH^t)$ of cycle $\langle b; b^{nt} = 1 \rangle$ of order $nt$ and group $H(t)$ and group $G_{mn}(t)$ is the amalgamated free product $(A(t) * B(t); H(t))$.

These decompositions of groups $G_{mn}$ and $G_{mn}(t)$ are assumed everywhere below, and such notions as free factor, reduced form, length of element and so on will refer to them.

Let us remark, at once, that since each of groups $A(t)$ and $B(t)$ is the amalgamated free product of two finite groups and group $G_{mn}(t)$ is the free product of groups $A(t)$ and $B(t)$ with finite amalgamation, it follows from results of paper [4] that for every $t$, group $G_{mn}(t)$ is conjugacy separable. So, to prove the conjugacy separability of group $G_{mn}$ it is enough, for any non-conjugate elements $f$ and $g$ of $G_{mn}$, to find an integer $t$ such that elements $f_{\rho_t}$ and $g_{\rho_t}$ are non-conjugate in group $G_{mn}(t)$.

Since in the decompositions of groups $A$ and $B$ as well, as of groups $A(t)$ and $B(t)$, into amalgamated free product stated above the amalgamated subgroups are contained in the centre of each free factor, by Proposition 1.4 we have

**Proposition 2.1.** For any element $g$ of group $A$ (or $B$) not belonging to subgroup $H$ the equality $g^{-1}Hg \cap H = \langle c \rangle$ (respectively, $g^{-1}Hg \cap H = \langle d \rangle$) holds. In particular, for any element $g$ of group $A$ or $B$ and for any element $h$ of subgroup $H$ element $g^{-1}hg$ belongs to subgroup $H$ if and only if elements $g$ and $h$ commute.

Similarly, for any element $g$ of group $A(t)$ (or $B(t)$) not belonging to subgroup $H(t)$ the equality $g^{-1}H(t)g \cap H(t) = \langle cH^t \rangle$ (respectively, $g^{-1}H(t)g \cap H(t) = \langle dH^t \rangle$) holds. In particular, for any elements $g$ of group $A(t)$ or $B(t)$ and $h$ of subgroup $H(t)$, element $g^{-1}hg$ belongs to subgroup $H(t)$ if and only if elements $g$ and $h$ commute.

Propositions 1.1, 1.2 and 2.1 lead to the following criterion for conjugacy of elements of groups $G_{mn}$ and $G_{mn}(t)$:

**Proposition 2.2.** Let $G$ be any of groups $G_{mn}$ and $G_{mn}(t)$. Every element of $G$ is conjugate to a cyclically reduced element. If lengths of two cyclically reduced elements...
are nonequal then these elements are not conjugate in $G$. Let $f$ and $g$ be cyclically reduced elements of $G$ such that $l(f) = l(g)$. Then

1. If $l(f) = l(g) = 1$ then $f$ and $g$ are conjugate in group $G$ if and only if $f$ and $g$ belong to the same free factor and are conjugate in this factor.

2. If $l(f) = l(g) > 1$ then $f$ and $g$ are conjugate in group $G$ if and only if element $f$ is $H$-conjugate or $H(t)$-conjugate to some cyclic permutation of $g$.

We now consider some further properties of groups $G_{mn}$ and $G_{mn}(t)$. The following assertion is easily checked.

**Proposition 2.3.** For any homomorphism $\varphi$ of group $G_{mn}$ onto a finite group $X$ there exist an integer $t > 1$ and a homomorphism $\psi$ of group $G_{mn}(t)$ onto group $X$ such that $\varphi = \rho_t \psi$.

Also, for any integers $t > 1$ and $s > 1$ such that $t$ divides $s$ there exists homomorphism $\varphi : G_{mn}(s) \to G_{mn}(t)$ such that $\rho_t = \rho_s \varphi$.

The same assertions are valid for groups $A$ and $B$.

**Proposition 2.4.** For any element $g$ of group $A$ or $B$, if $g$ does not belong to subgroup $H$ then there exists an integer $t_0 > 1$ such that for any positive integer $t$, divisible by $t_0$, element $g\rho_t$ does not belong to subgroup $H\rho_t$.

**Proof.** We shall assume that $g \in A$; the case when $g \in B$ can be treated similarly.

So, let element $g \in A$ do not belong to subgroup $H$ and let $g = x_1 x_2 \cdots x_r$ be a reduced form of $g$ (in the decomposition of group $A$ into amalgamated free product).

If $r = 1$ then element $g$ belongs to subgroup $\langle a \rangle$ i.e. $g = a^k$ for some integer $k$. Since $g \notin H$, integer $k$ is not divisible by $m$. Then for any integer $t > 0$, in group $A(t)$, element $g\rho_t$ of subgroup $\langle a; a^{mt} = 1 \rangle$ cannot belong to the amalgamated subgroup (generated by element $a^m$) of the decomposition of group $A(t)$ and consequently cannot belong to the free factor $H(t) = H\rho_t$.

Let $r > 1$. Every component $x_i$ of the reduced form of element $g$ is either of form $a^k$, where integer $k$ is not divisible by $m$, or of form $c^k d^l$ where $l \neq 0$. If integer $t_0$ is chosen such that the exponent $l$ of any component $x_i$ of the second kind is not divisible by $t_0$, then for any $t$ divisible by $t_0$ the image $x_i \rho_t = x_i H^t$ of such component will not belong to the amalgamated subgroup of group $A(t)$ (generated, let’s remind, by element $cH^t$). Moreover, as above in case $r = 1$, the images of components of the first kind will not belong to the amalgamated subgroup. Therefore, the form

$$g\rho_t = (x_1 \rho_t)(x_2 \rho_t) \cdots (x_r \rho_t)$$

of element $g\rho_t$ is reduced in group $A(t)$ and since $r > 1$, $g\rho_t$ does not belong to the free factor $H(t) = H\rho_t$. The proposition is proven.

**Proposition 2.5.** For any element $g$ of group $G_{mn}$ there exists an integer $t_0 > 1$ such that for all positive integer $t$, divisible by $t_0$, the length of element $g\rho_t$ in group $G_{mn}(t)$ coincides with the length of element $g$ in group $G_{mn}$.
Proposition 2.6. For any elements $f$ and $g$ of group $A$ (or $B$) such that element $f$ does not belong to the double coset $HgH$, then there exists an integer $t_0 > 1$ such that for any positive integer $t$, divisible by $t_0$, element $f_{ρ^t}$ does not belong to the double coset $H(t)(g_{ρ^t})H(t)$.

Proof. We can again consider only the case when elements $f$ and $g$ belong to subgroup $A$. So, let us suppose that element $f ∈ A$ does not belong to the double coset $HgH$. In view of Proposition 2.4, it is enough to prove that there exists a homomorphism $ϕ$ of $A$ onto a finite group $X$ such that element $f_{ϕ}$ of $X$ does not belong to the double coset $(Hϕ)(gϕ)(Hϕ)$.

To this end let's consider the quotient group $A = A/C$ of group $A$ by its (central) subgroup $C = ⟨c⟩$. The image $xC$ of an element $x ∈ A$ in group $A$ will be denoted by $x$. It is obvious that group $A$ is the (ordinary) free product of cyclic group $X$ of order $m$, generated by element $a$, and the infinite cycle $Y$, generated by $d$. The canonical homomorphism of group $A$ onto group $A$ maps subgroup $H$ onto subgroup $Y$ and consequently, the image of the double coset $HgH$ is the double coset $YgY$. Since $C ≤ H$, the element $f$ does not belong to this coset.

We can assume, without loss of generality, that any element $f$ and $g$, if it is different from identity, has reduced form the first and the last syllables of which do not belong to subgroup $Y$. Every $Y$-syllable of these reduced forms is of form $d^k$ for some integer $k ≠ 0$. Since the set $M$ of all such exponents $k$ is finite, we can choose an integer $t > 0$ such that for any $k ∈ M$ the inequality $t > 2|k|$ holds. Let's denote by $A$ the factor group of group $A$ by the normal closure of element $d^t$. Group $A$ is the free product of groups $X$ and $Y/Y^t$ and since different integers from $M$ are not relatively congruent and are not congruent to zero modulo $t$, then the reduced forms of the images $f$ and $g$ of elements $f$ and $g$ in group $A$ are the same as in group $A$. In particular, element $f$ does not belong to the double coset $Y/Y^t gY/Y^t$. Since this coset consists of a finite number of elements and group $A$ is residually finite, then there exists a normal subgroup $N$ of finite index of group $A$ such that

$$f ∉ (Y/Y^t gY/Y^t) · N.$$  

If now $θ$ is the product of the canonical homomorphisms of group $A$ onto group $A$ and of group $A$ onto group $A$ and $N$ is the full pre-image by $θ$ of subgroup $N$, then $N$ is a normal subgroup of finite index of group $A$ and $f ∉ (HgH)N$. Thus, the canonical homomorphism $ϕ$ of group $A$ onto quotient group $A/N$ has the required property and the proposition is proven.

3. Proof of Theorem

We prove first the following proposition.

Proposition 3.1. If elements $f$ and $g$ of group $G_{mn}$ such that $l(f) = l(g) > 1$ are not $H$-conjugate, then for some integer $t > 1$, elements $f_{ρ^t}$ and $g_{ρ^t}$ of group $G_{mn(t)}$ are not $H(t)$-conjugate.
Proof. Let \( f = x_1x_2 \cdots x_r \) and \( g = y_1y_2 \cdots y_r \) be the reduced forms in group \( G_{mn} = (A \ast B; H) \) of elements \( f \) and \( g \).

We remind (see Proposition 1.3) that elements \( f \) and \( g \) are \( H \)-conjugate if and only if there exist elements \( h_0, h_1, h_2, \ldots, h_r = h_0 \) of \( H \) such that for any \( i = 1, 2, \ldots, r \), we have

\[
    x_i = h_{i-1}^{-1}y_ih_i.
\]

It then follows, in particular, that for each \( i = 1, 2, \ldots, r \) elements \( x_i \) and \( y_i \) should lie in the same free factor \( A \) or \( B \) and define the same double coset modulo \( (H, H) \). So, we consider separately some cases.

Case 1. Suppose that for some index \( i \) elements \( x_i \) and \( y_i \) lie in different free factors \( A \) or \( B \) and define the same double coset modulo \( (H, H) \). Hence, by Proposition 1.3, in group \( G_{mn} \) elements \( f_{\rho_i} \) and \( g_{\rho_i} \) are not \( H(t) \)-conjugate.

Case 2. Let now for any \( i = 1, 2, \ldots, r \) elements \( x_i \) and \( y_i \) belong to the same subgroup \( A \) or \( B \) and for some \( i \) element \( x_i \) does not belong to the double coset \( Hy_iH \). By Proposition 2.6, there exists an integer \( t_1 > 1 \) such that for any positive integer \( t \) divisible by \( t_1 \), element \( x_i\rho_t \) is not in the double coset \( H(t)(y_i\rho_t)H(t) \). From Proposition 2.5, there exist integers \( t_2 > 1 \) and \( t_3 > 1 \) such that for any positive integer \( t \) divisible by \( t_2 \) the length of element \( f_{\rho_t} \) in group \( G_{mn}(t) \) is equal to \( r \) and for any positive integer \( t \) divisible by \( t_3 \), the length of element \( g_{\rho_t} \) in group \( G_{mn}(t) \) is equal to \( r \). Thus, if \( t = t_1t_2t_3 \) then in group \( G_{mn}(t) \), elements \( f_{\rho_t} \) and \( g_{\rho_t} \) have the reduced forms

\[
    (x_1\rho_t)(x_2\rho_t) \cdots (x_r\rho_t) \quad \text{and} \quad (y_1\rho_t)(y_2\rho_t) \cdots (y_r\rho_t)
\]

respectively and element \( x_i\rho_t \) is not in the double coset \( H(t)(y_i\rho_t)H(t) \). Again, by Proposition 1.3 these elements are not \( H(t) \)-conjugate.

Case 3. We now consider the case, when for any \( i = 1, 2, \ldots, r \) elements \( x_i \) and \( y_i \) lie in the same free factor \( A \) or \( B \) and also determine the same double coset modulo \( (H, H) \). We prove some lemmas.

Lemma 1. Let elements \( x \) and \( y \) of one of groups \( A \) or \( B \) do not belong to subgroup \( H \) and \( x \in HyH \), i. e.

\[
    x = c^\alpha d^\beta yc^\gamma d^\delta
\]

for some integers \( \alpha, \beta, \gamma \) and \( \delta \). If elements \( x \) and \( y \) belong to group \( A \), then integers \( \alpha + \gamma, \beta \) and \( \delta \) are uniquely determined by the equality (2). If elements \( x \) and \( y \) belong to group \( B \), then integers \( \beta + \delta, \alpha \) and \( \gamma \) are uniquely determined by equality (2).

Proof. Let elements \( x \) and \( y \) belong to subgroup \( A \) and let \( x = c^{\alpha_1}d^{\beta_1}yc^{\gamma_1}d^{\delta_1} \) and \( x = c^{\alpha_2}d^{\beta_2}yc^{\gamma_2}d^{\delta_2} \) for some integers \( \alpha_1, \beta_1, \gamma_1, \delta_1, \alpha_2, \beta_2, \gamma_2 \) and \( \delta_2 \). Rewriting the equality \( c^{\alpha_1}d^{\beta_1}yc^{\gamma_1}d^{\delta_1} = c^{\alpha_2}d^{\beta_2}yc^{\gamma_2}d^{\delta_2} \) as \( y^{-1}c^{\alpha_1-\alpha_2}d^{\beta_1-\beta_2}y = c^{\gamma_2-\gamma_1}d^{\delta_2-\delta_1} \), then, by Proposition 2.1, we conclude that \( c^{\alpha_1-\alpha_2}d^{\beta_1-\beta_2} = c^{\gamma_2-\gamma_1}d^{\delta_2-\delta_1} \) and also that this
element should belong to subgroup \(<c\), i. e. \(\beta_1 - \beta_2 = \delta_2 - \delta_1 = 0\). So, we have \(c^{\alpha_1 - \alpha_2} = c^{\gamma_2 - \gamma_1}\) and since the order of element \(c\) is infinite, then \(\alpha_1 - \alpha_2 = \gamma_2 - \gamma_1\).

Thus, \(\beta_1 = \beta_2, \delta_1 = \delta_2\) and \(\alpha_1 + \gamma_1 = \alpha_2 + \gamma_2\) as it was required. The case when elements \(x\) and \(y\) belong to group \(B\) is esteemed similarly.

**Lemma 2.** Let elements \(x\) and \(y\) of one of groups \(A(t)\) or \(B(t)\) do not belong to subgroup \(H(t)\) and \(x \in H(t)yH(t)\), i. e.

\[
x = (cH^t)^\alpha(dH^t)^\beta y(cH^t)^\gamma(dH^t)^\delta
\]

for some integers \(\alpha, \beta, \gamma\) and \(\delta\). If elements \(x\) and \(y\) belong to group \(A(t)\), then integers \(\alpha + \gamma, \beta\) and \(\delta\) are uniquely determined modulo \(t\) by equality (3). If elements \(x\) and \(y\) belong to group \(B(t)\), then integers \(\beta + \delta, \alpha\) and \(\gamma\) are uniquely determined modulo \(t\) by equality (3).

The proof of lemma 2 is completely similar to that of lemma 1.

**Lemma 3.** Let \(f = x_1x_2 \ldots x_r\) and \(g = y_1y_2 \ldots y_r\) be reduced forms of elements \(f\) and \(g\) of group \(G_{mn}\), where \(r > 1\) and let for every \(i = 1, 2, \ldots, r\) the equality \(x_i = u_i y_i v_i\) holds, for some elements \(u_i\) and \(v_i\) of subgroup \(H\). Then there exists at most one sequence \(h_0, h_1, h_2, \ldots, h_r\) of elements of subgroup \(H\) such that for any \(i = 1, 2, \ldots, r\)

\[
x_i = h_{i-1}^{-1} y_i h_i.
\]

Moreover, if \(u_i = c^{\alpha_i d^{\beta_i}}\) and \(v_i = c^{\gamma_i d^{\delta_i}}\) for some integers \(\alpha_i, \beta_i, \gamma_i\) and \(\delta_i\) (\(i = 1, 2, \ldots, r\)) and \(x_1, y_1 \in A\), then such sequence exists if, and only if, for any \(i, 1 < i < r,\)

\[
\begin{align*}
\alpha_i + \alpha_{i+1} + \gamma_i - 1 + \gamma_i &= 0, \text{ if } i \text{ is odd, and} \\
\beta_i + \beta_{i+1} + \delta_i - 1 + \delta_i &= 0, \text{ if } i \text{ is even.}
\end{align*}
\]

**Proof.** We suppose first that the sequence \(h_0, h_1, h_2, \ldots, h_r\) of elements of subgroup \(H\), satisfying equality (4), exists and let’s write its elements as \(h_i = c^{\mu_i d^{\nu_i}}\), for some integers \(\mu_i\) and \(\nu_i\).

Then, since for any \(i = 1, 2, \ldots, r\) the equality \(h_{i-1}^{-1} y_i h_i = u_i y_i v_i\) holds, we have

\[
y_i^{-1} (h_{i-1} u_i) y_i = h_i v_i^{-1}.
\]

As \(r > 1\), then every element \(y_i\), belonging to one of the subgroups \(A\) or \(B\), does not lie in subgroup \(H\), and consequently, from Proposition 2.1, for any \(i = 1, 2, \ldots, r\), we have the equality \(h_{i-1} u_i = h_i v_i^{-1}\). Substituting the expressions of elements \(h_i, u_i\) and \(v_i\), we have for every \(i = 1, 2, \ldots, r\)

\[
c^{\mu_{i-1} + \alpha_i d^{\nu_{i-1} + \beta_i}} = c^{\mu_i - \gamma_i d^{\nu_i - \delta_i}}
\]

and hence we obtain the system of numeric equations

\[
\mu_{i-1} + \alpha_i = \mu_i - \gamma_i, \quad \nu_{i-1} + \beta_i = \nu_i - \delta_i \quad (i = 1, 2, \ldots, r).
\]
Since by (6) for every \( i = 1,2,\ldots,r \) element \( h_i v_i^{-1} \) belongs to the intersection \( y_i^{-1} H y_i \cap H \) and, by supposition, elements \( y_1, y_3, \ldots \) belong to subgroup \( A \) and elements \( y_2, y_4, \ldots \) belong to subgroup \( B \), then from Proposition 2.1, it follows that for odd \( i \), we should have \( h_{i-1} u_i = h_i v_i^{-1} \in \langle c \rangle \), and for even \( i \), we should have \( h_{i-1} u_i = h_i v_i^{-1} \in \langle d \rangle \).

It means that for every odd \( i \) \( (i = 1,2,\ldots,r) \) we have the equalities \( \nu_{i-1} + \beta_i = 0 \) and \( \nu_i - \delta_i = 0 \), and for every even \( i \) \( (i = 1,2,\ldots,r) \) we have the equalities \( \mu_{i-1} + \alpha_i = 0 \) and \( \mu_i - \gamma_i = 0 \).

Hence, the values of the integers \( \mu_i \) and \( \nu_i \) are determined uniquely. Namely,

\[
\mu_i = \begin{cases} 
\gamma_i, & \text{if } i \text{ is even and } 2 \leq i \leq r \\
-\alpha_{i+1}, & \text{if } i \text{ is odd and } 1 \leq i \leq r - 1,
\end{cases}
\]  

and

\[
\nu_i = \begin{cases} 
-\beta_{i+1}, & \text{if } i \text{ is even and } 0 \leq i \leq r - 1 \\
\delta_i, & \text{if } i \text{ is odd and } 1 \leq i \leq r,
\end{cases}
\]

Moreover, from the equalities (7) it follows, that

\[
\begin{align*}
\mu_0 &= - (\alpha_1 + \alpha_2 + \gamma_1), \\
\nu_r &= \beta_r + \delta_{r-1} + \delta_r, & \text{if } r \text{ is even,} \\
\mu_r &= \alpha_r + \gamma_{r-1} + \gamma_r, & \text{if } r \text{ is odd.}
\end{align*}
\]  

Thus, the statement that there can exist at most one sequence of elements \( h_0, h_1, h_2, \ldots, h_r \) of subgroup \( H \) satisfying the equalities (4) is demonstrated.

Substituting the value \( \mu_{i-1} = \gamma_{i-1} \) and \( \mu_i = -\alpha_{i+1} \) defined in (8) in the equalities \( \mu_{i-1} + \alpha_i = \mu_i - \gamma_i \) of system (7), where \( 1 < i < r \) and \( i \) is odd, we obtain \( \alpha_i + \alpha_{i+1} + \gamma_{i-1} + \gamma_i \). Similarly, substituting the value \( \nu_{i-1} = \delta_{i-1} \) and \( \nu_i = -\beta_{i+1} \) defined in (9) in the equalities \( \nu_{i-1} + \beta_i = \nu_i - \delta_i \) of systems (7), where \( 1 < i < r \) and \( i \) is even, we obtain \( \beta_i + \beta_{i+1} + \delta_{i-1} + \delta_i = 0 \).

Thus, under the existence in subgroup \( H \) of sequence \( h_0, h_1, h_2, \ldots, h_r \) of elements satisfying (4), conditions (5) are satisfied.

Conversely, suppose conditions (5) are satisfied. Let

\[
h_0 = c^{-(\alpha_1 + \alpha_2 + \gamma_1)} d^{-\beta_1}
\]

and for all indexes \( i \) such that \( 1 \leq i < r \), we set

\[
h_i = \begin{cases} 
c^{\gamma_i} d^{-\beta_{i+1}}, & \text{if } i \text{ is even,} \\
-c^{-\alpha_{i+1}} d^{\delta_i}, & \text{if } i \text{ is odd.}
\end{cases}
\]

At last, for \( i = r \) we set

\[
h_r = \begin{cases} 
c^{\gamma_r} d^{\beta_r + \delta_{r-1} + \delta_r}, & \text{if } r \text{ is even,} \\
-c^{\alpha_r + \gamma_{r-1} + \gamma_r} d^{\delta_r}, & \text{if } r \text{ is odd.}
\end{cases}
\]
Let’s show that, the so defined sequence of elements $h_0, h_1, h_2, \ldots, h_r$ really fits to the equalities (4).

If $i = 1$, using the permutability of elements $c$ and $y_1$ we have

$$h_0^{-1}y_1h_1 = c^{\alpha_1+\alpha_2+\gamma_1}d^{\beta_1}y_1c^{-\alpha_2}d^{\delta_1} = c^{\alpha_1}d^{\beta_1}y_1c^{\gamma_1}d^{\delta_1} = x_1.$$  

If $1 < i < r$ and integer $i$ is even, using the equality $\beta_i + \beta_{i+1} + \delta_{i-1} + \delta_i = 0$ and permutability of elements $d$ and $y_i$, we have

$$h_{i-1}^{-1}y_ih_i = c^{\alpha_i}d^{-\delta_{i-1}}y_ic^{\gamma_i}d^{-\beta_{i+1}} = c^{\alpha_i}y_ic^{\gamma_i}d^{-(\delta_{i-1}+\beta_{i+1})} = c^{\alpha_i}y_ic^{\gamma_i}d^{\delta_i} = x_i.$$  

If $1 < i < r$ and integer $i$ is odd, using the equality $\alpha_i + \alpha_{i+1} + \gamma_{i-1} + \gamma_i = 0$ and permutability of elements $c$ and $y_i$, we have

$$h_{i-1}^{-1}y_ih_i = c^{-\gamma_{i-1}}d^{\beta_i}y_ic^{-\alpha_{i+1}}d^{\delta_i} = c^{-\gamma_{i-1}+\alpha_{i+1}}d^{\beta_i}y_id^{\delta_i} = c^{\alpha_i+\gamma_i}d^{\beta_i}y_id^{\delta_i} = x_i.$$  

If integer $r$ is even, then

$$h_{r-1}^{-1}y_rh_r = c^{\alpha_r}d^{-\delta_{r-1}}y_rc^{\gamma_r}d^{\beta_r+\delta_{r-1}+\delta_r} = c^{\alpha_r}d^{\beta_r}y_rc^{\gamma_r}d^{\delta_r} = x_r,$$

and if $r$ is odd, then

$$h_{r-1}^{-1}y_rh_r = c^{-\gamma_{r-1}}d^{\beta_r}y_rc^{\gamma_r+\gamma_{r-1}+\gamma_r}d^{\delta_r} = c^{\alpha_r}d^{\beta_r}y_rc^{\gamma_r}d^{\delta_r} = x_r.$$  

Lemma 3 is completely demonstrated.

Similar argument gives the

**Lemma 4.** Let $f = x_1x_2\cdots x_r$ and $g = y_1y_2\cdots y_r$ be reduced forms of elements $f$ and $g$ of group $G_{mn}(t)$, where $r > 1$, and let for every $i = 1, 2, \ldots, r$ the equality $x_i = u_iv_iv_i$ takes place, for some elements $u_i$ and $v_i$ of subgroup $H(t)$. Then there exists at most one sequence $h_0, h_1, h_2, \ldots, h_r$ of elements of subgroup $H(t)$ such that for any $i = 1, 2, \ldots, r$, we have

$$x_i = h_{i-1}^{-1}y_ih_i.$$  

Moreover, if $u_i = (cH^t)^{\alpha_i}(dH^t)^{\beta_i}$ and $v_i = (cH^t)^{\gamma_i}(dH^t)^{\delta_i}$ for some integers $\alpha_i$, $\beta_i$, $\gamma_i$ and $\delta_i$ ($i = 1, 2, \ldots, r$) and $x_1, y_1 \in A(t)$, then such sequence exist if and only if for any integer $i$, $1 < i < r$, we have

$$\alpha_i + \alpha_{i+1} + \gamma_{i-1} + \gamma_i \equiv 0 \pmod{t}, \text{ if } i \text{ is odd, and}$$

$$\beta_i + \beta_{i+1} + \delta_{i-1} + \delta_i \equiv 0 \pmod{t}, \text{ if } i \text{ is even.}$$
We can now end the consideration of case 3 and thus complete the proof of Proposition 3.1.

By Proposition 1.3, elements $f$ and $g$ are $H$-conjugate if and only if their cyclic permutation $x_2 \cdots x_r x_1$ and $y_2 \cdots y_r y_1$ are $H$-conjugate. Therefore, we can suppose, without loss of generality, that elements $x_1$ and $y_1$ belong to subgroup $A$.

By supposition, for every $i = 1, 2, \ldots, r$ there exist integers $\alpha_i$, $\beta_i$, $\gamma_i$ and $\delta_i$ such that
\[
x_i = c^{\alpha_i} d^{\beta_i} y_i c^{\gamma_i} d^{\delta_i}.
\]

If integer $i$, $1 < i < r$, is even, then $y_i \in B$, $y_{i-1}, y_{i+1} \in A$ and consequently, from Lemma 1, integers $\beta_i + \delta_i$, $\delta_{i-1}$ and $\delta_{i+1}$ do not depend from the particular expressions of the elements $x_i$ (in the form $x_i = u y_i v$, where $u, v \in H$), and these integers are uniquely determined by the sequences $x_1, x_2, \ldots, x_r$ and $y_1, y_2, \ldots, y_r$. Similarly, for any odd $i$, $1 < i < r$, integers $\alpha_i + \gamma_i$, $\gamma_{i-1}$ and $\alpha_{i+1}$ are uniquely determined by these sequences. It means, in turn, that the satisfiability of conditions (5) of Lemma 3 depends only on the sequences $x_1, x_2, \ldots, x_r$ and $y_1, y_2, \ldots, y_r$.

Let’s now consider conditions (5) of Lemma 3 are not satisfied, i.e. either for some even $i$, $1 < i < r$, the sum $\beta_i + \beta_{i+1} + \delta_{i-1} + \delta_i$ is different from zero, or for some odd $i$, $1 < i < r$, the sum $\alpha_i + \alpha_{i+1} + \gamma_{i-1} + \gamma_i$ is different from zero. Then it is possible to find an integer $t_1 > 1$, not dividing the respective sum. Let’s also choose, according to Proposition 2.5, the integers $t_2 > 1$ and $t_3 > 1$ such that for all positive integer $t$, divisible by $t_2$, the length of element $f \rho_t$ in group $G_{mn}(t)$ is equal to $r$, and for all positive integer $t$, divisible by $t_3$, the length of element $g \rho_t$ in group $G_{mn}(t)$ is equal to $r$. Then if $t = t_1 t_2 t_3$, in group $G_{mn}(t)$ elements $f \rho_t$ and $g \rho_t$ have reduced forms
\[
(x_1 \rho_t) (x_2 \rho_t) \cdots (x_r \rho_t) \quad \text{and} \quad (y_1 \rho_t) (y_2 \rho_t) \cdots (y_r \rho_t)
\]
respectively. Further, for every $i = 1, 2, \ldots, r$,
\[
x_i \rho_t = (c H^t)^{\alpha_i} (d H^t)^{\beta_i} (y_i \rho_t) (c H^t)^{\gamma_i} (d H^t)^{\delta_i}.
\]

From Lemma 2 and the selection of integer $t_1$ if follows that for elements $f \rho_t$ and $g \rho_t$, conditions (12) of Lemma 4 are not satisfied. Therefore from this lemma and Proposition 1.3, elements $f \rho_t$ and $g \rho_t$ are not $H(t)$-conjugate in group $G_{mn}(t)$.

Let now the reduced forms of elements $f$ and $g$ satisfy conditions (5) of Lemma 3. Then according to this lemma, in subgroup $H$ there exists the only sequence of elements $h_0, h_1, h_2, \ldots, h_r$ such that for any $i = 1, 2, \ldots, r$, we have $x_i = h_{i-1}^{-1} y_i h_i$. Since elements $f$ and $g$ are not $H$-conjugate, then elements $h_0$ and $h_r$ should be different. Since group $G_{mn}$ is residually finite, by Proposition 2.3 there exists an integer $t_1 > 1$ such that $h_0 \rho_{t_1} \neq h_r \rho_{t_1}$. Let’s choose one more integer $t_2$ such that in group $G_{mn}(t_2)$ elements $f \rho_{t_2}$ and $g \rho_{t_2}$ have length $r$. Then if $t = t_1 t_2$, in group $G_{mn}(t)$, $h_0 \rho_t \neq h_r \rho_t$, elements $f \rho_t$ and $g \rho_t$ have reduced forms
\[
(x_1 \rho_t) (x_2 \rho_t) \cdots (x_r \rho_t) \quad \text{and} \quad (y_1 \rho_t) (y_2 \rho_t) \cdots (y_r \rho_t)
\]
respectively and for every $i = 1, 2, \ldots, r$

$$x_i \rho t = (cH^t)^\alpha_i (dH^t)^\beta_i (y_i \rho t)(cH^t)^\gamma_i (dH^t)^\delta_i.$$ 

Moreover, in group $G_{mn}(t)$, for any $i = 1, 2, \ldots, r$, the equality

$$x_i \rho t = (h_{i-1} \rho t)^{-1} (y_i \rho t)(h_i \rho t)$$

holds.

Since the sequence $h_0 \rho t, h_1 \rho t, h_2 \rho t, \ldots, h_r \rho t$ is, by Lemma 4, the unique sequence of elements of subgroup $H(t)$ satisfying these equalities, then from Proposition 1.3, elements $f \tau t$ and $g \tau t$ are not $H(t)$-conjugate in group $G_{mn}(t)$.

Hence Proposition 3.1 is completely demonstrated.

We now proceed directly to the proof of Theorem.

As remarked above, for any $t > 1$, group $G_{mn}(t)$ is conjugacy separable. Therefore, for the proof of the Theorem it is enough to show that for any two non-conjugate in group $G_{mn}$ elements $f$ and $g$ of group $G_{mn}$, there exists an integer $t > 1$ such that elements $f \rho t$ and $g \rho t$ are not conjugate in group $G_{mn}(t)$. To this end we make use of criterion of conjugacy of elements of groups $G_{mn}$ and $G_{mn}(t)$ given in Proposition 2.2.

So, let $f = x_1 x_2 \cdots x_r$ and $g = y_1 y_2 \cdots y_r$ be the reduced forms in group $G_{mn} = (A \ast B; H)$ of two non-conjugate in group $G_{mn}$ elements $f$ and $g$. By Proposition 2.2 we can assume that elements $f$ and $g$ are cyclically reduced. In accordance with this proposition we must consider separately some cases.

1. $l(f) \neq l(g)$.

From Proposition 2.5, there exists an integer $t_1 > 1$ such that for any positive integer $t$, divisible by $t_1$, the length of element $f \rho t$ in group $G_{mn}(t)$ coincides with the length of element $f$ in group $G_{mn}$. Similarly, there exists integer $t_2 > 1$ such that for any positive integer $t$, divisible by $t_2$, the length of element $g \rho t$ in group $G_{mn}(t)$ coincides with the length of element $g$ in group $G_{mn}$. Thus, if $t = t_1 t_2$ elements $f \rho t$ and $g \rho t$ of group $G_{mn}(t)$ are, as it is easy to see, cyclically reduced and have different length. Hence, by Proposition 2.2, these elements are not conjugate in this group. Thus integer $t$ is the required.

2. $l(f) = l(g) = 1$.

In this case each of these elements belongs to one of the subgroups $A$ or $B$. Suppose first that both elements lie in the same of these subgroups; let it be, for instance, subgroup $A$. Since elements $f$ and $g$ are not conjugate in group $A$ and group $A$ is conjugacy separable [4], then by Proposition 2.3 there exists an integer $t > 1$ such that in group $A(t)$ elements $f \rho t$ and $g \rho t$ are not conjugate. Proposition 2.2 now implies that elements $f \rho t$ and $g \rho t$ are not conjugate in group $G_{mn}(t)$.

Let now element $f$ belongs to subgroup $A$, element $g$ belongs to subgroup $B$ and these elements don’t belong to subgroup $H$. By Proposition 2.4, there exist integers $t_1 > 1$ and $t_2 > 1$ such that for any positive integer $t$, divisible by $t_1$, element $f \rho t$ does not belong to subgroup $H \rho t$, and for any positive integer $t$, divisible by $t_2$, element
$g_{\rho_t}$ does not belong to subgroup $H_{\rho_t}$. Then if $t = t_1 t_2$, Proposition 2.2 implies that elements $f_{\rho_t}$ and $g_{\rho_t}$ are not conjugate in group $G_{mn}(t)$.

3. $l(f) = l(g) > 1$

Let $g_i = y_i y_{i+1} \cdots y_r y_1 \cdots y_{i-1}$ ($i = 1, 2, \ldots, r$) be all the cyclic permutations of element $g$. Since elements $g$ and $g_i$ are conjugate and elements $f$ and $g$ are not conjugate, element $f$ is not $H$-conjugate to any of elements $g_1, g_2, \ldots, g_r$. It follows from Proposition 3.1 that for every $i = 1, 2, \ldots, r$, there exists an integer $t_i > 1$ such that elements $f_{\rho t_i}$ and $g_i_{\rho t_i}$ are not $H(t_i)$-conjugate in group $G_{mn}(t_i)$. Let also integer $t_0 > 1$ be chosen such that for all positive integer $t$, divisible by $t_0$, elements $f_{\rho t}$ and $g_{\rho t}$ have length $r$ in group $G_{mn}(t)$. Then if $t = t_0 t_1 \cdots t_r$ in group $G_{mn}(t)$, elements $f_{\rho t}$ and $g_{i\rho t}$ have reduced forms

$$(x_1 \rho t)(x_2 \rho t) \cdots (x_r \rho t)$$

and

$$(y_i \rho t)(y_{i+1} \rho t) \cdots (y_r \rho t)(y_1 \rho t) \cdots (y_{i-1} \rho t)$$

respectively. Furthermore, elements $f_{\rho t}$ and $g_{i\rho t}$ are not $H(t)$-conjugate in group $G_{mn}(t)$. Since an arbitrary cyclic permutation of element $g_{\rho t}$ coincides with some element $g_i\rho t$, then from Proposition 2.2 it follows that elements $f_{\rho t}$ and $g_{\rho t}$ are not conjugate in group $G_{mn}(t)$.

The proof of Theorem is now complete.

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